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Eva O. L. Lantsoght

The A–Z of the PhD Trajectory

A Practical Guide for a Successful Journey

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A Practical Guide for a Successful Journey

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To Adeline

Contents

Part I The Steps of the PhD Trajectory

1 Introduction 3
  1.1 What Can You Find in this Book? 3
  1.2 Who Can Benefit from this Book? 4
  1.3 Using this Textbook for a Class or Series of Workshops 5
  References 6

2 Getting Started with a PhD 7
  2.1 Introduction and Learning Goals 7
  2.2 Familiarizing Yourself with Your New Workplace and Your New City 8
    2.2.1 Sorting Out Your Paperwork 8
    2.2.2 Getting Settled in Your New Workplace 8
    2.2.3 Exploring Your New Institution 9
    2.2.4 Exploring Your New City 10
  2.3 Discussing Mutual Expectations with Your Promotor 11
  2.4 Start Documenting Your Journey 13
    2.4.1 Setting Up a Research Journal and a Lab Book 13
    2.4.2 Log Your Activities 13
    2.4.3 How to Start Writing Early on 15
    2.4.4 Figure Out Your Data Storage Protocol 16
  2.5 Make a Rough Outline of Your Days/Weeks 19
    2.5.1 Plan the Outline of Your Days 19
    2.5.2 Eat, Move, Sleep 21
    2.5.3 Determine Your Non-negotiable Self-Care Activities 22
    2.5.4 On Creating Nurturing Morning Routines 23
    2.5.5 On Rolling with the Punches of Academia 23
  2.6 Summary 24
  Further Reading and References 25

3 Planning Your Time 27
3.1 Introduction and Learning Goals 27
3.2 Planning Your PhD 28
3.2.1 Determining Your Milestones 28
3.2.2 Setting Yourself Up for Success per Semester 30
3.2.3 Your Weekly Template 32
3.2.4 Defining Your Ideal Day 35
3.2.5 Applying the Weekly Template 37
3.2.6 On Rigidity in Schedules 38
3.2.7 On Learning How to Take Your Self-Imposed Deadlines Seriously 39
3.2.8 When Procrastination Hijacks Your Planning 40
3.2.9 Tools for Assisting Your Planning 41
3.3 Managing Your Time and Research 44
3.3.1 Project Management Basics 44
3.3.2 Tracking Your Time 46
3.3.3 Prioritizing 46
3.3.4 Using Lists Effectively 48
3.4 Self-Care and Taking Time to Take Care of Yourself 49
3.4.1 Planning Self-Care, Sleep, Movement, and Food 49
3.4.2 How to Break Out of Unhealthy Patterns 50
3.4.3 Reward Yourself for Sticking to Your Plan 52
3.5 Summary 52
Further Reading and References 53

4 Developing Your Literature Review 55
4.1 Introduction and Learning Goals 55
4.2 Browsing the Academic Literature 56
4.2.1 How to Find References 56
4.2.2 On Reading Broadly and Deeply 59
4.3 Processing References 61
4.3.1 Storing References 61
4.3.2 Engaging with the Literature 62
4.4 Finalizing Your Literature Review 65
4.4.1 When Have You Read Enough? 65
4.4.2 Bringing Everything Together 66
4.4.3 Keeping Track of the Literature After Finishing the Literature Review 69
4.5 The Next Step: Turning Your Literature Review into a Dissertation Chapter and Journal Paper 71
4.5.1 Turning Your Literature Review into a Dissertation Chapter 71
4.5.2 Turning Your Literature Review into a Journal Paper 72
4.6 Summary 73
Further Reading and References 73

5 Formulating Your Research Question 75
5.1 Introduction and Learning Goals 75
5.2 From Literature Review to Research Question 76
5.2.1 Identifying Gaps in the Knowledge 76
5.2.2 Self-Assessing Your Research Question 78
5.2.3 Creative Thinking 78
5.2.4 Convincing Your Supervisor of Your Research Question 82
5.3 Putting Your Research Question to Action 82
5.3.1 From Research Question to Subquestions 82
5.3.2 From Research Subquestions to Dissertation Chapters 84
5.3.3 From Research Subquestions to Actions and Planning 85
5.4 Summary 87
Further Reading and References 87

6 Preparing and Executing Experiments 89
6.1 Introduction and Learning Goals 89
6.2 Towards Your First Test Setup 90
6.2.1 Using the Literature Review to Define What You Want to Test 90
6.2.2 Designing Experimental Setups 91
6.2.3 Planning and Logistics for Your First Test 92
6.3 Managing a Series of Experiments 94
6.3.1 The Importance of Your Lab Book 94
6.3.2 Project Management Essentials 97
6.4 Thriving in the Lab 99
6.4.1 Making Friends 99
6.4.2 Staying Calm in the Face of Adversity 101
6.4.3 Processing Your Data 102
6.5 Reporting Experiments 103
6.5.1 Developing Your Experimental Report 103
6.5.2 From Experimental Report to Dissertation Chapter 104
6.5.3 From Experimental Report to Journal Paper 105
6.6 Summary 106
Further Reading and References 107

7 Honing Your Academic Writing Skills 109
7.1 Introduction and Learning Goals 109
7.2 Structuring Writing 110
7.2.1 Determining What You Need to Convey 110
7.2.2 Outlining Your Writing 111
7.2.3 Planning Your Writing 113
7.3 Finding Your Voice 117
7.3.1 Writing Styles and Document Types 117
7.3.2 Finding Your Voice Through Blogging 118
7.3.3 Practicing Writing to Develop Your Voice 119
7.3.4 On Expertise and Authority 123

7.4 Tips for Non-native Speakers of English ... 125
7.4.1 Typical Pitfalls for Non-native Speakers ... 125
7.4.2 Improving Your (Technical) English ... 126
7.4.3 Finding Your Voice in a Foreign Language ... 127
7.5 Tips for Productive Academic Writing ... 128
7.5.1 Best Practices for Productive Academic Writing ... 128
7.5.2 Dealing with Writer's Block ... 132
7.5.3 Fitting Writing into Your Schedule ... 133
7.6 Summary ... 134
Further Reading and References ... 135

8 Presenting Your Work ... 137
8.1 Introduction and Learning Goals ... 137
8.2 Preparing for a Presentation ... 138
8.2.1 Planning Towards a Presentation ... 138
8.2.2 Selecting Your Tools ... 140
8.3 Types of Presentations ... 140
8.3.1 Lectern Presentations ... 140
8.3.2 Poster Presentations ... 145
8.3.3 Presentations Without Slides ... 148
8.4 Tips for Non-native English Speakers and for Presenting in Different Languages ... 149
8.4.1 Improving Your Presenting Skills in Technical English ... 149
8.4.2 Presenting in Another Language ... 150
8.5 Best Practices for Successful Presentations ... 151
8.5.1 How to Gain Confidence in Presenting ... 151
8.5.2 Presentation Aftermath ... 152
8.6 Summary ... 154
Further Reading and References ... 154

9 Communicating Science in the Twenty-First Century ... 157
9.1 Introduction and Learning Goals ... 157
9.2 Blogging as a Researcher ... 158
9.2.1 Single-Author Blogs ... 158
9.2.2 Guest Posting ... 161
9.2.3 Multi-author Blogs ... 162
9.2.4 Benefits of Blogging ... 163
9.2.5 Barriers to Blogging ... 164
9.3 Twitter for Researchers ... 165
9.3.1 How to Engage with an Audience ... 165
9.3.2 Curating Content Through Storify ... 169
9.4 Online Branding for Scientists ... 170
9.5 Summary ... 173
Further Reading and References ... 173

10 Preparing for Your First Conference 175
10.1 Introduction and Learning Goals 175
10.2 Selecting a Conference 176
10.3 Selecting a Topic 178
10.3.1 The Right Topic for the Conference 178
10.3.2 Ideas for a Conference Paper 178
10.4 Planning Towards a Conference 181
10.4.1 Plan Your Time 181
10.4.2 Plan Your Activities to Get Ready 186
10.4.3 Prepare Your Outfits 188
10.5 Getting Most Out of a Conference 191
10.5.1 Navigating the Conference Schedule 191
10.5.2 Navigating the Attendants 192
10.5.3 Interacting During Sessions 193
10.5.4 Essential Self-Care 194
10.6 Summary 195
Further Reading and References 196

11 Writing Your First Journal Article 197
11.1 Introduction and Learning Goals 197
11.2 Selecting a Journal 198
11.2.1 Audience of a Journal 198
11.2.2 Impact Factor and Rankings 198
11.2.3 Open Access Publishing 201
11.3 Planning Towards Your First Draft 202
11.3.1 Finding Time for Writing – Slow and Steady 202
11.4 Planning Towards Submission 207
11.5 Writing a Good Abstract 209
11.5.1 How to Write an Abstract in 30 Minutes 209
11.6 Writing a Cover Letter 210
11.7 The Review Process 210
11.7.1 Timeline of Reviews 210
11.7.2 How to Implement Reviewers’ Comments 215
11.7.3 How to Reply to Reviewers’ Comments 215
11.8 Dealing with Rejection 218
11.8.1 The Reality of Rejection 218
11.8.2 How to Face Rejection 219
11.8.3 How to Move Forward and Resubmit Elsewhere 219
11.9 Writing Your Next Paper(s) 221
11.9.1 Identify Topics 221
11.9.2 Become a Productive Writer 223
11.9.3 Juggling Different Papers 225
11.10 Summary 227
Further Reading and References 228

12 Compiling Your Work into a Dissertation 229
12.1 Introduction and Learning Goals 229
12.2 Planning Towards Your Dissertation 230
12.2.1 How to Plan Your Dissertation 230
12.2.2 How to Kick-Start Your Writing 233
12.2.3 When to Start Writing 234
12.2.4 Writing Propositions 235
12.3 Structuring a Dissertation 236
12.3.1 How to Outline Your Dissertation 236
12.4 Staying Motivated When Writing Your Dissertation 238
12.4.1 A Little Goes a Long Way 238
12.4.2 How to Stay Motivated and Balanced 239
12.5 Writing the Introduction and Conclusions Chapters 241
12.5.1 How and When to Write Your Introduction 241
12.5.2 How to Write Conclusions 242
12.5.3 How to Identify Future Work 245
12.6 Implementing Comments of Committee Members 246
12.6.1 How to Compile a Balanced Committee 246
12.6.2 How to Implement Comments of Your Committee 248
12.7 Defending Your Thesis 248
12.7.1 From Finished Thesis to Defense 248
12.7.2 How to Prepare for Your Thesis Defense 249
12.7.3 Surviving Defense-Day 253
12.8 Summary 253
Further Reading and References 255

13 Navigating Career Options After Your PhD 257
13.1 Introduction and Learning Goals 257
13.2 Life After the Defense 258
13.2.1 Letting It All Sink In 258
13.2.2 Figuring Out What to Do Next 260
13.3 Career Options 261
13.3.1 Overview of Options 261
13.4 The Benefit of Your Academic Skills When Searching for a Job 265
13.4.1 Preparing Your Documents 265
13.4.2 Highlighting Your Unique Academic Skills 267
13.4.3 Attending Career Events 269
13.5 Tips for Success in Academia 272
13.5.1 Transitioning from PhD Student to Faculty Member 272
13.5.2 Becoming an Independent Researcher 275
13.6 Tips for Success in the Industry 277
13.7 Some Advice for Female PhDs 278

13.8 Going Abroad as an Academic 280
    13.8.1 The International Job Market 280
    13.8.2 Academic Nomadism 282
    13.8.3 Challenges of Working at Different Institutions 283
    13.8.4 Initiating International Collaborations 284
13.9 Summary 285
Further Reading and References 286

14 Epilogue 289
14.1 Summary 289
14.2 How to Use the Glossary A–Z of Part II 292
14.3 Sources of Further Reading 292
Further Reading and References 292

Part II Glossary

15 Glossary 297
15.1 A 297
15.2 B 304
15.3 C 309
15.4 D 317
15.5 E 321
15.6 F 325
15.7 G 329
15.8 H 333
15.9 I 334
15.10 J 339
15.11 K 341
15.12 L 342
15.13 M 346
15.14 N 351
15.15 O 353
15.16 P 356
15.17 Q 365
15.18 R 366
15.19 S 370
15.20 T 380
15.21 U 385
15.22 V 387
15.23 W 388
15.24 Z 393
References 393

Part I
The Steps of the PhD Trajectory

Chapter 1
Introduction

Abstract In this book, you can find information about the major milestones in your PhD trajectory, and how to reach them. We also discuss the soft skills that support the research process. This book is mostly aimed at PhD students in sciences and engineering. In particular, the topics that are discussed in this book are: defining your research question, developing a literature review, preparing and executing experiments, time management, scientific writing, academic presentations, and preparing for a career after the PhD.

1.1 What Can You Find in this Book?

In this book, you can find information about the major milestones in your PhD trajectory, and how to reach them. We also discuss the soft skills that support the research process. This book is mostly aimed at PhD students in sciences and engineering. In particular, the topics that are discussed in this book are: defining your research question, developing a literature review, preparing and executing experiments, time management, scientific writing, academic presentations, and preparing for a career after the PhD.

You can find two parts in this book: the formal course text, which runs from Chap. 1 through 14, and a glossary with reference items, organized from A to Z. This glossary can serve as a reference for common terms related to the PhD trajectory, and you can look up terms for inspiration and advice after completion of the course. Most entries will also refer you to relevant chapters in the course text.

I have written this book as a course text for PhD students, to offer material that can support students throughout their PhD trajectory, and to turn the tide in the trend of PhD students dropping out of their programs because they are lacking the right tools or support. In the Netherlands, for example, about 15% of all PhD candidates graduate within 4 years, and 70% after 8 years [1]. In the United States, the completion rate after 10 years is 57% [2]. There are many reasons why students drop out of their PhD programs. To reduce the rates at which students drop out, a better guidance of the students is essential. This book, and associated proposed course or series of workshops, aims at giving PhD candidates the right tools to carry out their research. During your PhD trajectory, you have to learn how to do research, a skill

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nobody has taught you in the past. Traditionally, your PhD promotor[1] will teach you the ropes of doing research and take you on as his/her apprentice during your PhD trajectory. But supervisors are busy people, often supervising a large number of students. To help students learn the transferable research skills they need, universities are offering more and more courses and workshops. This book, and its associated course or series of workshops, offers a structured way for introducing research skills to PhD students. Consider this book as an invitation to explore techniques and to use what works for you. Please don't take this book as a cookbook that will exactly tell you how to get your PhD. During your PhD trajectory, you will grow from student into independent scholar, a path that is nonlinear, deeply personal, and at times very messy and confronting. For this reason, this book focuses on planning and self-reflection – steps that are different for every person on the PhD trajectory. Consider this book as your toolbox: you can use it to learn skills, and then apply these skills on an as-needed basis.

What you will learn in this book is how to achieve the goals of your PhD trajectory (i.e. fulfilling the requirements for graduation) within a reasonable amount of time. You'll learn how to identify your goals (the major milestones of the PhD trajectory), plan for them, and carry them out successfully. We'll be discussing planning, time management skills, and the ability to manage one's self and energy frequently throughout this book.

You won't find the following topics in this book: a more technical discussion on qualitative versus quantitative methods, statistical analysis of data, and programming languages. For these topics, you can refer to textbooks that address these specific elements and skills that you may or may not need during your PhD.

1.2 Who Can Benefit from this Book?

This book can be useful for:

- M.Sc. students considering a PhD in STEM fields[2]
- PhD students in STEM fields
- The supervisors of PhD students in STEM fields
- Professors and/or coaches preparing to teach a course on research for PhD students

You don't need any prior knowledge on research skills to read this book. A course on research skills can stand alone within a doctoral studies program. The chapters are written so that they are suitable as a course text in a course taught over a single academic period, taught throughout workshops, or for self-study if your university does not offer courses to support learning about research skills.

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[1] Also called: supervisor or advisor. In this book, mostly European terms are used. Where relevant, a footnote with the term used in North America is given. Further information is also available in the glossary of Part II.

[2] This book focuses on the perspective of STEM fields, but many of the general ideas are valid for a wide range of fields

The second part of the book is a reference manual that you can use throughout your PhD trajectory. You can pick up this material at any point during your PhD trajectory and explore the concepts from the second part as you need them. From the glossary, you can revisit elements of the first part. The references to the relevant chapters are provided with the glossary items.

This book is in particular written for PhD candidates in STEM fields. The general concepts are valid for all fields. Since most books about the PhD trajectory are written from the perspective of the social sciences, you can find that this book is addressing some particular topics for the STEM fields: working in a laboratory, gender and diversity issues, and we focus additional attention on the soft skills PhD students in STEM fields may not have learned in their previous studies.

1.3 Using this Textbook for a Class or Series of Workshops

This textbook can be used for the development of a course that follows the regular academic year (i.e. a course with a length of a semester, trimester, or quarter, depending on the system of your institution), or it can be used to develop a series of workshops. If you teach this course in a regular academic period, you can work systematically through the first 14 chapters of the book. The glossary can serve as a reference for the students upon completion of the course. You can also take Chaps. 7, 8 and 9, which deal with communication skills, towards the beginning of the period in which you teach this material, but preferably after covering Chaps. 2 and 3.

If possible, a series of workshops during the PhD trajectory is to be preferred to work through this material. Form groups of maximum 12 PhD students that have started their trajectory at the same time, so that they can grow together through this series of workshops. Include plenty of time for discussions and reflection. If possible, combine a longer workshop with an overnight stay away from campus for the introduction of the series of workshops, so that the students can get to know each other better. In between the different workshops, at regular time intervals, and after the formal part of this series of workshops, it is recommended to organize intervision[3] meetings every 2 or 3 months in which the group of students can meet and discuss problems they are currently facing among their peers. In Table 1.1, you can find a proposed outline for the organization of this series of workshops. You can see the planning for the intervision meetings for the first 2 years. After this, it is recommended to keep organizing these meetings every 2 or 3 months. The dates for the continuing intervision meetings are not outlined in Table 1.1, as the length of the total PhD trajectory depends on the institution, and typically takes between 3 and 5 years.

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[3] Intervision meetings are meetings among peers, as opposed to supervision meetings which take place between supervisor and student. The goal of intervision meetings is to discuss difficulties and solutions, and use these meetings as a tool for learning from your peers.

Table 1.1 Proposed timeline for a series of workshops based on this course text

Nr.	Topic	Duration	Chapters	When?
1	Toolbox for a successful start to the PhD	2 days, overnight stay	1, 2, 3, 7, 8, 9	Start of PhD
2	Literature review	1 afternoon	4	Two weeks after nr. 1
3	Research question	1 afternoon	5	3 months into the PhD
4	Experiments	1 afternoon	6	6 months into the PhD
5	First conference	2 sessions of 1 afternoon	10	8 months into the PhD
6	First intervision, with instructor as facilitator	2 hours		10 months into the PhD
7	Second intervision	2 hours		At the end of the first year
8	First journal paper	2 sessions of 1 afternoon	11	15 months into the PhD
9	Third intervision	2 hours		18 months into the PhD
10	Fourth intervision	2 hours		20 months into the PhD
11	Fifth intervision	2 hours		22 months into the PhD
12	Dissertation	4 sessions of 1 afternoon	12	At the end of the second year
13	Finding a job	3 sessions of 1 afternoon	13	18–12 months before estimated graduation date

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2. Council of Graduate Schools. (2010). Ph.D. *Completion and attrition: Analysis of baseline demographic data from the Ph.D. Completion Project*.

Chapter 2
Getting Started with a PhD

Abstract In this chapter, a number of first skills that can be useful for a beginning PhD student are revised. A first topic is "familiarizing yourself with your new workplace and your new city". You will receive tips on how to get settled in your new workplace, and which procedures you need to review with Human Resources and immigration offices. We provide advice on getting to know fellow researchers in other research groups, through lunch lectures and intersectional activities. A next topic is "discussing your mutual expectations with your promotor." While ideally most PhD students have had a chance to discuss the project and what support their host university can offer, the beginning of your PhD would be a good time to discuss your mutual expectations in more detail. A next topic, called "start documenting your journey", deals with developing a research journal, a lab book, a log of activities and other documentation that can serve you later on. In this chapter, we will focus on learning how to document work. Following this discussion, comes the topic "figure out your data storage protocol". A schedule for making backups is also discussed. With a last topic "make a rough outline of your days/weeks", we will give some first tools for finding a work-life balance, as well as the first concepts of planning and working in harmony with our natural circadian rhythms.

Keywords Getting started · Meetings · Administration · Planning · Data storage · Organization · Exploring

2.1 Introduction and Learning Goals

In this chapter, a number of skills that are useful for a beginning PhD student are introduced. We will travel together from your moment of arrival, when you get to know your new institution and city, to your first meeting with your promotor, and your first days of work.

One of the topics of this chapter is related to setting yourself up for success. Sure, you could just save all your files in one big "My PhD" folder, but your dissertation-writing self will thank you for an organized structure of your files. Likewise, you could take the beginning of your PhD as it flows, but easing yourself into working with schedules and finding a schedule that works with your energy levels through-

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out the day will be a useful skill to develop so that you can work in an organized manner once your PhD trajectory starts to pick up speed.

This chapter is chockful with suggestions and ideas. You don't have to do everything at once. Consider this chapter a toolbox that you can use as you see it fit for your situation.

2.2 Familiarizing Yourself with Your New Workplace and Your New City

2.2.1 Sorting Out Your Paperwork

Before you can get started in your new place, you need to get your paperwork all sorted out. Don't let this administration wait until problems arise – coordinate from the early beginning (i.e. before your arrival) with the international office of your new institution and with the Human Resources department. Will you be considered a student with a scholarship, or will you be considered an employee with a salary? How will this affect your current and future standing with regard to taxes, building up retirement savings, and social security?

Make sure you bring all required documentation to arrange your legal situation, including notarized copies, and, if required, translations of all your documents. Is your previous degree accepted by your new institution, or do you need to have your degree registered or approved somewhere?

Think ahead about housing – will your university help you find (temporary) housing, or should you stay in a hotel for a few days while you scout for a place to live? How easy or hard is it to find housing? Along the same lines: do you need to get a health insurance, are healthcare providers available on campus, or do you need to find them in your new city?

Lastly, inquire if there are organizations for expats in general, or expats from your home country to get in touch with. They can inform you about the ins and outs of moving to your new institution, and perhaps you might be lucky enough to take over the room and furniture of somebody who just graduated for a soft price. Ask within the university, through alumni networks, and browse on Facebook for possible groups.

2.2.2 Getting Settled in Your New Workplace

Prior to your arrival, it might be a good idea to get in touch with the secretary of the research group where you'll be working to ask about a number of details: will you get an office and a computer? How will you get your key, door access, account on the university network with e-mail address? Are there any other practical things you need to take care of (permission to print/copy, coffee card…?).

Before you hit the ground running and dive into the lab, take a few days/weeks to familiarize yourself with your new work environment. Who will you work with?

How many PhD students work for the same supervisor? Get together with more experienced PhD researchers in your lab over lunch or coffee, and ask for their advice. If possible, ask if you can work along with them for a few days to learn from their routines.

Who else is working in the laboratory? Is there technical support? If so, get to know the technicians from the beginning of your research journey. You are part of a team, so show your team spirit and learn from the technicians – some of them might have been in your lab for 20 years and know exactly what all the noobs do wrong when they start. It's not because they may not have a PhD degree that they are not experienced in experimental work.

To familiarize yourself with your new workplace, ask a senior PhD student or lab technician for a tour. Ask them to show you what's inside of every cupboard, and what every machine does. Does your research group have a library of its own, maybe a collection of hard-to-find conference proceedings from colleagues who went there? You might not need everything at day 1 of your research, but it's good to know what is available and where to find it. By seeing what is possible in your research group, you may even get a few ideas.

Along the same lines, when you get a tour, make sure to note down for yourself where to find whichever product you need, or where to find those conference proceedings from 1996. Nothing is as annoying as having to explain the newbie four times in a row in which cupboard the markers are hiding.

Finally, I encourage you to get acquainted with the etiquette of your lab and/or research group. How do your fellow researchers work? When do people start working, when do they take a coffee break? When do you clean up after experiments? What are the opening hours of the laboratory and/or your building? Learn about the customs of the lab, and adhere to the unwritten rules of your lab. Again, you're in a team, you're not a lone wolf looking for mischief.

2.2.3 Exploring Your New Institution

Let's take it one step broader. Now that you've started to explore your research group and lab, start to familiarize yourself with your new institution and campus as well. Is there an orientation for new graduate students you can join, or an invitation for new employees to learn more about the institution?

Where are the restaurants? When are they open? Where can you find food at 10 pm, if needed? Where can you find coffee very early in the morning?

If something goes wrong – where can you find the nearest doctor, nurse and/or pharmacy? Is healthcare provided on your campus? Are there sports facilities on your campus? How can you join? Are there other clubs related to arts and hobbies on campus that are of your interest? What kind of activities are organized and when?

Where is the library? To which journals do you have access? How can you take advantage of the services offered by the library? Many libraries organize short workshops to introduce themselves and their services to new students – go and take advantage of that.

What other services and support can your university offer? Are there organized services such as intervision,[1] mentoring, and career advice? Is there psychological support and/or coaching available? Who can you talk to in confidence when you have a disagreement with your supervisor? Are employees unionized, does your type of contract allow you to join a union, and would joining a union be interesting for you? How can you access these resources?

In terms of research, which other research groups are involved with work of your interest? How can you get to know them? Do they present at occasional (lunch) lectures that you can attend? Are there intersectional activities you can attend?

2.2.4 Exploring Your New City

So, where did you end up living for the next three years or more? Explore your new city and its different neighborhoods. Where can you go and hang out during the weekends, on a sunny day, or during the cold months of winter? Which stores are open late during the week for when you need to buy groceries after a late class or a long day in the lab? How do you get around your new city? Is there (reliable) public transportation? Is it safe to return home late in the evening?

If you have a partner and/or children, identify places where you can go as a family on the weekend. Which options do you have for childcare and schools? If your partner does not work, are there groups for partners of international candidates? Can your partner volunteer for a cause?

Exercises

Time for your grand entrance into your new research group, institution, and city. Let's roll out the red carpet!

1. Celebrate your arrival by organizing a drink or cake-and-coffee get-together with your new colleagues. Ask the secretary or another fixed value in your research group how people take their breaks. If it's coffee breaks, bring cake (or maybe a typical snack or candy from your home country) to the coffee table to share with your new colleagues, so you can get to know them better.
2. Sign up for a tour of your new institution, or ask a senior PhD student if he/she has time to give you a tour along the facilities.
3. Check the five top things to do on Tripadvisor or a similar website for your new city, and go do these things. Doing so will enable you to get to know your new city a bit better, and if you don't make these visits at the beginning of your PhD, chances are you will never be able to find time for it.[2]

---

[1] Meetings between peers. For more information, refer to the glossary in Part II.

[2] Admittedly, that sounds as if doing a PhD means you will not have a life. But what I meant is that, once you live a certain amount of time in a city, you simply feel less inclined to go do all the touristy things. So go ahead and have fun while you still see your new city with fresh eyes.

2.3 Discussing Mutual Expectations with Your Promotor

While ideally most PhD students have had a chance to discuss about the project and what support their host university can offer, the beginning of your PhD is a good time to discuss your mutual expectations in more detail with your promotor.[3] Where are you starting from? Is there a proposal, or an updated version of the research proposal? Which deliverables need to be submitted to the funding body, and when? Where can you find the first references to start reading about the topic? Does your supervisor outline a direction for your research, or should you determine the direction of your research?

In practical terms, discuss with your promotor how you will work together [1]. How often will you meet? Will you have a meeting every week, or will you meet when you have results? How should you communicate your results: with short reports, with short presentations, or by sketching on a whiteboard? How often are you expected to keep your promotor posted about your work? Will you have a senior colleague stepping up as daily supervisor, or do you work solely with your promotor?

Are you expected to teach? If you are hired as a teaching assistant, the answer is easy. If you are, on the other hand, hired as a junior employee (as is often the case in Europe), you might not be entirely sure about what is expected from you in terms of teaching and supervising students. Will you be a teaching assistant, guiding students with their homeworks and projects, will you have a guest lecture once in a while, or will you be expected to step up and teach the lectures when your promotor is traveling?

How about conferences? Which conferences will you receive funding for to attend? Can you expect to receive full funding? Do you have to apply for travel scholarships, or is there a fixed budget for travel on your project?

What are the expectations with regard to publications? Will there be restrictions that apply on your publications? In some countries, PhD students are discouraged from publishing until they have finished their dissertation.[4] Other institutions will demand a number of journal papers as a graduation requirement.

Exercises

Prepare a template for your meetings [2] with your promotor and/or co-promotor.[5] For a template with explanations and ideas, see Fig. 2.1. Decide if you want to use printed copies in a binder, or digital files.

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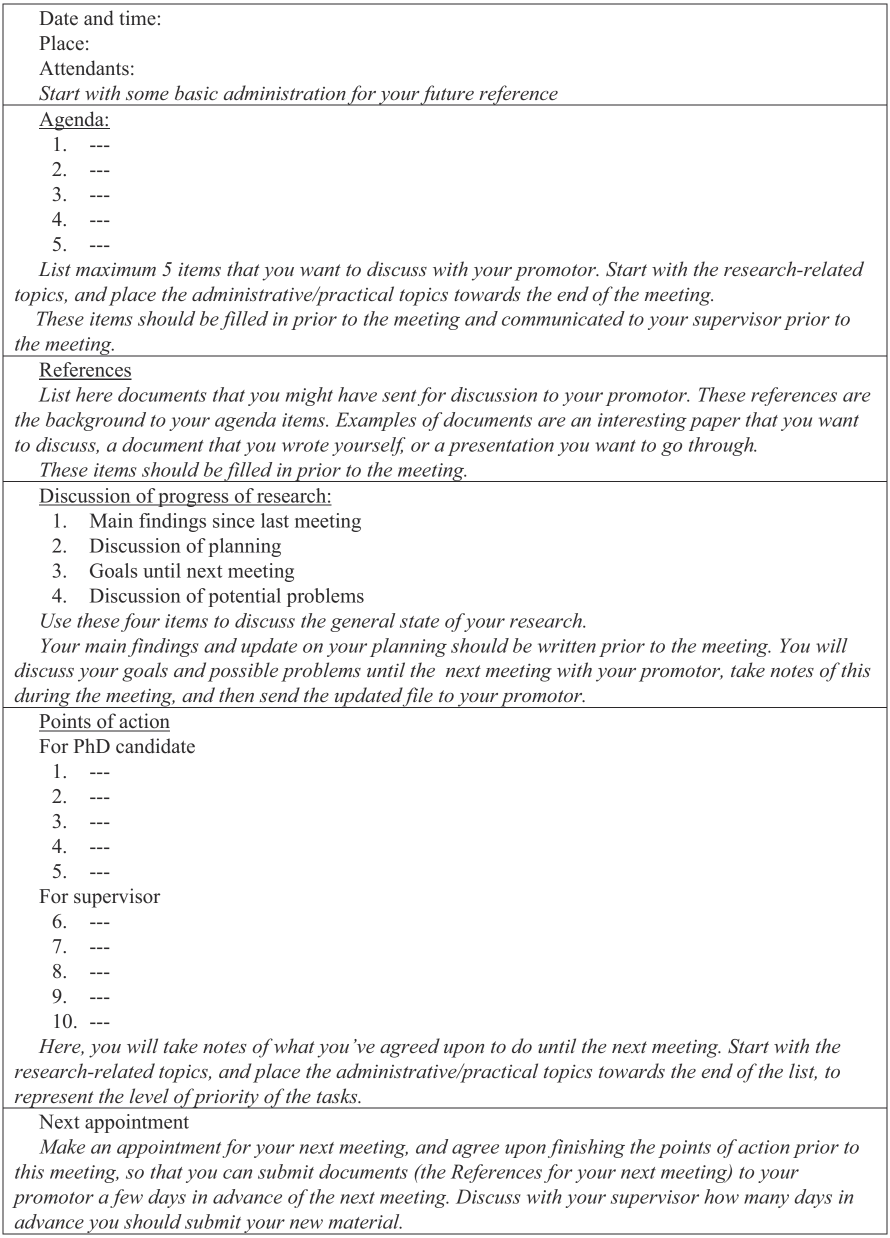
[3] Also called: advisor, supervisor.

[4] Also called: thesis.

[5] Also called: co-supervisor, co-advisor. In the Dutch context, the co-promotor can be your daily supervisor (assistant or associate professor). Until 2018, the promotor had to be a full professor in order to be legally allowed to graduate doctoral candidates, and it is still common practice that the promotor is a full professor. The co-promotor does not have to fulfil this requirement.



Date and time:
Place:
Attendants:
Start with some basic administration for your future reference

Agenda:

1. ---
2. ---
3. ---
4. ---
5. ---

List maximum 5 items that you want to discuss with your promotor. Start with the research-related topics, and place the administrative/practical topics towards the end of the meeting.

These items should be filled in prior to the meeting and communicated to your supervisor prior to the meeting.

References

List here documents that you might have sent for discussion to your promotor. These references are the background to your agenda items. Examples of documents are an interesting paper that you want to discuss, a document that you wrote yourself, or a presentation you want to go through.

These items should be filled in prior to the meeting.

Discussion of progress of research:

1. Main findings since last meeting
2. Discussion of planning
3. Goals until next meeting
4. Discussion of potential problems

Use these four items to discuss the general state of your research.

Your main findings and update on your planning should be written prior to the meeting. You will discuss your goals and possible problems until the next meeting with your promotor, take notes of this during the meeting, and then send the updated file to your promotor.

Points of action

For PhD candidate

1. ---
2. ---
3. ---
4. ---
5. ---

For supervisor

6. ---
7. ---
8. ---
9. ---
10. ---

Here, you will take notes of what you've agreed upon to do until the next meeting. Start with the research-related topics, and place the administrative/practical topics towards the end of the list, to represent the level of priority of the tasks.

Next appointment

Make an appointment for your next meeting, and agree upon finishing the points of action prior to this meeting, so that you can submit documents (the References for your next meeting) to your promotor a few days in advance of the next meeting. Discuss with your supervisor how many days in advance you should submit your new material.

Fig. 2.1 Meeting template

2.4 Start Documenting Your Journey

2.4.1 *Setting Up a Research Journal and a Lab Book*

Trust me, the day you will be writing your dissertation, you will not remember in detail what you did in your experiments, and where you applied that sensor. Make sure you document your work, keep all relevant information combined, and have an accessible data and/or storage protocol [3].

Take photographs of your experiments whenever you can, from different angles and at different distances. Later, when you are preparing a presentation, you will be glad when you find an overview photograph and not only detailed photographs.

From the very beginning of your research journey [4], I recommend you to keep a research journal and a lab book. You can buy some nice notebooks and pens, and use these to make notes; or you can go digital and use for example Evernote to combine lab notes, pictures, and other sources of information. If you decide to go digital, make sure that it is safe to use a laptop in your lab – if you work with chemicals that can get spilled over your laptop, you might just prefer a notebook and use handwritten notes. You can also use loose sheets of paper and combine them in a binder, with tabs to find the relevant documents when you need them.

For your research journal, you can make it personal and use longhand writing to describe what you did during the day, your wins of the day, and your reflections on your research. If you prefer typing, you can use the clean writing environment of 750words.com, where you can type out your daily rant about research: what you tried and did not work, as well as what were your successes of the day. If you don’t enjoy the purging effect of writing, you can just use for example Evernote and put a few bullet points of what you did that day and the insights you developed. You can even decide to write your observations into your calendar, if you use a digital calendar. Keeping a research journal serves two purposes: to document your journey, and to develop the skill of writing as a reflective practice. We will come back to calendars and planning in Chap. 3.

2.4.2 *Log Your Activities*

Before you can plan your work, you need to know how much time you spend on certain activities. Therefore, I recommend you start to log your time, and that you do this every time you want to evaluate or change your planning. With your tools of choice, you need to select a method that works for you, that you can stick to, and that will not distract you from the actual purpose of being productive.[6]

---

[6] For us STEM-folks who love tech gadgets (guilty as charged), it’s tempting to download all the planning and list apps and try out everything. You’ll spend more time playing around with the apps than reaping the benefits of these tools.

One method is to simply have a sheet of paper next to you and log the times manually when you change from one activity to the other. An example of a log of 1 hour could be:

- 8:00 am: arrival to my desk, unpack my things, greet colleagues
- 8:10 am: start reading paper
- 8:35 am: check my smartphone
- 8:40 am: continue reading paper
- 8:55 am: phone call from lab mate
- 8:57 am: go get coffee and go to the bathroom
- 9:00 am: continue reading paper

While this log might look extremely detailed, you will learn quite a number of things from this: you will learn during which times of the day you are less distracted, you will learn how much time you are effectively working (for this example: 40 minutes of reading in an hour of work), and you will be able to use your logs in the future to estimate how much time a certain task will take.

Another method could be very similar to the pen-and-paper approach. For this case, however, you can open a text file on your computer in Notepad and use the automatic time stamp feature (tap F5)[7] whenever you want to log your time and change activity. The disadvantage of this approach is that you need to be near a computer at all times. Laura Vanderkam [5] in her book "168 hours" recommends her readers to use an Excel file to log time.

The last method is using a software tool, such as ManicTime. This free software tracks automatically which program you are actively using, when you are using your computer, and when it is in sleeping mode. You can then easily tag slots of time with activities. I've used ManicTime religiously throughout my entire PhD, which helped me draw conclusions on how much time it really takes to prepare for a conference, to write a journal article, and to write a dissertation. The disadvantage of the software is that it works best when you are using your computer. If you go to the lab to do a number of things, you may end up tagging that entire time slot as "lab time".

If you want to get an idea of how much time you spend replying e-mail and browsing the internet, you can use RescueTime. You can categorize websites and computer programs in categories ranging from "very productive" (Matlab or MS Word, for example) to "very distractive" (the news website, and Facebook, for example). At the end of the week, you can see an overview of how much time you spent on your computer using computer programs in your "very productive" set, as well as see how much time you were distracted and using programs and websites of your "very distractive" category. The free version of RescueTime is a bit limited, but you can use it during the trial period to get an idea of what your time sinks are, and when during the day you have difficulties concentrating.

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[7] On a Windows machine.

2.4.3 How to Start Writing Early on

There are lovers and haters of the principle of "starting to write your dissertation from day one". Your early scribblings most likely won't make it into your final dissertation, but I'd encourage you to start writing early on. I think the discussion on when you should start writing is irrelevant – writing is a form of communication that is crucial in science. Moreover, writing is an excellent way to reflect on your work and progress. So the question is not "Should I start writing early on?", but "How can I start writing early on?"

Don't write in your first week thinking you are developing your first dissertation chapter. Write to practice this skill, and write to communicate your results to your advisor. Explain why a certain paper is of particular interest to you, or outline the strategies you used to find the limits of a theory that you studied. These small written documents make discussions with your promotor easier, and they help you practice writing. Writing is not just about communicating new insights – you can turn your notes into writing so you have material to discuss your current understanding of the topic.

Here are a few ideas of what type of material you can start writing from the beginning:

- **Summaries of papers**: Whenever you read a paper that turns out to be valuable, write a small summary. This summary can be really short (half a page). You can use the document to type out some equations that you might need later on.
- **Discussions of a set of papers:** If you've read a few papers on a similar topic, you can pull that material together and write a small report (5–10 pages). Important here is to discover which points are still open for discussion, where different authors contradict each other, and what the limits, boundaries and assumptions are. If you can apply these ideas to a set of data from the literature and play around a bit – even better! This discussion will prepare you for writing your literature review in the future.
- **Exploratory calculations**: If you are preparing experiments, document the calculations that lie at the basis of these experiments. Try out different methods to predict the outcome of your experiments. Type out the equations you used – you might end up using them quite often. If you are setting up codes and/or spreadsheets to support your calculations, write a discussion or little user manual to these tools. Don't wait until you have your own data to start making calculations and developing tools: set up your tools as early as you can, and use published data to validate them. If you are like me and have a hard time staying concentrated when you spend your entire day reading papers for your literature review, then infusing more active work and calculations at the beginning of your research will help keeping your engaged.

- **Plan of action**: Another important document to write at the very beginning is your Plan of Action, which can be a Research Plan and/or Education Plan[8] or any similar document. Brainstorm the different methods that you would like to apply, and assess the amount of time you will need. Write down how you interpret the agreements you made with your promotor, and then return this document to him/her for discussion. You'll use this plan during your annual evaluations[9] to see which milestones you have achieved or which tasks you should focus on a bit more.
- **Motivation for your research**: Why does your research matter? Motivating your research is not about getting ready to write your introduction chapter, but it is about getting the larger picture. Write that larger picture down in a document, and revisit it frequently.[10] If your research has practical applications, keep a tie to practice. If your research has broader impacts on society, place things into the right perspective.

Exercises

1. Set up your lab book and/or research journal: go buy a nice notebook and colored pens, or decide to go digital.
2. Make a template for your research journal entries or lab book entries, see examples for a journal entry in Fig. 2.2 and for a lab book entry in Fig. 2.3.
3. Decide how you will log your time, and start by logging a week. At the end of the week, analyze how you spent your time: how much time did you spend on research tasks (reading, analysis, experimental design), how much time did you spend on administration and e-mail? How often are you distracted? Are there times during the day when you are more distracted?

2.4.4 Figure Out Your Data Storage Protocol

To some, figuring out how and where you are going to store your data and research results is obvious. Right at the beginning of your PhD can be a good time to think about how you will set up a clean structure of folders on the space where you store your data. You can create folders for experimental results, literature, coursework, events, documents you generate, etc. and have a clean substructure in each of the main folders. Lay out your tree structure of folders at the beginning of your PhD trajectory, so you have an overview from the very start.

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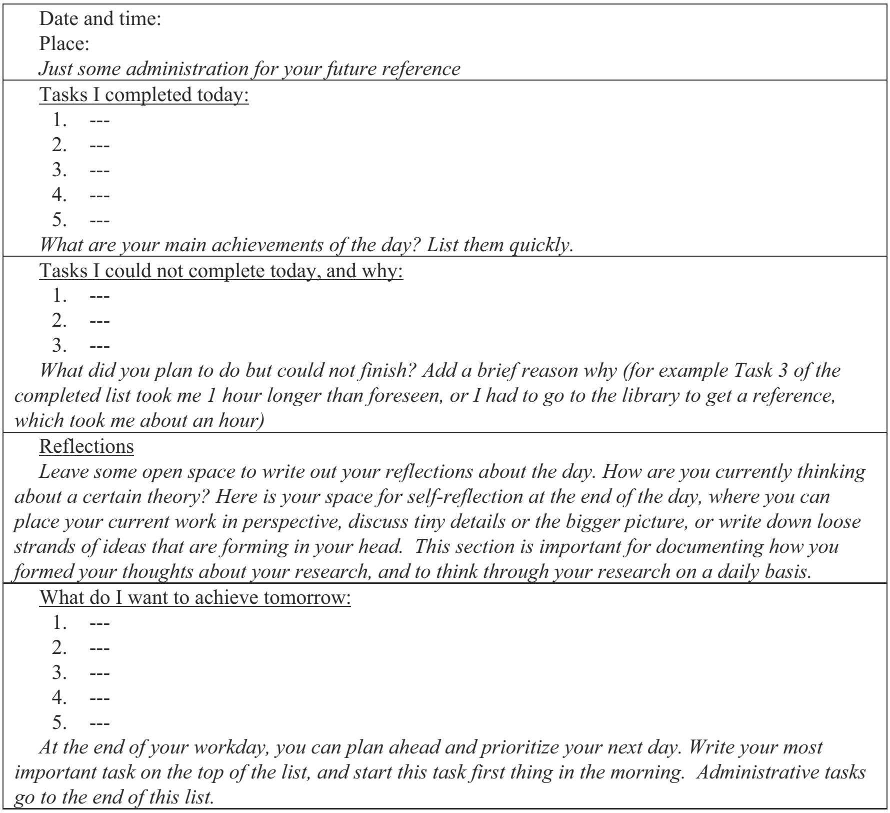
[8] It depends on your institution how important these documents are. Some places use your plan as a contract you have to fulfil, others use it as a tool for your planning, and others don't use it at all.

[9] Annual evaluations are typical for universities where PhD candidates are hired as employees.

[10] Whenever you need a reminder of why your work matters, which can be important when you are slogging through endless data.



Date and time:
Place:
Just some administration for your future reference

Tasks I completed today:

1. ---
2. ---
3. ---
4. ---
5. ---

What are your main achievements of the day? List them quickly.

Tasks I could not complete today, and why:

1. ---
2. ---
3. ---

What did you plan to do but could not finish? Add a brief reason why (for example Task 3 of the completed list took me 1 hour longer than foreseen, or I had to go to the library to get a reference, which took me about an hour)

Reflections

Leave some open space to write out your reflections about the day. How are you currently thinking about a certain theory? Here is your space for self-reflection at the end of the day, where you can place your current work in perspective, discuss tiny details or the bigger picture, or write down loose strands of ideas that are forming in your head. This section is important for documenting how you formed your thoughts about your research, and to think through your research on a daily basis.

What do I want to achieve tomorrow:

1. ---
2. ---
3. ---
4. ---
5. ---

At the end of your workday, you can plan ahead and prioritize your next day. Write your most important task on the top of the list, and start this task first thing in the morning. Administrative tasks go to the end of this list.

Fig. 2.2 Template for your research journal

The next thing you should decide on is where you are going to store your data. Will you use the hard drive of your office computer, a folder in the cloud, your university's network drive, or an external hard drive? I recommend using a folder in the cloud, so that you can seamlessly sync your work between your office computer, home computer, and laptop – if you use all of these.[11] Moreover, I recommend you back up your data regularly to an external hard drive – and maybe to several hard drives[12] (in case you want to make sure your data can survive the zombie apocalypse).

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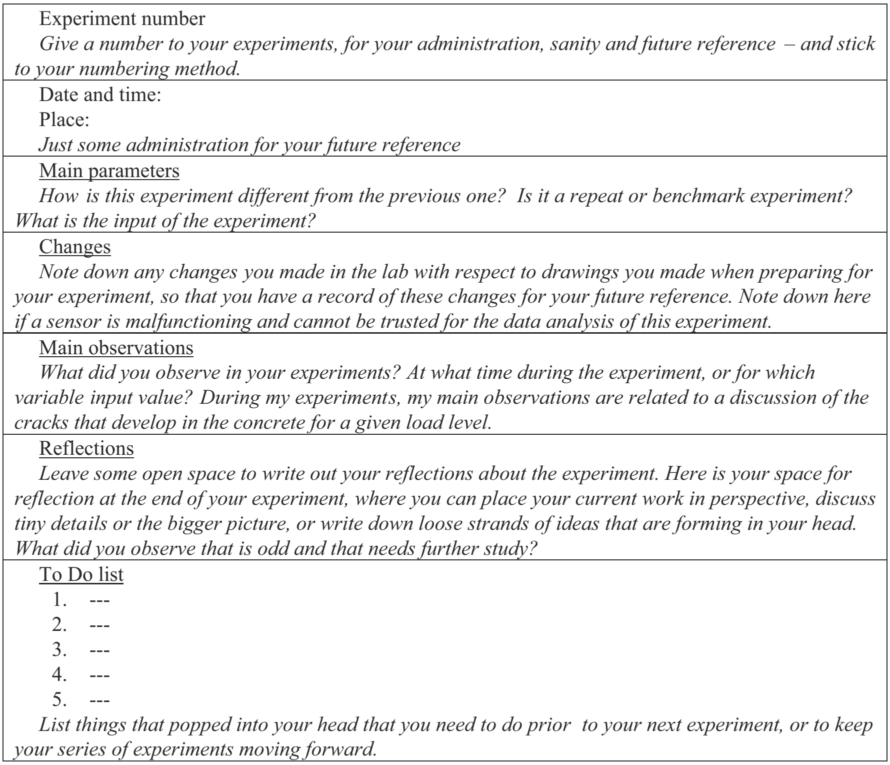
[11] Note that cloud folders are not infallible. I've had to have my Dropbox repaired/restored twice, and the syncing process after restauration can take a lot of time. For me, it meant limited access to my cloud drive for about a week.

[12] Store them at different locations! You don't want your laptop and all backup drives to get stolen from your car together.



Experiment number

Give a number to your experiments, for your administration, sanity and future reference – and stick to your numbering method.

Date and time:
Place:

Just some administration for your future reference

Main parameters

How is this experiment different from the previous one? Is it a repeat or benchmark experiment? What is the input of the experiment?

Changes

Note down any changes you made in the lab with respect to drawings you made when preparing for your experiment, so that you have a record of these changes for your future reference. Note down here if a sensor is malfunctioning and cannot be trusted for the data analysis of this experiment.

Main observations

What did you observe in your experiments? At what time during the experiment, or for which variable input value? During my experiments, my main observations are related to a discussion of the cracks that develop in the concrete for a given load level.

Reflections

Leave some open space to write out your reflections about the experiment. Here is your space for reflection at the end of your experiment, where you can place your current work in perspective, discuss tiny details or the bigger picture, or write down loose strands of ideas that are forming in your head. What did you observe that is odd and that needs further study?

To Do list

1. ---
2. ---
3. ---
4. ---
5. ---

List things that popped into your head that you need to do prior to your next experiment, or to keep your series of experiments moving forward.

Fig. 2.3 Lab book entry template

Having a backup is one thing, having a backup that is up-to-date is another thing. Make sure you know when you will sync your data and your backup, and do so at least once a week.[13] You can use software tools that automatically sync your data with your external drive, or you can manually copy your folder regularly to your external drive (keep in mind that you want to let it overwrite files if you have been working in files that have kept the same name).

Exercises

1. How are you going to store your data? Do you have an institutional cloud drive that you can access? If not, this might be a good time to open a Dropbox account or to try out Google Drive.
2. Go buy an external hard drive, or maybe even two. Yes, they are relatively expensive, but when your computer crashes or somehow files get corrupted, having access to a backup will be priceless.

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[13] Backup your experimental results after each experiment.

2.5 Make a Rough Outline of Your Days/Weeks

2.5.1 *Plan the Outline of Your Days*

Without going into all details about project management, scheduling, and time management, we will now look at the rough outline of your days. Which tasks do you need to fit into a given day? Are you working in the industry and doing your PhD part-time, or are you a full-time PhD student? Do you have young children that need your attention?

Consider your day with 24 hours. Subtract 8 for sleeping, 3 for eating and getting ready, and you are left with 13 hours. How do you want to spend these?

One example would be:

- 8 hours: PhD work
- 2 hours: commute
- 2 hours for exercise (including the time to get there and back)
- 1 hour for reading

Another example could be:

- 8 hours: office job
- 2 hours: commute
- 1 hour: workout at home
- 2 hours: PhD study

Think about what a good day would be like for you, and sketch a rough outline. Factor in how your body works – this is called your circadian rhythm, see Fig. 2.4. It's a fancy term for figuring out if you are a morning person or evening person,

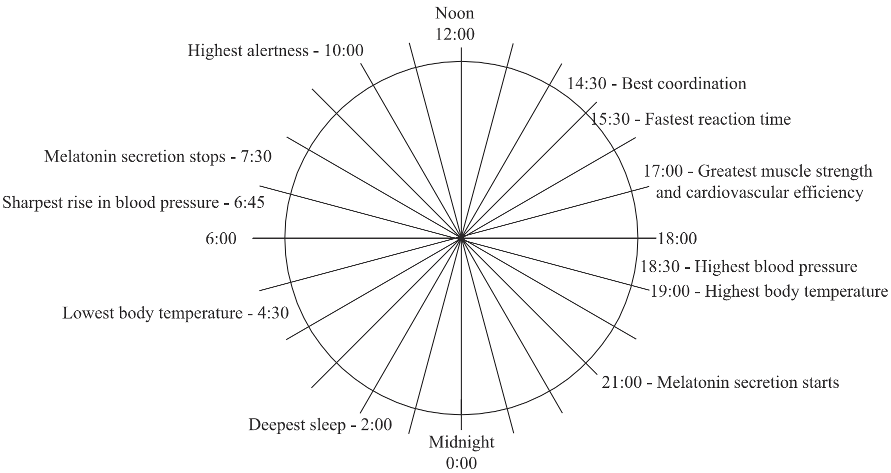
Noon
12:00
Highest alertness - 10:00
14:30 - Best coordination
15:30 - Fastest reaction time
Melatonin secretion stops - 7:30
17:00 - Greatest muscle strength and cardiovascular efficiency
Sharpest rise in blood pressure - 6:45
6:00
18:00
18:30 - Highest blood pressure
19:00 - Highest body temperature
Lowest body temperature - 4:30
21:00 - Melatonin secretion starts
Deepest sleep - 2:00
Midnight
0:00

Fig. 2.4 Example of circadian rhythm

when your energy levels drop during the day, and which tasks work best for you at which time of the day.

For example, you get a bit lethargic after lunch. If that's the case, right after lunch is not the best time of the day for you to do your deep thinking. Some people have their boost of energy right in the morning, others around 3 pm. Know when you are at your best, and plan your deep thinking sessions and writing sessions for those times of the day.

Try to think of your day in terms of waves: your body ebbs and flows during the day, and if you can softly flow with yourself, you will be more productive and get the same amount of work done in a shorter amount of time and with less friction.

While this section is about getting the ideal outline for your days and weeks, know that there is no such thing as a template for every single day, every year of your life. We change constantly, and an outline that worked for a while, will need some tweaks a few months later. I want to invite you to experiment, see what feels good for you, and make changes if you feel friction. Use your research journal to reflect on these experiments.

I've noticed that my ideal days are different depending on where I am living, and what time of the year it is: when I am in Ecuador I wake up earlier than when I am in the Netherlands, simply because in Ecuador life is already in full swing at 7 am, while in the Netherlands most people might just wake up at that time.

It takes time and some self-study to really learn how to listen to your body. You might want to overrule yourself by drinking rivers of coffee and beating yourself up mentally, saying "just two more hours and I will have finished this-and-this". It's so easy to try and force ourselves – but when you are doing research, you need your mind fresh and open to creative ideas, something that does not work very well when you are stressed, afraid, or tired.

If you are ready to start experimenting with your daily schedule, try out the following:

1. **Pay attention to your focus during the day**: When do you feel sluggish, perhaps craving sugar and caffeine? When are you performing at your best? When are you distracted? Can you schedule intensive tasks at the time of the day when you are focused, and easy administrative tasks when your energy is low?
2. **Sleeping and waking times**: If you don't put an alarm clock, when do you wake up - how much sleep do you really need? (Note: if you have young children or maybe even pets who wake you up early, it can be hard to figure out the results of this experiment…) If you are completely sleep-deprived, it takes some time before your sleeping and waking times regulate themselves. But try sleeping earlier for a while – larks and owls are pretty much half/half of the world's population, but in graduate school, it looks like everyone is an owl. There are too many larks trying to fit themselves into an owl schedule. You can take some cues from your parents as well: do they wake up very early and sit quietly reading their newspaper and sipping their coffee in the morning, or do they rush out last minute because they stayed up too late?

3. **Response to stimulants**: try to clear yourself from caffeine, sugar, fatty junk food, and alcohol for a few weeks (maybe a holiday would be a good time for a reset). Then, for example when you return to work after your holiday, pay close attention to how these stimulants affect you. Do you notice the rush after taking your coffee, followed by the dip during which you lose your focus? Do you notice the craving for potato chips, and then the lethargy that comes when your stomach is full of grease? I'm not saying you have to give up your coffee, chocolate bars, cup of wine, or potato fries (I deeply love them all), but maybe a fatty meal is not the best choice when you are struggling to finish a task before a deadline, and maybe all that coffee in the afternoon is one of the sources of your insomnia… So enjoy your vices, but enjoy them wisely.
4. **Response to exercise:** If you've been in the lab until 10 pm, is it a good idea to go for a run and then crash down into your bed? Most people get too energized from exercise, so experiment and see when you get the best results: early morning, in the afternoon, in the early evening or late at night?[14]

2.5.2 *Eat, Move, Sleep*

Referring here to Tom Rath's book "Eat move sleep" [6], I want to get your attention for three things you should never drop, no matter how busy you are. Too often in graduate school we are running around as sleep-deprived, stressed-out zombies that just can't juggle all the tasks we have to fulfill and drop a ball here and there.

When you make the outline for your day, make sure you take time to eat properly, and time to prepare your food. A bag of chips from the vending machine is not a meal. You can't live on take-out food constantly either (plus you typically don't have the budget to eat in restaurants as a PhD student). Plan when you are going to do your groceries, and which evenings you will need time to cook. You don't need to cook every day – you can make large batches, freeze them, and take out something when needed (buying in bulk is cheaper too, and chilis, stews, and soups with vegetables and beans are filling and cheap).

1. **Eat**: When I went to university, my mother kept telling me to make sure I eat enough, saying that you can't study well when you are hungry or eating poorly. She always asked me (and still does) what I cooked or what I am going to cook, also because food and shared meals are one of the cornerstones of Belgian culture. But there's a grain of truth in my mom's wisdom (well, more than a grain): food is the fuel you put into your body. If you are not eating properly, you will be missing (micro)nutrients, and perhaps not feel at the top of your game. Eat enough fruit and vegetables to get your micronutrients.
2. **Move:** Don't skip exercise because you are too busy. The American Heart Association [7] recommends 150 minutes per week of moderate exercise (at

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[14] If you have small children, it may be difficult to exercise at a time that is best for your body. Remember: any workout is better than nothing at all.

least 30 minutes for at least 5 days a week) or 75 minutes per week of vigorous exercise (at least 25 minutes for at least 3 days a week), combined with moderate to high-intensity muscle strengthening-activity at least 2 days per week. While this might sound like quite a commitment, consider biking or walking your commute to get minutes of moderate exercise. Inform at your university's gym as well – they typically have group classes that could count for your cardio activity, and check out their gym to see if you can do two sessions of strength training per week. Lifting is not just for bros, you know?[15]

3. **Sleep**: Sleep is important, and identifying your daily cut-off time for work is important to start finding the outline for your days. How much hours of sleep do you need? Very few people function well on less than 6 hours per night, so don't try to fool yourself, but listen to your body and its needs. Part of resting well also relates to getting good quality of sleep – make sure you can sleep in a cool, dark, and quiet room. Use white noise or background sounds if you live in a noisy student building. If you can't get your room entirely dark, get yourself a sleeping mask. Try to sleep and wake around the same time every day. If necessary, set an alarm for when you need to start your bedtime routine.

2.5.3 Determine Your Non-negotiable Self-Care Activities

Which hobbies do you have that really make you feel happy and fulfilled? By all means, keep these in your schedule. Creative hobbies, such as music, reading, or crafts can have a positive effect on your research, since they stimulate creativity. Perhaps you don't have time for your hobbies every single day, but you can fit them in a few times a week.

Which relaxing activities are important for you to indulge in every now and then? Don't skip them, but plan for them. How about keeping an evening a week just to yourself, to do what feels good right then? It can feel right to read a book, to take a bath, to go visit a friend or relative, or just hang out in the park – whatever feels right for you at the moment. Note that as academics we are not used to ask ourselves: "What would feel really good right now?" We are so caught up in everything that we have to do, and stuck in our heads, that thinking about what would feel good for yourself and your body might feel odd at first. This recommendation ties back to experimenting with your circadian rhythms – you can't make progress on your daily planning if the communication between your head and your body is disrupted. You can use your (research) journal to document your experiments and reflect on how certain choices make you feel.

Determine which self-care activities are key to your well-being, and prioritize them. If you are healthy and inspired, your work will flow forward much better.[16]

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[15] Again, if you are constrained because of the limitations of childcare, see what you can do. I'm currently exploring home workouts in the evening when my baby sleeps.

[16] Even if you are a parent, try to fork out a bit of time for yourself. If you are a single parent, this may be even harder – but remember that a less-stressed mom or dad is more fun for the little ones.

2.5.4 *On Creating Nurturing Morning Routines*

A good start of the day is half the work [8]. There is a difference in your state of mind between starting the day rushed, throwing in a breakfast and a coffee and storming out of the door, and taking your time in the morning to frame your mind for the day.

Think about your morning routine. Your goal could be to win as much hours of sleep as possible (which should not be an issue if you go to bed on time), or your goal could be to determine a morning routine that leaves your energized, and ready to dive into the day.

During a part of my PhD, my morning routine looked like this:

- 6:00 am – wake up, brush teeth, drink water, etc.
- 6:15 am – yoga & meditation (typically 40 minutes yoga and 20 minutes of meditation, but times are variable according to how I feel)
- 7:15 am – shower and get dressed
- 7:25 am – cook breakfast
- 7:40 am – bike to university
- 8:00 am – start working

While drafting this book, my routine looked like this[17]:

- 5:30 am – wake up, get dressed, make breakfast
- 6:00 am – exercise (crossfit)
- 7:15 am – back home, eat breakfast
- 7:25 am – meditate
- 7:35 am – shower, get dressed, go to the office
- 8:00 am – start working

2.5.5 *On Rolling with the Punches of Academia*

Ideal day and ideal week – all good and well, but every now and then academia throws us a curveball, and we need to dig deep for a while. As long as this emergency situation is for a short amount of time (say, maximum 3 weeks),[18] you can just isolate yourself from the world and get it done. Working 80 hours a week should be the exception, not the rule during your PhD (and during your academic career). It may even be impossible if you have a family to care for, and even if your partner can step in for you, excessive work hours will eventually corrode your family and social relationships.

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[17] As I am wrapping up this book, my routine is different because I have a 5-month old baby. I take time every morning to give her a baby massage, which helps us to relax and connect before I got to work.

[18] This limit is different for every person.

It's fine if you need to do an exceptional effort every now and then. There will always be times and semesters that have a peak period that seems to rob you from your life. Try to get it over with, and then go back to your regular life of normal days. I call this rolling with the punches of academia – if you get a punch, deal with it, and then go back to normal.

Don't get stressed if you suddenly have an intensive week, and then you remember you should be spending time on your hobbies, exercising 150 minutes a week plus two strength-training sessions, cooking fresh food, and sleeping enough. It's OK to cut back and soldier through for a little while – as long as it doesn't become a habit. Keep in mind that the longer you stay in emergency mode, the harder it becomes to return to your regular schedule that includes time to take care of yourself.

Exercise: Make Your Outline

1. What does your ideal day look like? First, I want you to write a paragraph describing what a great day looks like for you. Then, convert this paragraph into a rough outline for your day.
2. Which work, study, and self-care tasks do you want to fit into a week? Take a template of a week,[19] for example a blank Excel sheet, iCalendar, or Google Calendar, and start to fill it with these tasks. Make sure you leave enough time between activities so you can move from one task to another. Don't plan more than 75% of your time. We will discuss setting up a weekly template in detail in Chap. 3, but for now, I want you to get a grasp of how a good week looks like for you. Now that you know what would be a good week, try to implement this schedule. Try it out, journal about it, and then improve what did not work for you.

2.6 Summary

The take-home message of this chapter is: set yourself up for success right at the beginning of your PhD studies. Get your paperwork sorted out, get to know your new environment, make clear agreements with your promotor, start to keep track of your work, store your data in an organized way, and organize your days around your optimal working hours. While you might want to hit to ground running, the first weeks of your PhD are the right time to make sure you put the right pavement on the road to support you in the long run. If all the advice in this chapter seems like too much, then start with the basics (adjusting to your new place and discussing expectations with your promotor), and take it from there – one element at a time.

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[19] I'm not giving you a template to fill in here, because I want you to try it out for real right away. Do you use apple devices, then use iCal. If you are on Google and Android – then use Google Calendar. If you don't like tech gadgets that much, you can make a timesheet in Excel or a Google Drive spreadsheet.

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Chapter 3
Planning Your Time

Abstract In this chapter, planning and time management are discussed. A top-down approach for planning is explained, where we start from the entire period of the PhD trajectory (with 4 years as a reference), planning the major milestones. Then, we make a monthly, weekly and daily planning. Technological tools and smartphone applications that can be used to support the planning are highlighted. In a next part of this chapter, time management is discussed. We discuss how to use lists in a productive manner. The approach that we take here, is to first measure the time we spend on tasks. Once we know how much time certain tasks take us, and how much time is spent on tasks of minor importance (e-mail, chatting with colleagues…) we can improve our planning. We use the urgent-important matrix to select which tasks need more of your attention. A final topic deals with the need for self-care routines and sufficient sleep. Often, PhD students get so absorbed into their work that their social life and health start to suffer. In this chapter, you get the tools for identifying when you are getting stuck in unhealthy patterns, and how you can take action.

Keywords Planning · Time management · Lists · Scheduling · Weekly template · Energy management · Prioritizing

3.1 Introduction and Learning Goals

In this chapter, planning and time management[1] are discussed. By the end of this chapter, you will have a first planning for your PhD trajectory, for your semester (or other defined period of time, depending on the academic calendar of your institution), and a weekly template. Certainly, this planning is not set in stone, but you'll get all the necessary tools to start experimenting with your planning to find out what works best for you.

To develop your planning, a number of digital and analog tools are discussed, from which you can select what suits you best. We will intuitively review the basics of project management, so that you can apply these concepts to your PhD project. Advice from current and former PhD candidates on how they deal with planning

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[1] In fact, what you are managing is yourself and your energy levels, not "time". But because the term "time management" is so commonly used, we'll use this term throughout this book.

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E. O. L. Lantsoght, *The A-Z of the PhD Trajectory*, Springer Texts in Education,
https://doi.org/10.1007/978-3-319-77425-1_3

and scheduling is included, together with examples of schedules. The importance of leaving space and air in a planning is stressed many times, and an additional subchapter deals with self-care in academia in the broader sense. The importance of sleep, exercise, fun and self-care activities is highlighted, and it is discussed throughout the chapter how to keep space in your planning for such activities. You can also find advice on how to break out of unhealthy patterns in this chapter.

3.2 Planning Your PhD

3.2.1 Determining Your Milestones

Let's start by looking at the big picture of your PhD:

- How many years does your program take?
- What are the graduation requirements?
- When are you supposed to meet each of these requirements?

For example, a research-only PhD program in the Netherlands takes four years, and has as its requirement the publication of the dissertation and propositions, and the public defense. On the other hand, a PhD program in the United States can be three years, with qualifying exams in the first year, the proposal in the second year, and then the dissertation and defense in the third year, as well as a certain amount of coursework. If you have any doubts about the exact requirements for graduation, and their timing, make sure you ask your promotor or check with the department of academic affairs to be sure about what you are working towards.

Once you know the main requirements of your PhD trajectory, which I will call the milestones of your journey, you can start to plan. You have defined your milestones and their deadline – but you won't wake up one sunny morning in spring and defend out of the blue. Therefore, I recommend you to take these milestones, and start to count back to see which major tasks need to be done, and when.

Let me elaborate: say that you have to defend your proposal in the second year. Determine when you want to present your proposal. Do you need to submit a report prior to the presentation? How much time in advance? Say that it is three weeks in advance – place that deadline on your calendar as well. Then, count back: how many weeks do you need to prepare the document? How many weeks or months will you spend on reviewing the literature?

Another example: you are in a research-only program, and have four years until your defense. Mark down roughly in which months you could be defending[2] (summer months will be difficult because your committee members might be traveling). Count back the time between submitting the final version of the manuscript as approved by the committee and the defense (2–3 months). Then count three months back for interaction with the committee members. Then count one month back to have your final version approved by your promotor to be sent to the committee. From there you can start calculating back which chapters you should be writing, and when you should write them. While it can sound vague to you to plan which chapters you will write before you have done any of the research, you will know which topics need to go in your thesis. If you have no idea, you can always check a number of recent theses from your research group. A typical organization of a thesis is as follows:

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[2] In the Netherlands, the PhD candidate publishes the thesis before the defense. I've taken this situation as the reference throughout this book, but provided comments where necessary for the case of publishing the thesis after the defense.

1. Introduction
2. Literature review
3. Experiments
4. Analysis of the experiment
5. Development of a theory
6. Case study/Practical application/Recommendations for practice
7. Summary and conclusions

With such a general layout in mind, you can start identifying the main work you will be doing: reviewing the literature, doing experiments, processing these experiments, doing fundamental theoretical work, doing applied work – and then you can identify when you will need to be working on these tasks. We'll discuss this topic as well in Chap. 5 about the research question, as your subquestions will define your major tasks. Of course, this process is not linear: you can review the literature, develop a theory, test this with experiments, and then correct and revisit when you find differences between your expected and tested results.

For planning several years' worth of work, there are a number of tools you can use. You can mark ranges of dates in Google Calendar or iCal. You can print the calendar with the months of the years that you will be working on your research project, and mark the milestones and the steps towards them manually and hang this on your wall. One tool I find particularly insightful is the website Finished in Four [1], where you can see an overview of a four-year PhD program,[3] and use icons to indicate when you will be working on what. The icons make the overview very visual and give you your trajectory-at-a-glance. Important as well is to note the categories "holidays" and "space". Make sure you plan extra space in case things take longer, and don't forget to plan to take time off as well.

Since I'm quite a fan of how Google Calendar syncs across all my devices and allows for sharing with my husband and family, I use my Google Calendar to mark ranges of dates (months at a time) for major tasks (e.g. between these dates I will be doing experiments, or, I need these weeks to write this chapter). I use different color codes for writing chapters, doing research, conference travel, and holidays. You can see an example in Fig. 3.1. Since major tasks typically run over weeks or even months in time, you will see that the main chunk of February 2012 was spent on analysing my "combitests" (reinforced concrete slabs under a combination of loads

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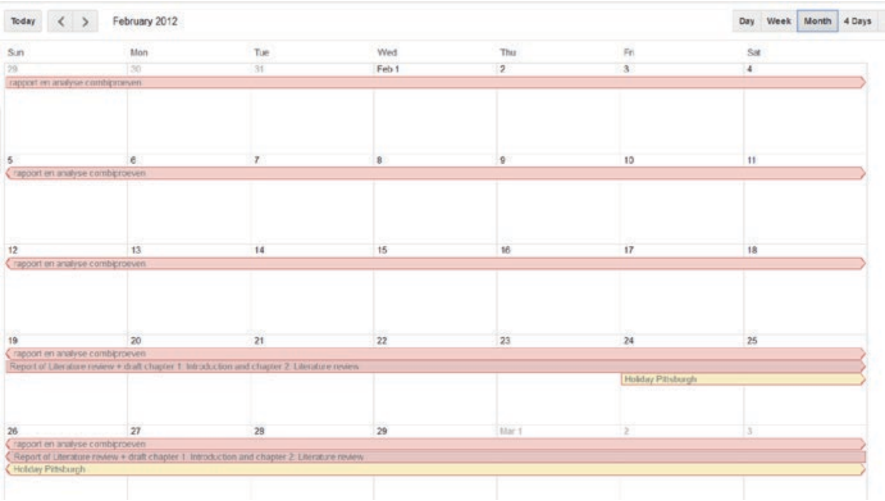
[3] Four years is the standard length of a PhD contract in the Netherlands, although it is common to get an extension.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February 2012
Day
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Report of Literature review + draft chapter 1: Introduction and chapter 2: Literature review
Holiday Pittsburgh
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29
Mar 1
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rapport en analyse combiproeven
Report of Literature review + draft chapter 1: Introduction and chapter 2: Literature review
Holiday Pittsburgh

Fig. 3.1 Excerpt of my roadmap to the defense from February 2012 (English and Dutch combined. When I show you something I used I did not alter anything, so you can find some fine Dunglish here and there)

[2]), and that towards the end of that month I started writing the literature review chapter of my dissertation as well as the introduction chapter. You can also see that I went on holidays to Pittsburgh to visit my husband,[4] and that I planned to keep doing some work during that holiday.[5]

3.2.2 *Setting Yourself Up for Success per Semester*

Now, let's zoom in and think per semester, or other academic period your institution uses.[6] Even if you are in a research-only program, it can be good to think about the next few months. A chunk of four months hits the sweet spot for many of us.

The first step is to identify what you want to achieve in a semester. What are your major goals for the semester? Don't lose yourself in all the details and how you are going to fit all your tasks, time-wise, but instead start by identifying your top five priorities for the upcoming semester.

If you haven't identified your top priorities yet, journal about them. Take a sheet of paper, make an entry in your research journal, a blank Word document, or a note in Evernote/Onenote/or whichever note-taking app you use and let your ideas flow.

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[4] We were on different continents throughout my PhD… but that's another story.

[5] In fact, most of the drawings in the second chapter of my thesis were drawn from my husband's place in Pittsburgh, while I was watching the snow fall and tried to stay as close to the heating as possible.

[6] For brevity, I will call this a "semester" in what follows.

Ask yourself what would be the red thread throughout your semester. Summarize this idea in a list of your five tasks for this semester.

Once you have outlined these five tasks (or even less, if you are working on a very large project such as your dissertation), try to identify when during the semester you will work on each project/task. Will you work on one project at a time,[7] or will you allot a few hours a week on each project, to make sure all your projects move forward steadily?

Identify how you will work first, and then map these tasks onto a schedule of the semester. If you will be traveling to conferences, or you will be taking holidays, mark down these time periods first – we will assume that these time periods will not be accessible for other work-related tasks. Estimate the time you need for working on your priorities, and highlight the weeks on your semester schedule. You can use a large sheet of paper with the weeks and days of the semester to mark your projects on, or you can use a digital calendar (iCal, Google Calendar…) to highlight the days that you reserve for a project or task. The highlighting method works best if you decide to tackle one task at a time – this approach is the best option if your tasks for example include designing a test setup, carrying out experiments, analyzing the test results, and writing the report.

On the other hand, if you are moving multiple projects forward at the same time (e.g. a series of experiments, writing a journal paper about research you did previously, and taking a course), then adding all these tasks simultaneously onto your schedule might not give you a good visual overview of what you are working on. In that case, you can use your list of priorities, and write the date ranges on this list.[8] You can also determine that you will work two days a week for example on your studies, one hour a day on your paper, and three afternoons a week on your experiment. In that case, you can use a list app to put reminders on your daily to-do list. Later in this chapter, we will discuss the effective use of lists in more detail.

Now that you have paid attention to your main priorities, you can start filling in the smaller tasks. Stephen Covey [3] calls these priorities the “Big Rocks”. Why Big Rocks? Well, imagine a jar – start filling the jar with the big rocks, and then pour on the sand. If you do the opposite: first pour in the sand, and then try to fit the big rocks, you won’t be able to fit the big rocks. So, let’s look at the sand of your semester now.

If you are taking coursework, take your syllabus and note on your calendar when homeworks are due and when you will be taking midterm exams. When will you have meetings with your promotor, and what do you need to finish before these meetings? Do you have self-imposed deadlines for your research? When should you follow-up (by e-mail or video-conference) with industry partners and/or (international) collaborators?

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[7] You may not know at the beginning of your PhD if you’ll be working on parallel projects. It is also possible that you will be preparing experiments and carrying out your literature review at the same time.

[8] Things can come up during the semester – keep enough space!

Last but not least – ask yourself how you will reward yourself for staying on track. Leave space open in your semester planning for fun things, and maybe already plan some fun activities to look forward to. It's OK to spend an entire weekend working, if necessary, but don't do so the entire semester. You need your time to recharge, refuel and get some fresh air. If you have a mid-semester break, identify how you want to spend it: work on a paper, or get out to the mountains and hike - both are great, deliberate options. Sleeping late because you spent the entire night scrolling through your Instagram feed, trying to "write a bit when you feel like", replying e-mails and watching Netflix – not so good, too much in that half-working half-relaxing state. Make a conscious choice, and enjoy it.

3.2.3 Your Weekly Template

We are ready to lay out a template for your weekly schedule. Now that you know what your five (or less) most important tasks for the semester are, and have identified the smaller tasks you need to take care of, you can sit down and see how you will fit in several responsibilities on a weekly basis.

The elements that you need to fit in can be:

- studying
- teaching (if you are a TA)[9]
- class preparation (if you are a TA)
- assist your promotor with smaller research tasks (if you are an RA)[10]
- dissertation research
- writing papers
- reading papers / keeping up with the output in your field
- responsibilities in your research group (such as organizing PhD student research meetings)
- service on committees and other regular meetings, inside or outside of your institution
- office hours (if you are a TA)
- time to reply e-mails
- administration time

Once you have identified your different elements that need to go into your weekly template, you can start to construct the framework of your weeks. First, think of how many hours a week you are willing to work and study: 30? 40? 50? I don't recommend that you plan to work more than 60 hours a week, because your brain needs to refresh and refocus from time to time as well. Moreover, there are always other, small things that might take some extra time. So, if you start by planning to work 60 hours, it easily becomes 80 hours a week if you hit a rough patch in the semester.

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[9] TA = teaching assistant, this term is mostly used in North America.

[10] RA = research assistant, this term is mostly used in North America

Next step: distribute the hours that you have over the different categories. Typically, your time can be divided along the different categories (just giving you some rough estimates – things can look very different for you if your responsibilities are different), and the total number of hours should be equal to or smaller than the maximum number of hours a week you are planning to spend on work and study:

- teaching or taking classes: the number of hours you are actually in class, plus adding in commute time if you have to commute
- class preparation (if you are lecturing): two hours per hour of class if it's a course you've taught before; four if it is a new course [4]
- studying (if you have coursework): two to four hours per hour of class to study and prepare homework
- research: for me this is a few chunks of two hours throughout the week, but if you are a PhD candidate in a research-only program, this category can take up at least 20 hours a week
- writing documents and papers: at least an hour a day – always be writing
- reading papers / keeping up with the output in your field: at least twice a week an hour
- faculty responsibilities or responsibilities within your research group: depending on the type of task and frequency of meetings
- service on committees and other regular meetings: as scheduled
- office hours: depends on your university guidelines
- time to reply e-mails: about an hour a day
- administration time: at least half an hour a day – if it takes 20 minutes to stand in line and get copies, you need more random admin time

You can see an example of my current weekly template in Fig. 3.2.[11] I make a new weekly template at the beginning of every semester, depending on the tasks I have. Above the daily plans are blocks of days, where I could either be indicating which long-term project I am working on, or, as in this example, show the period of the final exams. I am also using color-coding to separate different categories of work:

- **Green = Workouts**: When I am in Ecuador, I opt for morning workouts, when I am in the Netherlands, I go in the evening. In the weekly template for the semester I used as an example, I am training crossfit 6 days a week, and yoga (not shown in my planning) 4 days a week at home (unless I'm tired or too sore or feeling sick).
- **Light blue = Research**. This category has different tasks: time for moving research projects forward (calculations, mostly), and time for working on documents for scientific committees.

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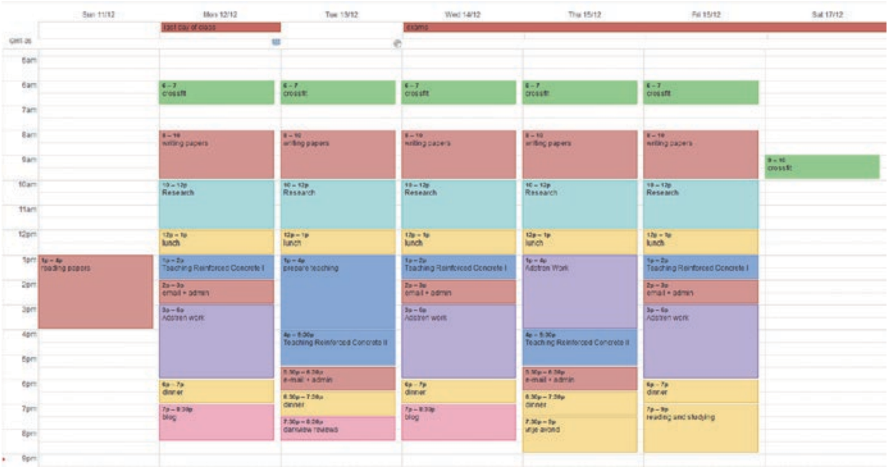
[11] Before baby.



Sun 11/12
1p – 4p reading papers

Mon 12/12
last day of class
6 – 7 crossfit
8 – 10 writing papers
10 – 12p Research
12p – 1p lunch
1p – 2p Teaching Reinforced Concrete I
2p – 3p email + admin
3p – 6p Adstren work
6p – 7p dinner
7p – 8:30p blog

Tue 13/12
6 – 7 crossfit
8 – 10 writing papers
10 – 12p Research
12p – 1p lunch
1p – 4p prepare teaching
4p – 5:30p Teaching Reinforced Concrete II
5:30p – 6:30p e-mail + admin
6:30p – 7:30p dinner
7:30p – 8:30p [illegible] reviews

Wed 14/12
exams
6 – 7 crossfit
8 – 10 writing papers
10 – 12p Research
12p – 1p lunch
1p – 2p Teaching Reinforced Concrete I
2p – 3p email + admin
3p – 6p Adstren work
6p – 7p dinner
7p – 8:30p blog

Thu 15/12
6 – 7 crossfit
8 – 10 writing papers
10 – 12p Research
12p – 1p lunch
1p – 4p Adstren Work
4p – 5:30p Teaching Reinforced Concrete II
5:30p – 6:30p e-mail + admin
6:30p – 7:30p dinner
7:30p – 9p vrije avond

Fri 16/12
6 – 7 crossfit
8 – 10 writing papers
10 – 12p Research
12p – 1p lunch
1p – 2p Teaching Reinforced Concrete I
2p – 3p email + admin
3p – 6p Adstren work
6p – 7p dinner
7p – 9p reading and studying

Sat 17/12
9 – 10 crossfit

Fig. 3.2 Example of a weekly template

- **Yellow = Personal time**. A researcher needs to eat, and cook to get to eat said food. I make a meal plan for the week, base my grocery list on that meal plan, and then cook a fair amount of all meals on Sunday night. I also reserve some time for studying (mostly MOOCs that I follow), and try to reserve one night a week for relaxing ("vrije avond" = my free evening).
- **Blue = Teaching**. This category involves class preparation time, as well as the time for actual teaching. For the semester in Fig. 3.2 I got course load reduction and only taught two courses, and two courses that I had taught before – so no need to develop much new material. For grading exams, I will add more time in the teaching category. I like to grade homeworks and exams right after receiving them – I like being punctual about returning work to my students, as a fair exchange for my being rather strict about the deadlines of their work ("you respect my time, and I respect your time").
- **Pink = Blog scheduling**. This category involves preparing and scheduling guest posts, writing posts, and working on this book.
- **Red = Work**. This general "work" category contains my writing time, reading time, e-mail + admin, and appointments. As you can see, I start each day with two hours of writing (something I strive for, but cannot achieve each and every single time). I try to reserve one hour for e-mail + admin each day, but sometimes I need considerably more time to get back to my Inbox Zero.[12]
- **Purple = Consultancy work**. I'm involved as a consultant with my husband's company called Adstren, and I reserve time each week to work on projects. Some weeks are busier than others, so if this category does not need my immediate attention, I replace it with research time.

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[12] The idea behind Inbox Zero is that you read, reply, and file e-mails, so that only e-mails that need to be processed remain in your inbox. You can read more about Inbox Zero in the glossary in Part II.

One thing I would like to stress again, is that I filter out e-mail and admin, and bunch all these small tasks into an hour of mail/admin a day. I'm consciously not replying to every single mail the moment it shows up on my phone (I typically stow away my phone in the drawer and close my mailbox anyway), and e-mail has a low priority for me: I'd rather miss my daily hour of replying e-mails than my daily hour (or two) of writing papers.

On a weekly basis, you can think of planning time for workouts, social activities, date nights and other "regular" activities that you want to do repeatedly during the semester. Make time for them, and put them in your planning. You will feel much better when you arrange quality time for yourself (whether that means an evening of reading a good book, taking a bath, or crushing a workout) than when you just stick around the house after work, eat, and veg out on the couch. I am not saying that you are never allowed to do so and always have to be productive, but that in-between state typically makes you wonder what happened to your time without making you feel rejuvenated.

3.2.4 *Defining Your Ideal Day*

Remember your ideal day from Chap. 2? Now that you have your weekly template, make sure that your daily plan coincides with your circadian rhythms. Take your plan from your weekly template, and add the specific tasks for this day or week. Prior to the start of a week, you can fill out specific tasks into your weekly template. An example is shown in Fig. 3.3, in which you can see how I fill specific tasks into the categories laid out in the weekly template, and move some blocks around where needed. There's no such thing as a "standard" week in academia – there will always be exceptional events, deadlines, priorities, and perhaps some travel (as you can see for the Saturday of Fig. 3.3).

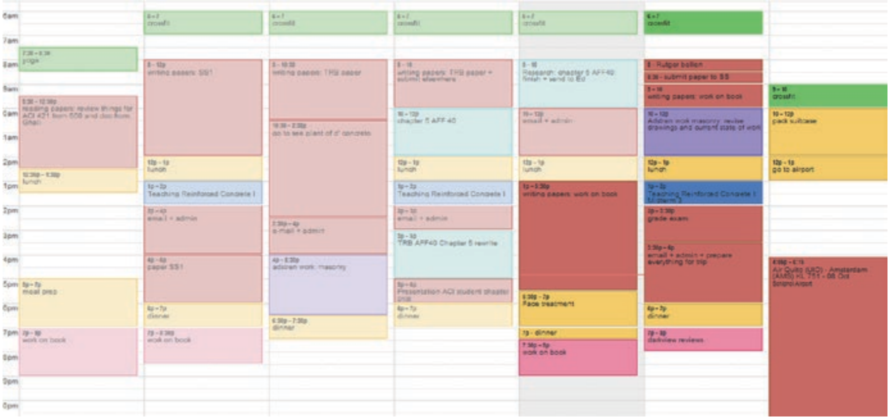

Fig. 3.3 Example of daily planning in the framework of the weekly template

The example of Fig. 3.3 shows the combination of teaching, research, and consulting work that makes up my days, a few years past graduation from the PhD program. My schedule looked quite different, and less partitioned, during my PhD years. It is an example of a week (the first week of October 2016, to be precise) based off the weekly template of that semester, shown in Fig. 3.2.

Throughout my PhD, I consistently started my day around 8 am – ready to start experiments. Since I was mostly working together with a technician in the lab (who starts at 7:45 am) and my daily supervisor, I would make sure to be in my office around 8 am. My early starts were productive [5]. I typically took a coffee break in the morning. Sometimes we'd celebrate a birthday, and then we would all eat cake together (one more reason to go and do research in the Netherlands [6]). Most of the days I'd have a 15-minute coffee break in the morning with some of my colleagues to have a snack, a cup of tea and chat. At noon, I went for lunch with my colleagues. I'd usually go to the cafeteria around 11:45 am already to be earlier than the other users of the microwaves, in order to avoid the microwave-queue. Our lunchbreaks took about 30 minutes. Sometimes I'd go into the lab after lunch and check out new developments on my setup with my technician colleague. Most days during my PhD, I'd leave my office sometime between 5 pm and 6 pm**,** and make sure I'd have an activity scheduled for the evening so that I really had to leave my office. If I didn't have an activity scheduled, I felt tempted to stay until 10 pm. Here's what my typical evening activities looked like (keeping in mind my low budget as a graduate student):

- On Mondays, I went to the gym around 6:00 pm or 6:30 pm for a class, and then home, to prepare my food for the next day, shower, and write CD reviews or blog.
- On Tuesdays, I used to do my groceries and batch-cook food for the rest of the week. I'd often watch online lectures in the meantime, or listen to podcasts to learn something new.
- On Wednesdays, I used to go to choir practice, or -once I got fired from the choir from missing too many rehearsals because of my busy conference schedule- I'd go to the gym and then make time to read or study an online course.
- On Thursdays, I would practice yoga at home, and make time for relaxation, such as reading a book in my bath tub.
- On Fridays, I would spend 2 hours to either clean the kitchen or bathroom, and then clean my room as well.
- On Saturdays, I would take care of all my pending errands, take time to study online courses, blog and read or watch a movie.
- On Sundays, I would start my day in the gym, often followed by time in the sauna, and then work all through the afternoon, often until 9 pm.

In the final year of my PhD, I tried to sleep earlier than the previous years, and would often be in bed by 9:30 pm or 10 pm, to make sure I get all the rest I need [7].

Rebecca Pollet, a PhD candidate in Biochemistry [8], discovered that her ideal day is based on including what she is interested in, and what motivates her into her daily schedule. For her, that means the interaction with undergraduate students that are carrying out smaller research projects under her supervision, which helps her to stay on top of the laboratory techniques they are implementing. The discussions arising from the questions of the undergraduate students also inspire her to design new, exciting experiments, or to improve the controls of experiments.

3.2.5 Applying the Weekly Template

Over the past years of experimenting with the weekly template, I've made numerous course-corrections, and have some practical tips for you:

1. **Plan time for buffer.** Keep in mind that for 8 hours of being at work, you can get about 6 hours of work done (on a very good day). There's always time that goes lost in between tasks, and an endless string of distractions. Avoid scheduling every single minute, leave enough air in your schedule, and overestimate the time it takes to get something done. For example, if you have a two-hour block for a task, you typically will be able to squeeze in three pomodoros,[13] and effectively work 1,5 hours.
2. **Don't plan more than 75% of your time**. If you start with filling your schedule with blocks of tasks, you might get a bit frustrated after some time when you learn that you never get done what you planned to do. There are always random extra things that creep up on you during the day. There's always a little fire that needs extinguishing right away. While my boxes of time in my schedule (see Figs. 3.2 and 3.3) seem to be back-to-back, I only fill them with tasks that take no more than 75% of the allotted time.
3. **E-mail takes a lot of time.** You can spend your entire day with your mailbox open and reply every single message right away – but it adds additional unwanted distractions to your workflow. I allow an hour a day for replying and archiving e-mails, but some days I need up to three to four hours to plow through my mailbox. If I see e-mail accumulating, I will reserve an afternoon to take care of my overflowing mailbox, and reschedule the work I originally planned to a later time and date.
4. **Interruptions**. If you are a TA, students will be lining up at your door at every possible hour when you are in your office (often ignoring your office hours whenever they see your face). So, if you have teaching responsibilities, schedule in sufficient time for such interruptions – especially close to a homework deadline or a midterm exam.
5. **Going with the flow of a topic**. Sometimes, if you feel you are on a roll with something, it is OK to ignore your planning and just keep surfing that good wave. When I am deeply buried in a research problem and I find myself steadily working towards the untangling of a big knot, I prefer to keep working a bit more,

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[13] A Pomodoro is a period of 25 minutes during which you focus on one single task. Afterwards, you take a break of 5 minutes. You can read more about the Pomodoro technique in the glossary in Part II.

instead of switching to my next planned task. Your weekly schedule is a tool to help you get your work done, not something you should always adhere to with religious fervour.

6. **Don't postpone writing**. When you have a lot of teaching duties, you may think: "This semester I am teaching new courses, so I'm going to postpone writing that article until next semester." And then, your next semester is there, and you have yet another challenge that takes up all your time so that you need to postpone your writing again. Reserve time for writing, regardless of your other duties, even if it is just 30 minutes a day.

3.2.6 On Rigidity in Schedules

When you schedule all your activities, and mechanically work through them, you may be missing out on the freedom to do what you feel like doing, and lose spontaneity. Living your life like a regimented machine is not an appealing thought, especially since we value our academic freedom highly.

As I've mentioned before: your schedule is a tool to support you, not something you should follow rigidly at all times. When your fun evening activities start to feel like chores, it is time to stop and think: "What would feel good right now?" If you've been sitting all day, and it would feel good to move, go work out. If you've been rushing around the lab all day, and feel tired and worn out to the bone, respect that feeling and rest. If some night you get sucked into the wormhole of opening tabs in your browser, and feel too tired the next day, don't beat yourself up but go to bed early. As long as this doesn't happen every day, it is OK.

Remember that nobody is perfect. It's OK to fail at successful adulting every now and then. It's OK to feel overwhelmed and spend an evening watching makeover shows or cake-baking contests.[14] As long as you eventually crawl out of your hole of self-pity and get yourself back together and ready to roll, all is well. Roll with the punches, adjust your combat plan, and gear up for your next battle.

If your planning is too tight, during your workday as well as for your evening activities, it is time to rethink your planning. If you start to feel disheartened or stressed because you can never finish everything in the amount of time allotted for your evening tasks, then reduce what you take on. If you have too many duties, even fun ones, reconsider and identify which ones feel like chores and which ones truly fuel you. Identify what is closest to your core and your personal values. If necessary, use journaling to flesh out this question – the answer will also help you define your "personal brand" (see Chap. 9).

The world of Instagram and productivity blogs might make you feel like we all need to wake up early, eat clean, work out, drink green juice, meditate, and do all the “right” things, but sometimes I prefer to hang out with friends, indulge in all the wine, go to bed in the early morning, and sleep all day – and as long as the perfectionists of the internet don’t make us feel guilty about doing so, we are good.

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[14] Or staring at the turned-off TV screen while plowing through an entire box of nuts – something I did a lot when I had just returned to work after my maternity leave. Going to bed, or switching on the TV would have made more sense.

3.2.7 On Learning How to Take Your Self-Imposed Deadlines Seriously

The very basis for my habit of taking my own planning seriously dates back to the time when I was studying in Brussels. In the Belgian system, exams come only twice a year, at the end of about four months of classes. When I started, some courses were still year-long courses and if we failed the exam after the first semester of that course, we could still recover the course by taking an oral exam on the entire course at the end of the academic year. After the period of classes, we had three weeks to study and then three weeks of exams, with usually three days in between the exams. Homework is not as common as in the US system, and is typically not factored in for the final grade (or only as a small percentage), and the amount of theory is typically much larger in my impression. We’d have to memorize entire books with proofs and derivations for every course.[15]

In my very first year I ended up with 50 cm of paper[16] which I had to put into my head some time during the next six weeks. The class period was over, so I was mainly in isolation, and with an amount of material I had never seen before. I was not too positive about ever being able to pass any exam at all. And I indeed failed Linear Algebra (I’ll never forget that), and I barely passed Chemistry. Before that, I had always passed all exams in school with flying colors and minimal effort, but suddenly I was struggling. I was merely struggling with the amount of material I had to work through, taking my short concentration span into account, and my average need for sleep, and relatively large need for breaks and creative activity.

In the Belgian system, every class typically leads to two exams: a theoretical exam (about the derivations of formulas or proofs) and an exam of exercises. I used to do pretty bad on the exercises, since I never really managed to prepare for those. I would try to work through a bunch of examples the day before the exam, not giving my brain the time to really master the material.

Bit by bit, I realized I had to change my way of working. One reason was that I wanted to get rid of the insane amount of stress I’d have during those weeks of exams, and the other reason was that I wanted to master the material – not just study to pass the exam and then forget all about it.

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[15] I’m not sure if the density of an engineering program in Belgium is the best method for developing engineering skills, but this method is used in Belgium, and this is where I learned to work through large amounts of material. Certainly, you learn how to study long periods of time in isolation and develop strong mathematical skills through such a program.

[16] Not including reference textbooks.

So, I started to study during the year. With 40 hours of class a week and compulsory labs which need preparation, it was hard to find time to study (and still being able to practice sports, take music lessons, sing in a band, go out, and all that). I started to actually understand what we were doing in the exercises, and be able to put all the material together and understand the whole story behind the theoretical work. I would make a planning half-way the semester and start working through all the proofs and derivations in the books. Some classes I skipped deliberately to work through the material on my own, during the hours of the lecture. I found what worked best for me, but in order to be able to do so, I really had to respect my own planning.

As my planning became better, I started to get better results, started to be respected by my classmates and my self-confidence grew along the way. I also started to enjoy studying. In spring, I would take my plastic table outside and sit in the pleasant spring weather to study during the day, and then I would reward myself with relax-time in the evening.

Getting such positive results from learning to work in advance became my main motivation to start in time and respect my self-imposed deadlines. I ended up starting a homework the day it was assigned instead of close to its deadline. By now, it has become a habit and I would never want to end up getting so stressed that I am brain-paralyzed again.[17]

Whereas I learned out of necessity to take my planning and deadlines seriously, you can start to implement this method bit by bit yourself. Select one paper that you need to write, and commit to delivering this paper at a self-imposed deadline before the "real" deadline. For a conference paper, try to deliver a month in advance. Take your self-imposed deadline, and plan back to when you need to have the feedback from your coauthors, when you need to deliver your first draft, and when you need to start writing. Put this plan into reality, and enjoy being ready early for once. If the feeling is positive, repeat this approach for your next paper or project – until all of your projects run ahead of their hard deadlines.

3.2.8 When Procrastination Hijacks Your Planning

Let's now look at another problem that occurs. You've made a shiny new planning. You are motivated to make things work. You start on a positive note. But then you think you'll quickly check your mailbox, and start replying a few urgent e-mails. And then you need to look up something on the internet, and before you know it, you find yourself reading the history of the Prussian Kingdom on Wikipedia somewhere in the afternoon… All is lost, and your motivation sinks to the bottom.

If procrastination gets you into its shiny claws every single day, and your planning is not working, then start with one small change at a time. Try processing all e-mail at a fixed time during the day, for example. Consciously focus your attention on this single change for at least two weeks[18] before you start making more changes to your routines (or lack thereof). Change one single thing [9] at a time before you try to overhaul your life.

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[17] To date, I've never missed a deadline.

Then, have an honest look at your procrastination habits [10]. Checking Facebook gives you instant pleasure, but at the same time you are depriving yourself of the ability to go home early and do something you really enjoy. Observe your own behavior: What type of procrastination are you susceptible to? What triggers this kind of procrastination? How often do you feel the urge to leave your work and do something else? You can use your research journal to explore these questions, and revisit these questions regularly.

Now that you know your triggers and traps, try to watch the urge, and just hang in that feeling of unpleasantness, and then watch the urge go away. This mindfulness[19] technique is one of the most powerful methods to get a hold of your impulses.

If you've started to resent your research, and have a hard time motivating yourself, remember that the ability to do research is an intellectual privilege for the lucky few. Try to find the spark of joy and lightness in your work again. In the end, science is a lot of fun [11]. Revisit your motivation for doing a PhD in the first place [12] and reread the "Motivation for research" document you developed in Chap. 2. If you never really considered your motivation and just rolled into your PhD trajectory, make a journal entry in your research journal about your motivation. If something is blocking you at a deeper level, seek professional help [13].

If you're a recovering procrastinator, be gentle on yourself: if today was wasted, you start with a clean slate again tomorrow. Write in your research journal. When I go through bouts of having poor concentration and not getting my work moving forward, I journal about it. I grade myself for a couple of days. One day will be a 4/10 in terms of productivity, and then I analyze in my journal what precisely went wrong. The next day might be a 7/10, and I celebrate my success and see why I was feeling motivated. It could be because I worked out in the morning. It could be because I ate something that did not make me lethargic. It could be some good news that made feel like a million bucks.

3.2.9 *Tools for Assisting Your Planning*

Let's now look at technological tools (desktop and smartphone applications) that can assist you in your planning. We can identify three categories: tools for planning, tracking, and reminding. While new apps are developed every day, and keeping this list up-to-date will not be possible, you will find here an overview of the type of tools that you can look for. When you are developing your planning skills, try out a few different apps and see which one you feel most comfortable with. Once you have something that works, make some tweaks and changes over time, but don't fall for the trap of trying out every new shiny app out there – it will only cost you more time.[20]

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[18] Two weeks is a rough estimate. It really depends on you and the task under consideration how much time it takes before something becomes a habit. Be honest with yourself, journal about your progress, and only take the next step when you feel ready to do so.

[19] Mindfulness is the art of being fully present. You can find more about mindfulness and mindfulness meditation in the glossary in Part II.

So let's now see the different tools that are available to support your planning:

- **Tools for planning**
  - ***General overview***: Select a planning tool (hand-written or digital) for planning towards your defense, and stick to it. You can buy yourself a nice yearly/monthly/daily planner (when you do so, make sure your planner allows for the bigger picture, and not only has pages for your daily activities): many custom planners or even the everything notebook [14] are available for this purpose. You can also go digital and use Google Calendar, iCal, or a similar service. As long as you always have access to your planning (either by carrying it in your bag or having it in the cloud), you're good to go.
  - ***To Do lists***: later in this chapter, we will touch upon To Do lists in more detail, but for now we will focus on the available tools. Again, you can write down your to do lists inside your hand-written planner, or you can go digital. I used to make my weekly and monthly plans in Word documents, but now I've transitioned to using an app for my tasks. I use Todoist, but there are many similar apps out there (Google Tasks, Google Keep, Any.do, Remember the Milk, Wunderlist, …) that offer similar functionalities. Within your list app, make sure you can have separate categories (personal, writing papers, general work to dos, thesis to dos, …) to keep a clear overview. Additionally, I keep lists with research ideas, thesis topics for students, and other more loose, non-timed elements in Evernote (similar tools include Onenote, Google Keep, Simplenote, Together, Nevernote, …).
  - ***Daily appointments***: You can use your weekly template as a basis to add daily appointments into a cloud-based tool, or you can use a paper planner. Even though I started using Google Calendar a long time ago for outlining long-term projects, I preferred to carry my paper planner with me. Only after a few years, and after investing in a smartphone did I make the switch to also having my appointments in Google Calendar. Hybrid paper-digital solutions can work too, as long as you have access to your material when needed.
- **Tools for tracking:** When you are new to planning, new to research, or making some changes in your workflow processes, it is good not only to plan, but also to track your time to see how your planning aligns with reality. If you have a procrastination problem, these tracking tools can show you (perhaps not in the most

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[20] I can't repeat this often enough. Don't try out every new shining app for productivity. Consider what you need, not all that is available.

pleasant way) how much time you are spending on a daily and weekly basis browsing the internet. Examples include ManicTime (free software, in which you can add tags to slots of time and then see how much time you spend on each activity on a daily/weekly/monthly/yearly basis) and RescueTime (free software, which tracks how much time you spend using computer programs that are productive and distracting). When you have a bad procrastination habit, and you want to limit the amount of time you spend on certain websites, you can use tools like Freedom, Cold Turkey for Chrome, or Leechblock for Firefox to limit or block your access to these websites or the internet entirely. It's important to note here as well that for a while, you can use these tools to battle your procrastination problem. Over time, however, you need to address the problem that lies at the source of your procrastination: perfectionism, anxiety…[21]

- **Tools for reminding**: You could have a separate tool to remind you about upcoming deadlines. You can also integrate your deadlines into your To Do list tool and/or work deadlines on your calendar. You can have not only the actual deadlines in your planner or on your To Do list, but also provide some reminders two weeks prior to the deadline, or more, so that you have sufficient time to actually work on the paper or project.

Exercises

Revise the previous material of this chapter, and use the provided information to determine the following:

1. The technological tools that you will try out for planning, to do lists and reminders. Select maximum two tools per category and evaluate these after two weeks to see with which tools you'll stay.
2. A list of your current responsibilities, deadlines, and other elements that need to fit into your planning
3. A rough outline for your PhD until your defense, based on the milestones described previously.
4. The five most important things that you need to accomplish this semester
5. Your weekly template for this semester
6. The outline for this week and next week, based on your weekly template
7. Your daily appointments for this week and next week, embedded in your template. Also schedule when you will make your next planning, ideally on Friday afternoon for the upcoming week, or on Sunday.

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[21] This only works when you procrastinate using your computer. You can switch on blocking and tracking software, but if you then start to procrastinate on your phone, your actions are defeating their purpose.

3.3 Managing Your Time and Research

3.3.1 Project Management Basics

Any large research project, whether it is writing a PhD dissertation, working on a journal publication or writing a grant proposal, is obviously rooted in your analytical skills and research abilities, but won't get finished unless you manage your project and time.

In most fields, however, our training in managing projects (related to research or not), is rather limited. In the Netherlands, there is good support from universities and funding bodies for short workshops that can help you develop these managing skills. In other parts of the world, less support is sometimes available.

If you have no training in managing projects or have never really streamlined your research processes, stop and pause for a moment and ask yourself[22]: "What does my usual workflow process look like?". Then, ask yourself: "How can I do this more efficiently and effectively?". When you already track your time as we discussed before, you have the raw data to analyse your workflow processes.

To work more effectively during your PhD, it is important to ask yourself regularly: "Does this answer my research question?" (see Chap. 5). If not, file it in a "sometime" folder (or a "research ideas" tally in Evernote) and play with that idea later. At this point, it is not relevant enough to spend more time on it.

To work more efficiently, you can follow these steps:

1. **Write a quick outline**[23]: Start with a plan. If you just start researching in the wild without a plan, it would be like driving to a new place without a map or GPS. Before you do anything else, before you estimate how much time the whole thing will take you, just take a sheet of paper and write down a quick outline of the steps that need to be done. For these steps, list down the tasks that you need to carry out, and estimate how much time they will take you. Always add 20–30% extra time as a buffer for your tasks to be on the safe side. For big parts of your research, you might think: "Well, I'm doing research, so I don't know yet how much time this thing will take me!" Certainly, this is true – but you should at least know how you want to start, and which calculations or steps you will take first. Use the subquestions of your research question (see Chap. 5) to guide you. Develop your planning based on the information available. If it turns out that your originally planned approach does not lead to useful research results, then course-correct, roll with the punches, and adjust your plan.

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[22] Use your research journal to write down your observations.

[23] Outlines do not work for everybody. Analyze your learning methods. If necessary, make lists instead, use mindmaps, use your journal to identify what you need to work on, how, and when, or invent a new method. Another method could be to take a separate sheet for every subtask. If you have a proposal, there's guidance depending on the promised deliverables. Your PhD trajectory is a time to learn about yourself, you work habits, and which methods help you get your work done.

2. **Plan the parts of your outline:** Once you have your outline, you can start planning when you will be doing these tasks. Whenever you plan, keep in mind that you never get to really "work" all the hours that you are in your office. There can be phone calls, e-mails, and other interruptions. Remember the "e-mail and admin" category we discussed earlier? You can try to allot that time slot for all these interruptions to free more uninterrupted research time. Unless you have no single other responsibility but your task at hand, you will need to carve out a few hours a day to work on it. For PhD candidates, the other responsibilities can be limited, and you typically can devote at least five to six hours a day to your research project. For a starting assistant professor who is developing new courses and has a high teaching load, finding one to two hours a day for research is a challenge (tip: early in the morning is a good time, before students start showing up and other tasks creep into your research time). Now, take your physical or digital calendar, and start scheduling time slots to work on your research tasks. If you have your weekly template, evaluate your available blocks, and see if you can fit the tasks for your project into these blocks, scheduling maximum 75% of your time.
3. **Assemble your toolkit:** Before you enthusiastically start delving into your new project, take a moment to ask yourself: "What do I need?" Do you have the books you need, or do you know where to find them in the library? Do you have access to journals and software licenses? Do you have the material in the lab that you need for your experiments? Take a moment to make an inventory. If something is missing, start bugging the right people for getting your licenses or material to avoid that you'll get stuck at some point, waiting for the delivery of a missing piece of equipment.
4. **Checkpoints:** Plan time while you are working on your project to check your progress and course-correct if necessary. A checkpoint can be a meeting with your supervisor at a certain point into your research to see if you are on track and if he/she agrees with the direction in which you are going. Another checkpoint can be your weekly or monthly self-assessment [15], in which you analyze what work you did the past week/month, which work you did not do, and why you couldn't do it. Revise how much time things really take you. Think about what goes particularly well, and what you are struggling with, and adjust your workflow processes where needed. Self-assessments are important in the process of becoming a fully independent researcher.
5. **Document your assumptions and process:** While working on your research project, keep track of the trails that did not work. Keep a version management tab in your spreadsheets [16] so that you know what you did, when you did it, and why you made certain changes. In science, your basic assumptions are extremely important; so write them down. I like keeping track of my assumptions and choices in a separate file. I also like keeping all the handwritten pages that led to my ultimate choice for a certain model or theory, so that I can later on revisit the logic I followed. Often, I take pictures of these sheets and store them as backup in Evernote.
6. **Project journal:** You will lose pages of calculations, and you will forget where you put a certain measurement device in an experiment. Therefore, use your

labbook and research journal, and write down briefly what you did every day in your project, which files you created or worked with, and why you made certain choices. Such a journal will give you the quick overview of the progress of your project, and can be a lifesaver when you try to remember what you did a few months earlier.

3.3.2 Tracking Your Time

As mentioned before, tracking your time is as important as planning your time when you are learning how much time different tasks take. The important part here is to be honest with yourself. If you spent an entire hour on social media, don't track that timeslot as "matlab programming". Don't beat yourself up about it either – you don't have to share the results of your time tracking with your supervisor, he/she is just interested in your results, regardless if it took you two hours to come to an important result or 200 hours. You are in the process of learning how to work more effectively and efficiently, and you are doing this tracking just for yourself; to assess yourself and learn from the results. I recommend that you track your time in detail for a week, and that you use more general apps (ManicTime, RescueTime…) for a larger period of time. You can discuss the changes you made to your planning based on your tracking results in your research journal.

3.3.3 Prioritizing

To select the tasks that need your attention first, and to prioritize your efforts, it is important to identify where these tasks lie in terms of importance and urgency, see Fig. 3.4. When you have an overflowing To Do list, it is important to know which task you need to complete first, and which task can wait a bit (or can be delegated,

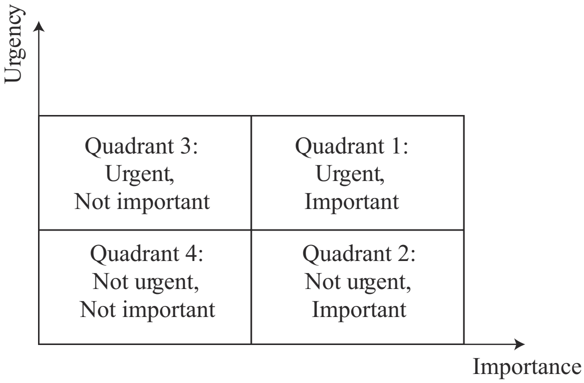
Urgency
Quadrant 3: Urgent, Not important
Quadrant 1: Urgent, Important
Quadrant 4: Not urgent, Not important
Quadrant 2: Not urgent, Important
Importance

Fig. 3.4 The urgent-important matrix [3]

or removed from your list altogether). There is always some admin work that needs to be done, and always e-mails that need to be answered. But what matters for your career in the long run is the completion of your dissertation and your publications.

Take your To Do list, and categorize your tasks according to the urgent-important matrix [17]. Some typical tasks in these four categories are:

1. **Category 1: Important and urgent**
   - Conference paper deadlines
   - Arranging lab equipment to arrive
   - Teaching
   - Carrying out experiments
2. **Category 2: Important and not urgent**
   - Writing journal papers (almost never with a deadline)
   - The core of your research
   - Keeping up with the literature
   - Long-term goals
   - Sports
   - Enough sleep
3. **Category 3: Not important and urgent**
   - Grading
   - Meetings
   - Registration deadlines
   - Some pending admin work
   - Phone calls, e-mail
   - Visitors
4. **Category 4: Not important and not urgent**
   - Chatting with colleagues[24]
   - Web browsing
   - Busy work

The urgent-important matrix is not only helpful when assessing your To Do list. It is also a tremendous tool to evaluate how you are spending your time. If you are tracking your time, calculate how much time you are spending in each of these categories. Over time, you want to spend more time in Category 2 and less in Categories 3 and 4. Category 2 is the deep science, where you don't reap the benefits after a short amount of time, but where you are doing most of your progress.

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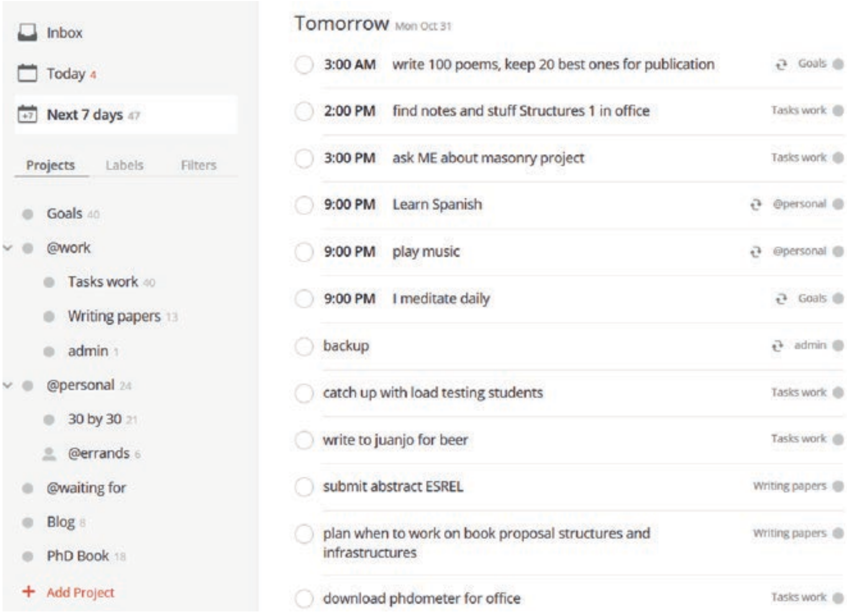
[24] This can also be "important not urgent" as discussing your work with your colleagues can give you new ideas, and building good relations with your colleagues is important so that you don't feel lonely, stressed, and isolated.



Tomorrow Mon Oct 31

○ 3:00 AM write 100 poems, keep 20 best ones for publication ⟳ Goals
○ 2:00 PM find notes and stuff Structures 1 in office Tasks work
○ 3:00 PM ask ME about masonry project Tasks work
○ 9:00 PM Learn Spanish ⟳ @personal
○ 9:00 PM play music ⟳ @personal
○ 9:00 PM I meditate daily ⟳ Goals
○ backup ⟳ admin
○ catch up with load testing students Tasks work
○ write to juanjo for beer Tasks work
○ submit abstract ESREL Writing papers
○ plan when to work on book proposal structures and infrastructures Writing papers
○ download phdometer for office Tasks work

Fig. 3.5 Example of lists (The entry that was due at 3 am should have been 9 pm – possibly the times were confused as I traveled through time zones. As always, I am just taking inedited material from my own tools)

3.3.4 *Using Lists Effectively*

In order to use lists effectively, you need to have a To Do list that suits your needs. You don't want an endless list of meaningless (Category 4 from Fig. 3.4) tasks – you'd still be tired at the end of the day, but you'd have accomplished very little. You can see an example of how I use my lists in Fig. 3.5, as I use different categories of tasks, and recurring tasks.[25] Additionally, I use my daily planning in my weekly template (Fig. 3.3) for my most important tasks.

Know that what worked for you during your undergraduate studies may not be the right approach during your PhD. We never have it all figured out. We never know it all. Life is about searching and experimenting, and that is the whole journey – remember Cavafy's poem Ithaka [18].[26]

Make sure your lists reflect the actual time you need for things. If day after day, week after week, you have to postpone some activities, you have to reduce the amount of tasks you plan and increase the time allotted to each activity. Finding a planning and list system that works for you is an iterative process. Just consider it a learning process, and eventually you will have a system that suits you. Journal about your trials and errors. There's no one-size-fits-all solution to planning, and you can't outsource your planning to someone else: you need to be honest with yourself and acknowledge when and how you work best, and how much time tasks take you.

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[25] Recurring tasks have the ⟳ symbol.

[26] Or make yourself a cup of tea and go read the poem.

If the end of your contract is drawing near, and the amount of work ahead of you seems unsurmountable, then be ruthless at cutting away tasks that don't matter now. Always ask yourself: "Will this answer my research question?", or "Will this activity bring me closer to PhD completion?" Use this guidance to select the tasks you need to focus on.

If you need to prioritize, identify three tasks for the day that are your three Most Important Tasks [9]. Work on these tasks first thing in the morning, while you are still fresh, and before other distractions creep into your day. Your three most important tasks would be tasks that keep your current part of your research moving forward, or, if you are close to completion, three tasks that bring the completion of your dissertation closer. These are the tasks I schedule in my time slots of my daily planning (see Fig. 3.3).

An interesting method for organizing lists is what Adam Feinman [19], a PhD student in Biomedical Engineering at USC, uses. His list, which contains everything he needs to accomplish and everything he desires, gets updated every week. The list is organized like an outline, with each task numbered, and then detailed as subtasks. The tasks can be papers that need to be written, experiments that need to be done, conference trips that need to be planned, or personal items.

Exercises

1. Select which system you will try out for keeping your lists.
2. Make an overview of the different tasks that you need to be working on now and during this semester. You can make this overview according to different categories: research, teaching or coursework, service duties, conferences, other work duties, and list your tasks per category.
3. Add these tasks to your lists: when should you be working on these, and when are the deadlines. Do you have any recurring tasks that need to be repeated on your list?

3.4 Self-Care and Taking Time to Take Care of Yourself

3.4.1 Planning Self-Care, Sleep, Movement, and Food

This final topic deals with the need for self-care routines and sufficient sleep. To make sure you take good care of yourself, you need to reserve time for it. Your PhD should never be a cause for your social life and health to dwindle down.

As you can see in Fig. 3.2, I plan my workouts.[27] A lot of your planning, and planning of your self-care depends on your circumstances. You can see in Fig. 3.2

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[27] As mentioned previously, when I am in Ecuador it works best for me to plan my workouts first thing in the morning, and when I am in the Netherlands, I go after work.

that I don't plan activities past 9 pm on weekdays, so that I can get enough sleep.[28] I leave large time slots open on weekends to fill with self-care and social activities, and usually do my food prep for the week on Sunday afternoons. My schedule also includes enough time to sit down for my meals, and eat properly.

Dr. Silvia Tavares, a lecturer in Urban Design at James Cook University in Cairns, Australia, [20] warns us that we should never accept "being tired" as a norm.[29] If you are tired, take some rest, and spend more time on activities that help you recharge. Moreover, to avoid getting to an overworked state, Dr. Tavares recommends to add physical activities to all budgets, especially time and financial budgets.

3.4.2 How to Break Out of Unhealthy Patterns

Does the following situation sound familiar to you? *You have a lot of work to do, and feel rather stressed. You stay late in the lab to finish something, and your dinner is a bag of chips from the vending machine. You come home very late, and try to sleep right away, but your mind is too busy to shut down, so you watch your entire Instagram feed or all the Buzzfeed videos. You finally fall asleep very late in the night. Your alarm goes off in the morning to go back to work. You snooze for 40 minutes extra, skip breakfast, and rush out of the door, back to the lab, where the whole cycle repeats itself. You feel tired and have difficulties concentrating, and you notice that you made some mistakes in your work the day before. You decide to set this straight right away, and stay in even longer to fix your errors.*

This cycle certainly is not healthy. Try this for a few weeks, and eventually you will catch a virus, develop insomnia, or just feel plain miserable. To avoid letting yourself down the drain that far, it is good to have a planning that leaves enough air for self-care, sleep, exercise, food, and fun. But what if you find yourself caught in a vicious circle of stress, snapping at your friends that you really don't have time to go see them on Friday night, and does anybody even know how hard your PhD program is?

If that's the case, the first step is to acknowledge to yourself that you are overdoing it. There are plenty of people in academia that wear themselves out to absurd levels, so standing up to say that you want to have a life requires going against the tide. In an environment where people brag about the eight hours of sleep in total they had over the last week, saying that you sleep eight hours a night is almost like swearing in the church. I've been eyed very suspiciously in the past, but I have built a strong publication record while teaching three courses per semester and obtained tenure at the tender age of 31, which gives me some credit. There are academics who seem to be built of steel, and who can keep going on forever, but most of us are not like that. If you find yourself stuck in an unhealthy rut, at least come clean with yourself, and acknowledge that you are not doing yourself and your family (if you are married or in a committed relationship and/or have kids) good.

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[28] Not always a success, but certainly a goal I am working on

[29] Unless when you have a newborn baby, I'd add as a comment.

The next step is to sit down for a moment and reflect on your situation. You are working long hours. OK, what are the projects, tasks, and deadlines you need to take care of? Can you use the urgent-important matrix from Fig. 3.4 to identify what needs your undivided attention right now? What are your three highest priorities at the moment? What can you postpone until you have a bit more time? What can you give up or delegate? Distill the most important tasks from your list of tasks, projects, and deadlines, and start working on those tasks every day first thing in the morning, before interruptions disturb you.[30]

Now that you know what you need to focus on, make a list of changes you would like to make to take better care of yourself. A few ideas for your list are:

- eat at least one home-cooked meal per day
- get enough sleep (for example, at least 7 hours a night)
- get your 150 minutes of moderate activity and two strength training activities [21] every week
- play every day with your pet and/or kids
- spend at least one evening a week reading a good book
- practice with a band or orchestra, or take painting classes

Once you've identified what you would like to do, and which activities you would like to combine with your academic pursuits, pick one thing that seems the most important right now for you. Are you really tired, and kept alive by coffee, then commit to improving your sleep first. Do you need to catch your breath after walking up a single flight of stairs, then start getting some exercise. Pick one thing, and only one thing, and focus on making a change for the next 21 days[31] [9]. Don't overhaul your entire life overnight – you might keep it up for a few days, but then you will easily fall back into your old patterns. Go slowly, gradually, so that you have the time to adjust and the mental clarity and energy to commit to one change at a time.

If you can't stick to your commitment for making a change, then stop yourself in your tracks, and question yourself why you wanted to make a change in the first place. Write your motivation down in your journal. Remember the stress and how you were feeling prior to dedicating yourself to trying to change your unhealthy patterns. Doesn't feel good, does it? If you don't see the beneficial effects of making a change right away, have some patience with yourself. Climbing out of a hole is not an overnight adventure, so allow yourself time to recover and find the sunlight again.

---

[30] Keep your smartphone stowed away, and your mailbox and social media sites closed while you need to concentrate.

[31] According to [22], 21 days is a gross simplification – it really depends on you and the task to determine how long it takes before something becomes a habit.

3.4.3 Reward Yourself for Sticking to Your Plan

One good thing about having a planning, is that at the end of the day, when you achieve your goals, you can sit back and reward yourself. If you work hard, you should pat yourself on your back. Nobody will come after you to pat you on your back, so you have to take care of it yourself....

- Finished a paper on time? Go get yourself a massage.
- Submitted your research proposal? Head to the beach for a weekend.
- Graded all those exams? Time for a movie.
- Got a paper accepted? Go out to dinner and celebrate.

Life is to be enjoyed - and as academics, we're often too hard on ourselves. Take good care of yourself, and put a bit of sparkle into your semester. This bit of magic and unicorn dust will make your semester (or year) so much more balanced and enjoyable. Laura Vanderkam suggest keeping a list of fun activities [23].

Taking time out to celebrate your wins is a vital part of your research. It is a moment to sit back, and look back on how far you've come. If you just keep moving forward without ever having a moment to relax and reflect, you'll find yourself stuck in a tunnel, and perhaps funnel down into unhealthy habits.

Exercises

1. Take the schedule that you developed at the beginning of this chapter. Does your long-term planning include weeks of holidays and extra air? Does your weekly template allow time for staying sane and healthy?
2. Make a list of seven fun things you would like to do this semester, including activities that take between one hour and a full day or even an entire weekend. Plan these activities, in such a way that you have something to look forward to about every two weeks.
3. If you are currently stuck in a rut, revise the section on how to break out of unhealthy patterns, and implement these recommendations. Write in your research journal about the change you want to make, and how you currently are feeling.

3.5 Summary

This chapter helps you get started with getting a grip on your PhD project and your time. Wherever you are in the PhD process, you have learned here how to set up a successful planning, how to include enough time for yourself so your thesis does not eat your life, and how to roll with the punches if your planning fails. With setting up your planning and laying out what needs to be done, you are warming up your research muscles in the right way to start your project with the right tools. The information and changes suggested in this chapter may be a lot. Start by trying out one element, or use this chapter on an as-needed basis.

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Chapter 4
Developing Your Literature Review

Abstract This chapter covers your literature review. The first topic is related to finding the right references. We discuss how broad and how deep you should be reading to explore the literature in your field. You get tips for finding references. After the part about finding the references and reading them comes the topic on how to process the references. We encourage you to start writing as early as possible. An example of something you can start writing after reading your first paper, is a short summary, together with a discussion of the paper, and some questions to discuss with your supervisor. In this way, you can shape the literature review report in an organic manner. Students often ask: "When am I done with reading for my literature review?" We analyze this question, and identify when you are ready to finalize your literature review. But behold, you are never "done" with reading, and we discuss the importance of keeping up-to-date with the scientific output in your field of study. Finally, we discuss briefly how you can turn your literature review report into a dissertation chapter or into a journal paper, depending on which format your institution requires for graduation.

Keywords Literature review · Literature survey · State-of-the-art · Academic reading · References · Reference management

4.1 Introduction and Learning Goals

This chapter covers the literature review, which is typically the first research activity you carry out during your PhD. By the end of this chapter you will have learned how to go from reading your first papers, to writing your literature review report, to summarizing this information into the literature review chapter of your dissertation or into a review paper.

To find interesting papers for your research, you need to learn how to browse the academic literature. You will learn how to find papers, and how your reading changes from the beginning, when you need to study your research topic, to the end, when you can engage with the scientific literature of your research topic. After reading a reference, it is important you store it in such a way that you can find it back whenever you need it. You will set up your storage protocol in an exercise.

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E. O. L. Lantsoght, *The A-Z of the PhD Trajectory*, Springer Texts in Education,
https://doi.org/10.1007/978-3-319-77425-1_4

To write the literature review report, there are a number of different ways to organize the material you have worked through. These different approaches are discussed, and specific ideas for interdisciplinary research topics are given. Finally, we discuss how you can summarize the information from your literature review report into a chapter of your dissertation or into a review paper.

4.2 Browsing the Academic Literature

4.2.1 How to Find References

At the beginning of your PhD trajectory [1], most likely your supervisor will give you at least something to get you started with reading. You can start your search into the literature based on the references in the document(s) that you get from your supervisor,[1]. and then again look at the references in these references, and so on and so forth. If your supervisor is too busy to get you started, ask other PhD students, post-docs, and colleagues in your research group for recommendations.

Additionally, I suggest you start to browse your research topic based on keywords in search engines such as Scopus or Google Scholar to find relevant articles, see Fig. 4.1. You can miss these references if the original documentation from your supervisor follows one school of thought. If you have never used a search engine for academic publications before, contact your library staff. They often organize workshops or short trainings to teach you how to access the publications your library is subscribed to.

Another good starting point is a review paper written by an authority in your field (often an emeritus professor looking back on the past decades of research on a certain topic), or a document on this topic published by a technical committee. Look up which organizations in your field form technical committees, which of these are relevant to your research topic, and which documents they have produced. Review papers and technical documents typically include a large number of references for you to check out.

For books, I recommend you to visit your university's library and browse the available books relevant to your research. Check out these books, and then look up the references of these books. You can also use the digital tools of your library, and read these books online, but who doesn't enjoy escaping into the library to browse books and enjoy the silence, or reading a print book in a quiet corner of the library or in a café with a good espresso?

If you need to find a reference, but your library does not have access to the document, try a general search in Google. Many scholars provide PDFs of their articles on their personal webpages. Alternatively, the article can be hosted on a dedicated site such as ResearchGate or Academia.edu, see Fig. 4.2. If the reference was published not too long ago, chances are that the author(s) are still working at the same place that is listed as their affiliation on the article. You can look up the author(s) on

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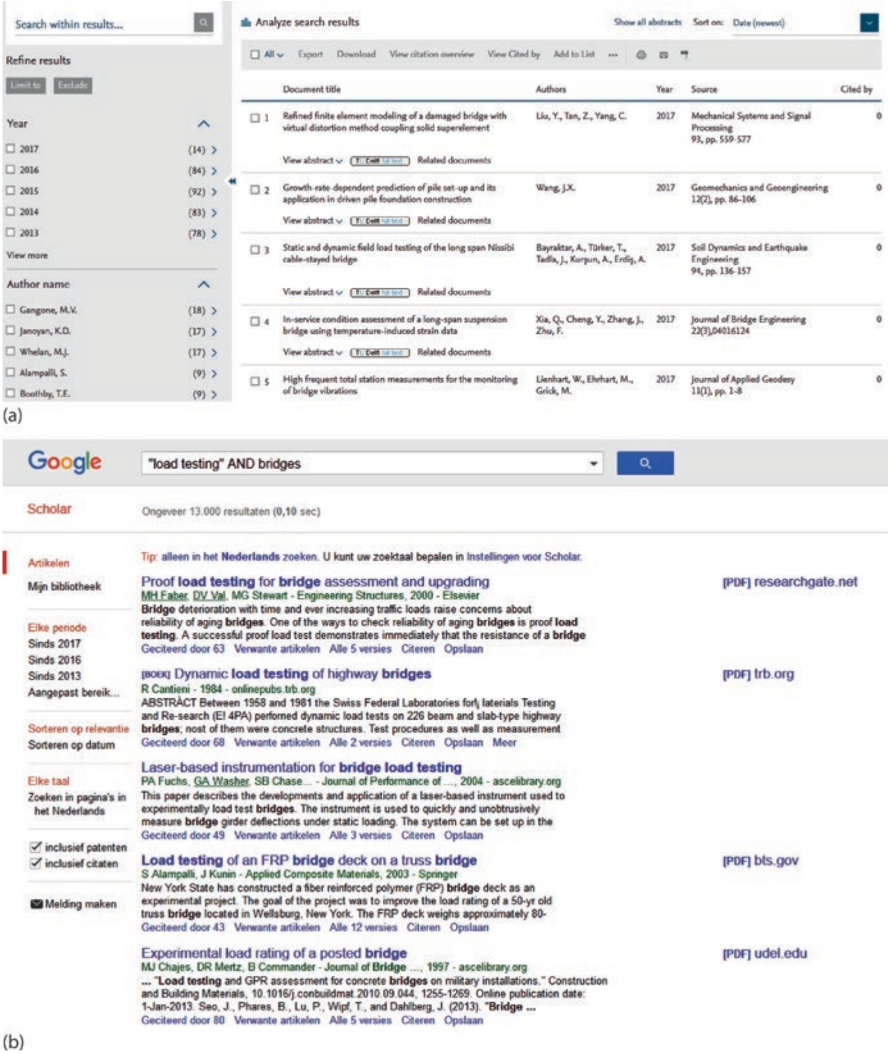
[1] Promotor, advisor.



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☐ 3	Static and dynamic field load testing of the long span Nissibi cable-stayed bridge View abstract Related documents	Bayraktar, A., Türker, T., Tadla, J., Kurşun, A., Erdiş, A.	2017	Soil Dynamics and Earthquake Engineering 94, pp. 136-157	0
☐ 4	In-service condition assessment of a long-span suspension bridge using temperature-induced strain data View abstract Related documents	Xia, Q., Cheng, Y., Zhang, J., Zhu, F.	2017	Journal of Bridge Engineering 22(3),04016124	0
☐ 5	High frequent total station measurements for the monitoring of bridge vibrations	Lienhart, W., Ehrhart, M., Grick, M.	2017	Journal of Applied Geodesy 11(1), pp. 1-8	0

Google Scholar   "load testing" AND bridges

Ongeveer 13.000 resultaten (0,10 sec)

Artikelen
Mijn bibliotheek

Elke periode
Sinds 2017
Sinds 2016
Sinds 2013
Aangepast bereik...

Sorteren op relevantie
Sorteren op datum

Elke taal
Zoeken in pagina's in het Nederlands

☑ inclusief patenten
☑ inclusief citaten

Melding maken

Tip: alleen in het **Nederlands** zoeken. U kunt uw zoektaal bepalen in Instellingen voor Scholar.

Proof **load testing** for **bridge** assessment and upgrading   [PDF] researchgate.net
MH Faber, DV Val, MG Stewart - Engineering Structures, 2000 - Elsevier
Bridge deterioration with time and ever increasing traffic loads raise concerns about reliability of aging **bridges**. One of the ways to check reliability of aging **bridges** is proof **load testing**. A successful proof load test demonstrates immediately that the resistance of a **bridge**
Geciteerd door 63   Verwante artikelen   Alle 5 versies   Citeren   Opslaan

[BOEK] Dynamic **load testing** of highway **bridges**   [PDF] trb.org
R Cantieni - 1984 - onlinepubs.trb.org
ABSTRÀCT Between 1958 and 1981 the Swiss Federal Laboratories for; laterials Testing and Re-search (E! 4PA) perfomed dynamic load tests on 226 beam and slab-type highway **bridges**; nost of them were concrete structures. Test procedures as well as measurement
Geciteerd door 68   Verwante artikelen   Alle 2 versies   Citeren   Opslaan   Meer

Laser-based instrumentation for **bridge load testing**
PA Fuchs, GA Washer, SB Chase... - Journal of Performance of ..., 2004 - ascelibrary.org
This paper describes the developments and application of a laser-based instrument used to experimentally load test **bridges**. The instrument is used to quickly and unobtrusively measure **bridge** girder deflections under static loading. The system can be set up in the
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Load testing of an FRP **bridge** deck on a truss **bridge**   [PDF] bts.gov
S Alampalli, J Kunin - Applied Composite Materials, 2003 - Springer
New York State has constructed a fiber reinforced polymer (FRP) **bridge** deck as an experimental project. The goal of the project was to improve the load rating of a 50-yr old truss **bridge** located in Wellsburg, New York. The FRP deck weighs approximately 80-
Geciteerd door 43   Verwante artikelen   Alle 12 versies   Citeren   Opslaan

Experimental load rating of a posted **bridge**   [PDF] udel.edu
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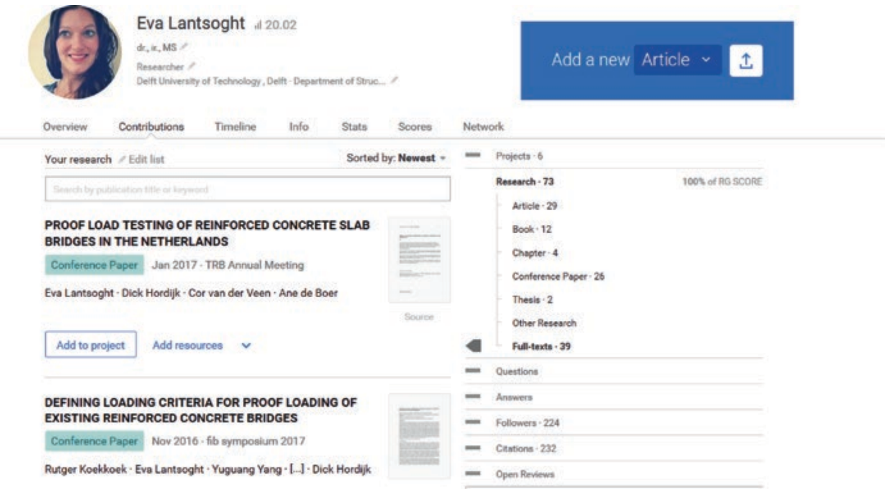
Geciteerd door 80   Verwante artikelen   Alle 5 versies   Citeren   Opslaan

Fig. 4.1 Search for "load testing" AND bridges. Compare the results from (**a**) Scopus and (**b**) Google Scholar

Google, look for an e-mail address (almost all universities provide contact information of their academic staff), and ask them if they would be so kind to send you the article. Most researchers are happy to hear from someone conducting research in their field, and are willing to share their article with you, as well as answer questions you may have about their publication.

There are no real shortcuts to know which references are important [1], and to find the "right" references. If you start to see a certain paper referenced many times, it means that it has been rather influential in your field. To know which paper is going to be the cornerstone on which you start building your work, you need to have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PROOF LOAD TESTING OF REINFORCED CONCRETE SLAB BRIDGES IN THE NETHERLANDS
Conference Paper Jan 2017 · TRB Annual Meeting
Eva Lantsoght · Dick Hordijk · Cor van der Veen · Ane de Boer

DEFINING LOADING CRITERIA FOR PROOF LOADING OF EXISTING REINFORCED CONCRETE BRIDGES
Conference Paper Nov 2016 · fib symposium 2017
Rutger Koekkoek · Eva Lantsoght · Yuguang Yang · [...] · Dick Hordijk

Fig. 4.2 Articles available for direct download via ResearchGate

defined your research question clearly. But in order to flesh out your research question, you need to have a good grasp of the literature in your field. You will need to explore the literature to look for open ends that require further research, and for contradictions in your field. If you find topics on which authors disagree, and can identify which piece of information they are missing to conclude their discussion, you've just found the pond of the research question fish.

I encourage everybody to read a lot. Read recent issues of important journals in your field cover to back. Read classic papers in your field. Read books and technical documents. The more you read, the more tools you develop in your mind. This advice on reading a lot does not only apply to beginning PhD students – it is a basic premise for all scholars, and it is the first step that is required for every research project. If you start with a limited understanding of the scholarly output in a certain field, and you start to do research on a topic, you risk building something on a poor foundation. In other words, you are risking the whole house to slowly sink into sloppy soil. I'm a big fan of peripheral reading to broaden your knowledge in your field.[2]

A final issue here is language. While the majority of scientific publications are written in English, there are large bodies of work available in other languages (in my field, especially in German). If you can, search for literature references in several languages, and explore the important journals in your field in foreign languages. Most journal articles that are not published in English include the abstract in English, and sometimes the figure captions. Even if you don't speak the language of the article, looking at the figures sometimes already gives you an idea of what the paper is about, and if you should ask a friend who speaks that language to have a look at it (I do this when I come across an interesting paper in Chinese, for example).

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[2] My Endnote library, which I started to build in 2010, currently holds a little less than 2400 references.

4.2.2 On Reading Broadly and Deeply

When carrying out your literature review, you should read both broadly and deeply. You need to gain an understanding of your research topic in depth, so you should study the references that are important in your field in a detailed way. Additionally, you need to gain an understanding of a number of tangentially related problems, so you need to read across a broad spectrum of disciplines. For these publications, you don't need to read to the level of analyzing line per line, equation per equation, but you need to read to grasp a general understanding of these fields. If you are carrying out interdisciplinary research, there might be a number of topics for which you need to read deeply, and then a whole host of topics for which you need to read broadly.

In order to read deeply and broadly, it is important that you understand which publications are the key publications in your field (the papers you need to study thoroughly), and which papers require less of your mental space and focus. The key publications can be a subset of papers that your supervisors hands over to you, if you are lucky. If you have no help in getting started with your literature review, you will need to do a bit of exploratory reading before you can identify which papers are crucial for your research, and which help set the general background of the problem.

There are different ways in which we read, depending on how we interact with the academic literature [2]. I've divided the different approaches into six categories, or stages of reading:

1. **The novice**: The novice has just started to explore the scientific literature on a certain topic, or is perhaps even completely new to reading technical papers at all. As a novice, you may spend more than a week working your way through the first paper on your research topic. You read and reread almost every sentence, and still feel you don't full understand the contents. You doubt if you are qualified to do research on this topic. Hold on tight, keep working, keep scribbling down notes, and see where it takes you.
2. **The apprentice**: After being a novice for a while, you will reach the point where you finally start to grasp the research topic and learn the concepts. The energy of the apprentice still goes into understanding what the topic is exactly about, which parameters are important, and which researchers played an important role in the development of the field and/or currently shape the field. However, the apprentice has developed a basic understanding of the topic.
3. **The sponge:** Once you have gained the basic tools and understood the basic concepts, you reach the stage in which you start to absorb information like a sponge. You find yourself taking a fair amount of notes, but reading starts to be a bit faster than in the beginning. The concepts finally seem familiar to you. At this point, as you start picking up speed, you need to start archiving and building a database about the information you read, see "processing references". At this stage, when you read a paper, your focus is fully on the contents of the paper itself, in a rather narrow sense. Sponge-mode typically lasts a few months.

4. **The concluder**: As a concluder, you start to engage with the scientific literature more directly. Once your brain has taken in the information from a fair number of papers, it starts to play a more active role. You start to see similarities between a set of papers, and start to draw some conclusions from what you have read so far. The concluder-stage is a good point to start writing about your observations and conclusions in your research journal.
5. **The interrelater**: In the interrelater-stage, you start to put together information from the entire range over which you have been reading, across decades and disciplines. You start to see your own work in the light of the field or fields that you are studying. You start to see how certain tools from a different discipline can be valuable for your work. The bigger lines and schools of thought appear, and you are now fully engaging with every document you read. As a novice and apprentice, you sit and listen to a paper. As an interrelater, you sit and have a conversation with a paper.
6. **The mongrel**: Dr. Inger Mewburn[3] described this stage of reading in a blog post [3], describing how with this method you simply go for what you need in a document. When you need a select piece of information from a paper or document, you can dive into it and grab what you need – quickly. If a topic is not fully the focus of your research, but interesting enough to chew through a few papers on this topic, you can scan these papers quickly and steal the good parts. Go for the quick-and-dirty approach: read the abstract and conclusions, look at the pictures, and skim through the beginnings and endings of the paragraphs to find what is useful for you. With this method, you can tear through a paper in 15 to 20 minutes. In this stage, you are more oriented on yourself and your research than on the contents of the paper itself. As an interrelater, you were sitting down and having a conversation with a paper, while as a mongrel, you barge into the kitchen of the author, munch down a big piece of cake, and leave again.

Exercises

1. Go to the library and find five books that are related to your research field. Read the interesting chapters, and look up the references given at the end of these chapters.
2. Look at the references you have collected so far. Which ones require deep study, and which ones help you get a broader understanding of your research field and connected fields?
3. Identify at which stage of reading you are. Write a short paragraph, preferably in your research journal, and discuss the following:
   (a) How you currently are reading,
   (b) Which preparation and/or training you already have related to reading scientific papers, and
   (c) How you currently are analyzing the material in your field.

---

[3] If you haven't done so yet, subscribe to her blog, the Thesis Whisperer.

4.3 Processing References

4.3.1 Storing References

Once you have started to download, copy, and/or print references, you need to think about how you will keep your references accessible and searchable. Remember how we discussed setting up your data storage protocol in Chap. 2? Having your data structured, easily searchable, and regularly backed-up so that you don't lose anything, is just as important for your references as for any of your other documents.

How will you save your references? Will you print out each article, and save them in large binders? Having physical copies can be pleasant for taking notes, but if you move elsewhere at the end of your PhD, binders and boxes full of articles can be impractical.

If you want to keep your physical copies organized, I recommend you sort your copies alphabetically by first author in binders. Organizing hard copies by topic can become convoluted if publications fit into different categories of topics [4]. I had initially started to organize my hard copies by topic, but decided to redo my storage after having read about 300 papers. While reorganizing the papers, I could see more clearly the links between the articles, and how my research fell into three major categories (slab bridges, one-way shear, and two-way shear). The afternoon that I spent on reshuffling all papers was actually really productive, as I started to become more aware of the basic assumptions, paradigms, differences, and similarities between the different publications.

Build a digital archive of your articles. Consider how you will name your files (Title-Author-year.pdf or Year-Author.pdf, for example), and how you will keep your documents structured (for example, in subfolders per topic).

Additionally, you should build a database with your references. There are specific software packages that you can use for this purpose (EndNote, Zotero, Mendeley…) [5], see Fig. 4.3, and these tools are essential to doing research. Start building your database as early in your PhD trajectory as possible.[4] These software tools make your database of references easily searchable by author, title, keywords, and more, and you can add your own notes to the database entries as well. Long gone are the days of making overview tables in MS Excel, lists of references in MS Word, or boxes with index cards for your references. An additional (and important) advantage of building your database of references is that these tools come with plug-ins for your word processing software, which allow you to easily insert citations and build a list of references for an article in the right output style. If you prefer to read from your hard copies, you can still use your database software to look up who was the first author of the paper you want to revise, and then locate the hard copy in your binder [4].

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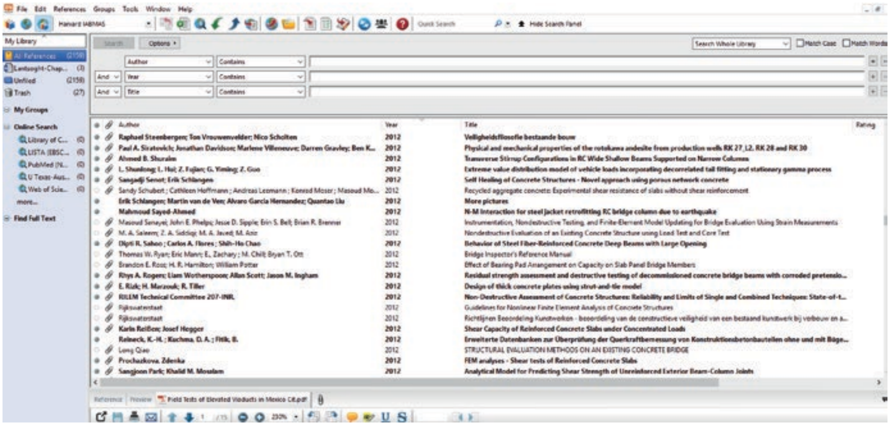
[4] In fact, I encourage my undergrads to start building a database of the literature.



	Author	Year	Title	Rating
	Author	Year	Title	Rating
📎	Raphael Steenbergen; Ton Vrouwenvelder; Nico Scholten	2012	Veiligheidsfilosofie bestaande bouw	
📎	Paul A. Siratovich; Jonathan Davidson; Marlene Villeneuve; Darren Gravley; Ben K...	2012	Physical and mechanical properties of the rotokawa andesite from production wells RK 27_L2, RK 28 and RK 30	
📎	Ahmed B. Shuraim	2012	Transverse Stirrup Configurations in RC Wide Shallow Beams Supported on Narrow Columns	
📎	L. Shunlong; L. Hui; Z. Fujian; G. Yiming; Z. Guo	2012	Extreme value distribution model of vehicle loads incorporating decorrelated tail fitting and stationary gamma process	
📎	Sangadji Senot; Erik Schlangen	2012	Self Healing of Concrete Structures - Novel approach using porous network concrete	
📎	Sandy Schubert; Cathleen Hoffmann; Andreas Leemann; Konrad Moser; Masoud Mo...	2012	Recycled aggregate concrete: Experimental shear resistance of slabs without shear reinforcement	
	Erik Schlangen; Martin van de Ven; Alvaro Garcia Hernandez; Quantao Liu	2012	More pictures	
	Mahmoud Sayed-Ahmed	2012	N-M Interaction for steel jacket retrofitting RC bridge column due to earthquake	
📎	Masoud Sanayei; John E. Phelps; Jesse D. Sipple; Erin S. Bell; Brian R. Brenner	2012	Instrumentation, Nondestructive Testing, and Finite-Element Model Updating for Bridge Evaluation Using Strain Measurements	
📎	M. A. Saleem; Z. A. Siddiqi; M. A. Javed; M. Aziz	2012	Nondestructive Evaluation of an Existing Concrete Structure using Load Test and Core Test	
📎	Dipti R. Sahoo; Carlos A. Flores; Shih-Ho Chao	2012	Behavior of Steel Fiber-Reinforced Concrete Deep Beams with Large Opening	
📎	Thomas W. Ryan; Eric Mann; E. Zachary; M. Chill; Bryan T. Ott	2012	Bridge Inspector's Reference Manual	
📎	Brandon E. Ross; H. R. Hamilton; William Potter	2012	Effect of Bearing Pad Arrangement on Capacity on Slab Panel Bridge Members	
📎	Rhys A. Rogers; Liam Wotherspoon; Allan Scott; Jason M. Ingham	2012	Residual strength assessment and destructive testing of decommissioned concrete bridge beams with corroded pretensio...	
📎	E. Rizk; H. Marzouk; R. Tiller	2012	Design of thick concrete plates using strut-and-tie model	
📎	RILEM Technical Committee 207-INR	2012	Non-Destructive Assessment of Concrete Structures: Reliability and Limits of Single and Combined Techniques: State-of-t...	
📎	Rijkswaterstaat	2012	Guidelines for Nonlinear Finite Element Analysis of Concrete Structures	
📎	Rijkswaterstaat	2012	Richtlijnen Beoordeling Kunstwerken - beoordeling van de constructieve veiligheid van een bestaand kunstwerk bij verbouw en a...	
📎	Karin Reißen; Josef Hegger	2012	Shear Capacity of Reinforced Concrete Slabs under Concentrated Loads	
	Reineck, K.-H.; Kuchma, D. A.; Fitik, B.	2012	Erweiterte Datenbanken zur Überprüfung der Querkraftbemessung von Konstruktionsbetonbauteilen ohne und mit Büge...	
📎	Long Qiao	2012	STRUCTURAL EVALUATION METHODS ON AN EXISTING CONCRETE BRIDGE	
📎	Prochazkova, Zdenka	2012	FEM analyses - Shear tests of Reinforced Concrete Slabs	
📎	Sangjoon Park; Khalid M. Mosalam	2012	Analytical Model for Predicting Shear Strength of Unreinforced Exterior Beam-Column Joints	

Fig. 4.3 Organizing references in Endnote. The paperclip shows which references have a digital attachment with the original publication

4.3.2 *Engaging with the Literature*

Don't sit down and read for months on end. Engage with the literature from the beginning. If you sit with the literature for months, it is difficult to bring material to meetings with your supervisor. Start producing short documents about the material you read so that you have something tangible showing your progress. These documents will eventually be the first building bricks of your final literature review document. Starting to write out your thoughts about the publications you read is a good way to get started with writing from the beginning. Don't wait with writing until you need to deliver your literature review report, or, if your PhD program only requires the dissertation in the end, don't wait with writing until you have reached the point in which you feel you have all the information to start delivering your dissertation. You won't have the right tools to start writing if you don't practice. Start writing as early as possible, start receiving feedback from your supervisors about your writing early, and take enough time to find your writing voice before you actually tackle your full dissertation. We'll discuss this topic in depth in Chapter 7. An excellent method on engaging with the literature is presented in "Becoming an academic writer" [6] (2nd edition), where a matrix is presented on integrating writing with reading the literature.

There are many ways in which you can start engaging with the literature from the moment you start reading. Here are some examples:

1. **Summary:** write a short summary of the paper you read. Include an introduction situating the paper into the general scope of your field, a summary of the material you read, and then a discussion of the material. Write down what were the main

assumptions of the research, and emphasize anything that strikes you as interesting, particular, or odd.

2. **Discussion of set of papers**: after reading a set of papers from the same school of thought, you can summarize these papers together. Alternatively, if you have read a few papers from different schools of thought, you can summarize the main ideas of each theory, and try to find the main similarities between the theories, and the main differences. Include your observations and thoughts in a separate section.
3. **Discussion of a certain parameter:** if you have looked at a number of papers reporting on experimental results, you can start to organize the material based on each parameter that was varied in experiments. Not only will such a discussion serve you to get an understanding of the literature, it will also help you set up your own experiments, and then help you analyze your results in the light of the published literature. If you think you don't have time to write the discussion just yet, or if you feel like you have not read enough on the topic yet, you can take a printscreen of the most important part of a paper on the topic, and already add this information to the document that contains the discussion of a certain parameter in the future, see Fig. 4.4.
4. **List of questions to discuss with your supervisor:** whenever something strikes you as interesting, strange, particular, or odd, write it down to discuss it with your supervisor. While you may not have time to discuss every single observation, documenting your thoughts is a good beginning to critically analyze the literature.
5. **Description of short calculation:** perhaps you find an interesting theory in paper X, and an interesting set of experiments in paper Y. Then, in a short document, you can outline how you checked the results from the experiments from paper Y to the theory from paper X. While this study technically already goes a bit further than the pure literature review, it is an essential part in going from sitting and observing the literature to actually engaging with the literature, and helps you transition smoothly from just reading to taking a step further and doing research with the available material. We will discuss other methods of engaging with the results from the literature in Chap. 5.
6. **Derivation of theory:** if you read a theoretical paper, and some steps in between the derivations are missing, you first need to assess to which level you need to understand the theory. If it is crucial for your research, you need to sit down, and do all the intermediate calculation steps. If it is a paper that falls more into the "reading broadly" category, then it is less important for you to sit and document the derivations. The same category also contains important papers with calculations: for these publications, you need to take a sheet of paper, make the calculations yourself, and see if you can arrive to the same results.

By developing small documents discussing papers, you are gradually shaping your final literature review report. When the day comes to start writing your litera-

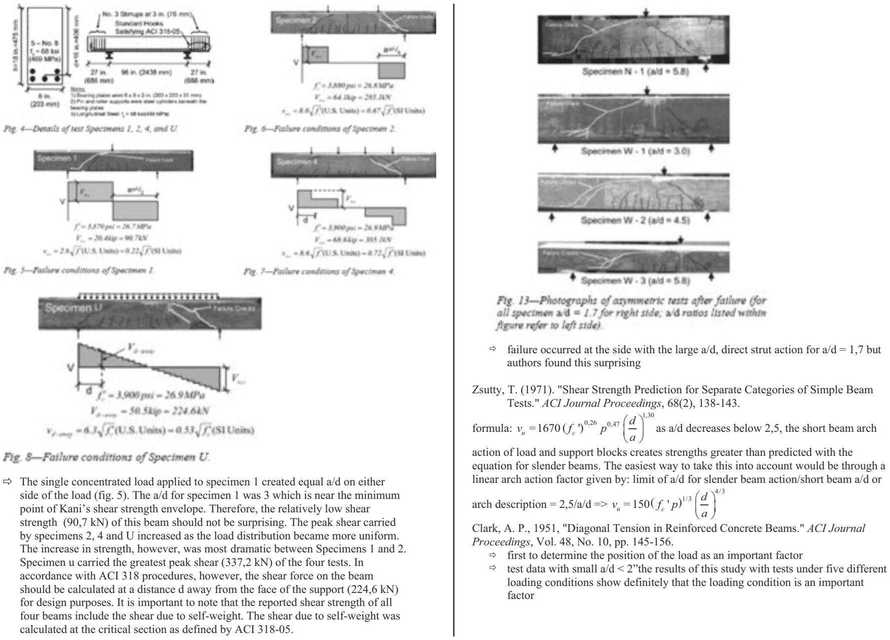

Specimen 2
Specimen 1
Specimen 4
Specimen U
Failure Cracks
Specimen N - 1 (a/d = 5.8)
Specimen W - 1 (a/d = 3.0)
Specimen W - 2 (a/d = 4.5)
Specimen W - 3 (a/d = 5.8)

Fig. 4—Details of test Specimens 1, 2, 4, and U.

Fig. 6—Failure conditions of Specimen 2.

Fig. 5—Failure conditions of Specimen 1.

Fig. 7—Failure conditions of Specimen 4.

Fig. 8—Failure conditions of Specimen U.

⇨ The single concentrated load applied to specimen 1 created equal a/d on either side of the load (fig. 5). The a/d for specimen 1 was 3 which is near the minimum point of Kani's shear strength envelope. Therefore, the relatively low shear strength (90,7 kN) of this beam should not be surprising. The peak shear carried by specimens 2, 4 and U increased as the load distribution became more uniform. The increase in strength, however, was most dramatic between Specimens 1 and 2. Specimen u carried the greatest peak shear (337,2 kN) of the four tests. In accordance with ACI 318 procedures, however, the shear force on the beam should be calculated at a distance d away from the face of the support (224,6 kN) for design purposes. It is important to note that the reported shear strength of all four beams include the shear due to self-weight. The shear due to self-weight was calculated at the critical section as defined by ACI 318-05.

Fig. 13—Photographs of asymmetric tests after failure (for all specimen a/d = 1.7 for right side; a/d ratios listed within figure refer to left side).

⇨ failure occurred at the side with the large a/d, direct strut action for a/d = 1,7 but authors found this surprising

Zsutty, T. (1971). "Shear Strength Prediction for Separate Categories of Simple Beam Tests." *ACI Journal Proceedings*, 68(2), 138-143.

formula: $v_u = 1670\,(f_c')^{0{,}26}\, p^{0{,}47} \left(\frac{d}{a}\right)^{1{,}30}$ as a/d decreases below 2,5, the short beam arch action of load and support blocks creates strengths greater than predicted with the equation for slender beams. The easiest way to take this into account would be through a linear arch action factor given by: limit of a/d for slender beam action/short beam a/d or arch description = 2,5/a/d => $v_u = 150(f_c' p)^{1/3} \left(\frac{d}{a}\right)^{4/3}$

Clark, A. P., 1951, "Diagonal Tension in Reinforced Concrete Beams." *ACI Journal Proceedings*, Vol. 48, No. 10, pp. 145-156.

⇨ first to determine the position of the load as an important factor

⇨ test data with small a/d < 2"the results of this study with tests under five different loading conditions show definitely that the loading condition is an important factor

Fig. 4.4 Taking screenshots and adding comments of different references that discuss the effect of a certain parameter (*a/d*) in the reported series of experiments

ture review, you won't be staring at a blinking cursor on a white screen, but you will have material available that you start to rearrange and interconnect to develop your full literature review report.

Exercises

1. If you haven't already done so, download a reference management software, and add all the papers you have read so far. Don't skip this step – the more papers you read, the harder it becomes to find time to sit down and do this, or worse, to find back that paper you read three months ago but of which you can't remember the first author's name.
2. Take the last five papers you read, and decide how you will interact with these papers. Either write a short summary of each paper separately, or start with a document outlining the similarities and differences between these papers.
3. Make an appointment with your supervisor to discuss the document you just wrote. If you feel insecure about your writing, find peers within your research group or department who are in the same situation, and form a supportive writing group. Get together to write, and exchange feedback on your writing.

4.4 Finalizing Your Literature Review

4.4.1 When Have You Read Enough?

PhD students often ask: “When am I done with reading?”[7] Let’s rephrase this question as “When am I ready to write my literature review report?” The answer to the first question is, obviously, never. You are never ready with reading, as you will need to stay up-to-date with the scholarly output in your field as long as you want to consider yourself a self-respecting scholar. But this does not mean that you will never be ready to produce your literature review report.

As discussed previously, you will feel yourself going through different phases of reading. Once you have reached the phase of the interrelater, you are in the right mindset to see the connections between the publications you have analyzed. If you are engaging with the literature, you move away from writing summaries of papers separately, and you move towards writing pieces that bring together a number of references. If you have reached this level of overview of the literature, you have enough material to bring it all together and write your literature review report.

Another indicator for knowing that you have read enough, is when you feel confident you have covered all the important references. Reading all the published output on the topics you are studying is of course impossible, but when you review the list of references of a paper, and you recognize the majority of the authors and publications, you have come a long way. When you read a new article, and you find yourself nodding in agreement or frowning in disagreement while you are reading, you have reached a level of understanding of your field that will allow you to write a good literature review report.

When you have read a good number of papers, and produced a few pieces of smaller writing to engage with the literature, you have had a chance at wetting your feet. However, for many PhD students, the literature review is the first large report they produce during their PhD trajectory. This effort requires a level of writing you have not needed before. If you wrote a comprehensive Master’s thesis, and received good feedback from your supervisor on your writing, you already have some good tools in your hands to go and tackle the literature review. If not, don’t despair: acknowledge that the literature review is a long and technical process. Writing a literature review is a skill you can learn. If you need further support on this topic, there are good reference books that can guide you in the process and teach you the ropes of writing a literature review [8–12], and websites like http://www.howtodoaliteraturereview.com/ are dedicated to the topic.

4.4.2 Bringing Everything Together

When you feel ready to bring everything together [5], decide how you want to outline[5] your literature review. There are a number of possible ways to organize your overview of the existing literature:

- **Chronologically**: if you study a rather narrow field, you can give a chronological overview of the main achievements in this field over time, and how the research field has developed since its beginnings.
- **By theme:** if your research is interdisciplinary (for more information, see below), you need to subdivide your literature review into smaller sections that each discuss the different topics and themes necessary for your research.
- **By school of thought/theory**: as you read theoretical work in your field, you might identify how different scholars follow different schools of thoughts, adhere to different assumptions, or have developed different theories. Organize your literature review by discussing each set of papers that focus on a single school of thought, and give a clear overview of the main standing theories in your field.
- **By type of experimental setup**: if you have looked at experimental research, you can subdivide the experiments that you read about based on the different elements or samples that were tested, and discuss similar experiments together.
- **By studied parameter:** if you have looked at experimental research, you can arrange the experiments on similar elements or samples based on the different parameters that were studied.

In a second part of your literature review, you can discuss how you have engaged with the literature. You can discuss the different assumptions, the similarities, and differences between theories. You can perhaps include your opinion in a separate paragraph, together with a discussion on how you will implement what you have learned from the literature review into your own research. If experimental results are important, you can compile a database of existing experimental work that you can use for comparison to your results later in your research. An example table of contents of a literature review[6] is given in Fig. 4.5.

If you feel like you are not ready yet to find the right outline of your literature review report, make a mindmap to get an overview of the different topics you have read about. While making this mindmap, try to see the connections between the different topics, or identify which topics should be discussed separately. An example is given in Fig. 4.6.

If you are not a visual person, take your research journal, and write down how you currently see the literature. Just have a brainstorming session, and tell yourself (your research journal) what you have read so far, what were the main topics that you looked at, and ask yourself how you would structure this information. If you feel that

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[5] Note that outlining does not work for everybody.

[6] The outline of this document grew organically – and that may be the way outlining works for you: as a starting point, but not as something that is set in stone.

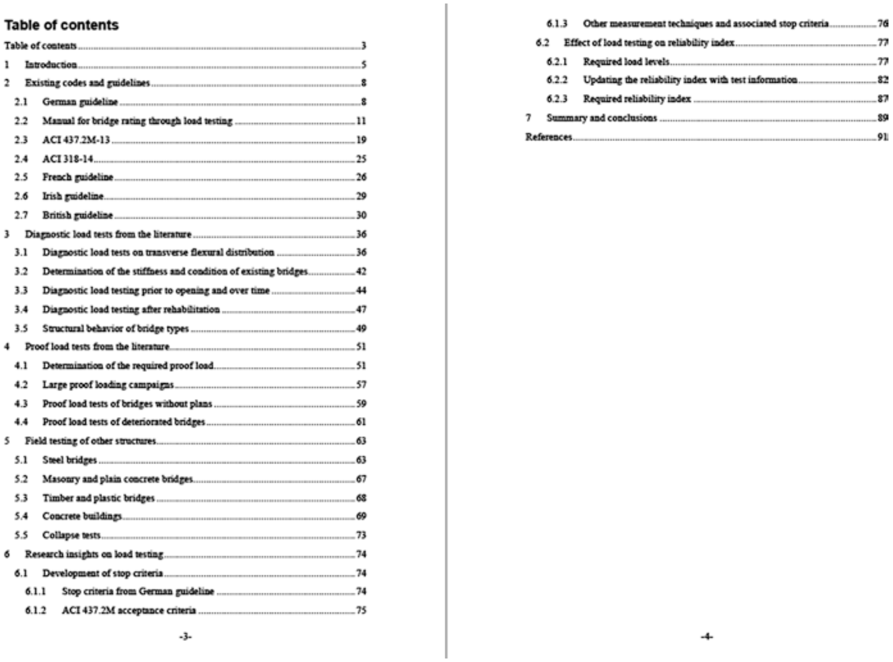

Table of contents

Table of contents 3
1 Introduction 5
2 Existing codes and guidelines 8
  2.1 German guideline 8
  2.2 Manual for bridge rating through load testing 11
  2.3 ACI 437.2M-13 19
  2.4 ACI 318-14 25
  2.5 French guideline 26
  2.6 Irish guideline 29
  2.7 British guideline 30
3 Diagnostic load tests from the literature 36
  3.1 Diagnostic load tests on transverse flexural distribution 36
  3.2 Determination of the stiffness and condition of existing bridges 42
  3.3 Diagnostic load testing prior to opening and over time 44
  3.4 Diagnostic load testing after rehabilitation 47
  3.5 Structural behavior of bridge types 49
4 Proof load tests from the literature 51
  4.1 Determination of the required proof load 51
  4.2 Large proof loading campaigns 57
  4.3 Proof load tests of bridges without plans 59
  4.4 Proof load tests of deteriorated bridges 61
5 Field testing of other structures 63
  5.1 Steel bridges 63
  5.2 Masonry and plain concrete bridges 67
  5.3 Timber and plastic bridges 68
  5.4 Concrete buildings 69
  5.5 Collapse tests 73
6 Research insights on load testing 74
  6.1 Development of stop criteria 74
    6.1.1 Stop criteria from German guideline 74
    6.1.2 ACI 437.2M acceptance criteria 75

-3-

    6.1.3 Other measurement techniques and associated stop criteria 76
  6.2 Effect of load testing on reliability index 77
    6.2.1 Required load levels 77
    6.2.2 Updating the reliability index with test information 82
    6.2.3 Required reliability index 87
7 Summary and conclusions 89
References 91

-4-

Fig. 4.5 Example literature review

writing gives you too much pressure, then use the recording app of your phone and just talk to yourself, or to your pet, or a friend while you let your thoughts flow.

For those of you who have a research topic (Topic B) that falls right in between two topics (Topic A and Topic C), or if you are combining a methodology from one field with research in another field, and there are very few references that discuss your actual topic, organizing your literature review can be a bit more of a challenge [13]. In this case, you should discuss Topics A and C separately first, without discussing your own thoughts, or without mentioning how your Topic B is related to these topics. Then, you can add a next section that is a “discussion”, in which you highlight the similarities and differences between Topics A and C, and explain how Topic B fits in there. Subsequently, you can add a next section that is a “discussion”, in which you highlight the similarities and differences between Topics A and C, and explain how Topic B fits in there. Then, you can add an “outlook” or “future research” section in which you your plans for researching Topic B based on what you learned about Topics A and C. You can find an example of an outline of such a literature review in Fig. 4.7.

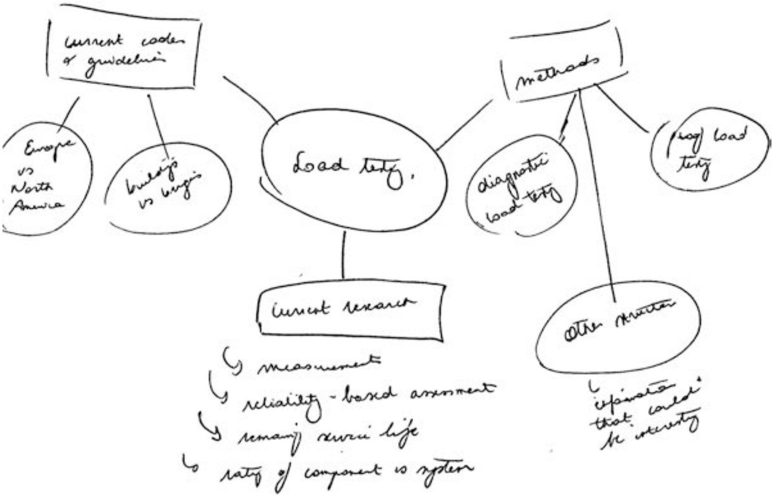
current codes or guidelines
Europe vs North America
buildings vs bridges
load testing.
methods
diagnostic load testing
proof load testing
current research
measurement
reliability-based assessment
remaining service life
rating of component vs system
other matters
aspects that could be interesting

Fig. 4.6 Example of sketching a mindmap, related to the outline from Fig. 4.5

Dr. Ben Libberton, the founder of the LiteratureReviewHQ website, which is fully dedicated to the topic of doing a literature review,[7] stresses that the literature review is a scholarly skill that can be learned, and outlines his three main tips for writing the literature review [14] as follows:

1. **Alter your perspective**: consider the literature review as a creative challenge instead of an unsurmountable task. Think of the literature review as an interesting challenge, instead of something you dread. We are free to observe the entire problem before making judgments, and we are free to step away and think.
2. **Plan more than you do now**: Planning is not just a vague exercise – outlining your thoughts is the first step of writing. Firstly you plan and work out exactly what it is you want to say. Then, when you write, you simply decide how you are going to say it. The beauty is that doing it this way, before you sit down to type, you already know exactly what you are going to say.
3. **Feedback**: Give and seek feedback at every stage of your writing. Seek feedback by explaining peers what your problem is and what you are trying to do. Giving feedback is a powerful way to improve your writing by learning from the work of your colleagues and reading it critically. By reading different writing styles and learning to spot mistakes, you will improve your own writing and your literature review as you edit the document.

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[7] The website contains excellent information, but it seems like it is not being updated anymore.

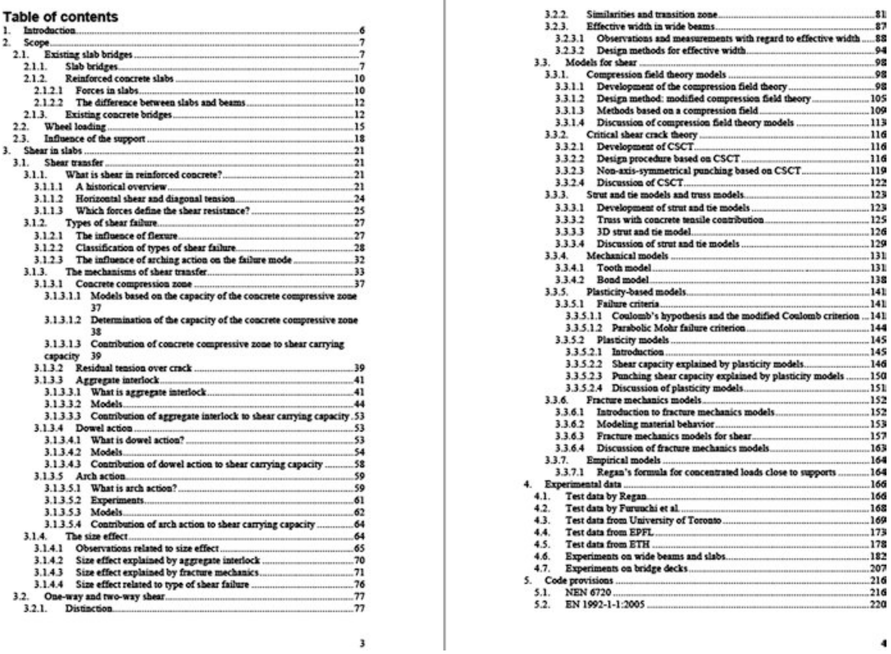

Table of contents

1. Introduction 6
2. Scope 7
2.1. Existing slab bridges 7
2.1.1. Slab bridges 7
2.1.2. Reinforced concrete slabs 10
2.1.2.1 Forces in slabs 10
2.1.2.2 The difference between slabs and beams 12
2.1.3. Existing concrete bridges 12
2.2. Wheel loading 15
2.3. Influence of the support 18
3. Shear in slabs 21
3.1. Shear transfer 21
3.1.1. What is shear in reinforced concrete? 21
3.1.1.1 A historical overview 21
3.1.1.2 Horizontal shear and diagonal tension 24
3.1.1.3 Which forces define the shear resistance? 25
3.1.2. Types of shear failure 27
3.1.2.1 The influence of flexure 27
3.1.2.2 Classification of types of shear failure 28
3.1.2.3 The influence of arching action on the failure mode 32
3.1.3. The mechanisms of shear transfer 33
3.1.3.1 Concrete compression zone 37
3.1.3.1.1 Models based on the capacity of the concrete compressive zone 37
3.1.3.1.2 Determination of the capacity of the concrete compressive zone 38
3.1.3.1.3 Contribution of concrete compressive zone to shear carrying capacity 39
3.1.3.2 Residual tension over crack 39
3.1.3.3 Aggregate interlock 41
3.1.3.3.1 What is aggregate interlock 41
3.1.3.3.2 Models 44
3.1.3.3.3 Contribution of aggregate interlock to shear carrying capacity . 53
3.1.3.4 Dowel action 53
3.1.3.4.1 What is dowel action? 53
3.1.3.4.2 Models 54
3.1.3.4.3 Contribution of dowel action to shear carrying capacity 58
3.1.3.5 Arch action 59
3.1.3.5.1 What is arch action? 59
3.1.3.5.2 Experiments 61
3.1.3.5.3 Models 62
3.1.3.5.4 Contribution of arch action to shear carrying capacity 64
3.1.4. The size effect 64
3.1.4.1 Observations related to size effect 65
3.1.4.2 Size effect explained by aggregate interlock 70
3.1.4.3 Size effect explained by fracture mechanics 71
3.1.4.4 Size effect related to type of shear failure 76
3.2. One-way and two-way shear 77
3.2.1. Distinction 77

3

3.2.2. Similarities and transition zone 81
3.2.3. Effective width in wide beams 87
3.2.3.1 Observations and measurements with regard to effective width 88
3.2.3.2 Design methods for effective width 94
3.3. Models for shear 98
3.3.1. Compression field theory models 98
3.3.1.1 Development of the compression field theory 98
3.3.1.2 Design method: modified compression field theory 105
3.3.1.3 Methods based on a compression field 109
3.3.1.4 Discussion of compression field theory models 113
3.3.2. Critical shear crack theory 116
3.3.2.1 Development of CSCT 116
3.3.2.2 Design procedure based on CSCT 116
3.3.2.3 Non-axis-symmetrical punching based on CSCT 119
3.3.2.4 Discussion of CSCT 122
3.3.3. Strut and tie models and truss models 123
3.3.3.1 Development of strut and tie models 123
3.3.3.2 Truss with concrete tensile contribution 125
3.3.3.3 3D strut and tie model 126
3.3.3.4 Discussion of strut and tie models 129
3.3.4. Mechanical models 131
3.3.4.1 Tooth model 131
3.3.4.2 Bond model 138
3.3.5. Plasticity-based models 141
3.3.5.1 Failure criteria 141
3.3.5.1.1 Coulomb's hypothesis and the modified Coulomb criterion ... 141
3.3.5.1.2 Parabolic Mohr failure criterion 144
3.3.5.2 Plasticity models 145
3.3.5.2.1 Introduction 145
3.3.5.2.2 Shear capacity explained by plasticity models 146
3.3.5.2.3 Punching shear capacity explained by plasticity models 150
3.3.5.2.4 Discussion of plasticity models 151
3.3.6. Fracture mechanics models 152
3.3.6.1 Introduction to fracture mechanics models 152
3.3.6.2 Modeling material behavior 153
3.3.6.3 Fracture mechanics models for shear 157
3.3.6.4 Discussion of fracture mechanics models 163
3.3.7. Empirical models 164
3.3.7.1 Regan's formula for concentrated loads close to supports 164
4. Experimental data 166
4.1. Test data by Regan 166
4.2. Test data by Furuuchi et al. 168
4.3. Test data from University of Toronto 169
4.4. Test data from EPFL 173
4.5. Test data from ETH 178
4.6. Experiments on wide beams and slabs 182
4.7. Experiments on bridge decks 207
5. Code provisions 216
5.1. NEN 6720 216
5.2. EN 1992-1-1:2005 220

4

Fig. 4.7 Example of outline of literature review of interdisciplinary topic

4.4.3 *Keeping Track of the Literature After Finishing the Literature Review*

After finishing your literature review, you need to keep up-to-date with the scientific output in your field of study. At this point, it is not necessary to sit down for days on end and plow through dozens of papers at a time, but you still need to know what is going on in your field, and stay informed about the recent developments. While the scientific output is ever-growing, and reading every single new paper is virtually impossible, there are a number of strategies you can use to stay informed about the advances in your field [15]:

- **Use an RSS feed for your keywords**. You can use an RSS feed for a few keywords so that you get automatic updates of papers that are published with these keywords.
- **Subscribe to updates of your favorite journals**. Identify the most important journals in your field, and subscribe to their new publications through e-mail updates. Some organizations give free or very cheap student memberships, which include access to all or a part of the publications. They then send you an e-mail when the latest issue of the journal is published, granting you instant access to the latest publications.

- **Follow your favorite researchers**. Set up an account with LinkedIn, ResearchGate, and Academia.edu (you can find more about the use of these websites in Chap. 9), and follow your favorite researchers. You will receive updates and notifications when they have published new research. Do you consider all the additional e-mail as annoying and unhelpful? Then unsubscribe from the e-mail notifications, and check the websites once a week.
- **Google Scholar recommendations.** If you don't have a Google Scholar profile yet, make one now – it's very easy and fast. Once you have your own Google Scholar profile, you will see custom recommendations for new publications based on your own publication record whenever you visit Google Scholar.
- **Attend conferences**. New research is first presented at conferences, and then published in journals. If you want to stay informed on the latest tendencies in your field, it is important you attend conferences (and present your work, and engage with other researchers, of course). For more about conferences, see Chap. 10.
- **Don't forget to explore the history**. While you might be focused on keeping informed about the recent publications in your field, it is important you also keep reading more papers that were published in the past. Don't forget about the roots of your research field. You could be surprised when reading the work of pioneers in your field to find out how many useful ideas still can be found in this early work.
- **Don't just pile – read!** Whenever you find an interesting article, don't just print it and place it on a pile, or save it in a "to-read" folder. You should have some time, at least once per week, to sit and read the papers you came across. In the planning recommendations from Chap. 3 I recommended to reserve time regularly for reading. You can plan your reading session during the week, and perhaps make it a nice event for yourself by taking your e-reader or printed articles, and go sit in a café while reading and enjoying a good coffee. I currently like reading in the weekend, in the company of my cat. In the past, I set aside at least three evenings per week to read two to three papers.
- **Volunteer as a reviewer**. Towards the end of your PhD, you can be considered as a reviewer for conferences and/or journals, which is an excellent way to learn about recent research, and engage in the scientific discussion. Dr. Veronika Cheplygina [16], Assistant Professor at Eindhoven University of Technology, has the following recommendations on starting to review papers: mention your interest to senior academics, create accounts on the websites of journals you are considering submitting to or reviewing for (without necessarily planning to submit a paper any time soon), and maintain an online presence with your university page and Google Scholar (and/or ResearchGate, Academia.edu, LinkedIn).

Exercises

1. Make a mindmap of the literature you have read so far. Which areas need further reading, and which parts have you covered well so far?
2. Decide how you will keep track of the literature in the future. Set up an RSS feed, subscribe to mailing lists, or add a reminder in your to do list to search the literature at least once a week.
3. Decide when you will set aside time for reading the references you have harvested. Leave at least one timeslot in your weekly template for reading.

4.5 The Next Step: Turning Your Literature Review into a Dissertation Chapter and Journal Paper

4.5.1 Turning Your Literature Review into a Dissertation Chapter

What is your requirement for graduation: a full-length dissertation (the “big book”-style PhD thesis), or a collection of journal papers? If you need a big book style thesis, you will need to include a literature review chapter into your dissertation. If you need a collection of journal papers, each paper you publish needs a literature review section to frame the work in the body of knowledge of your field. Alternatively, you can publish your literature review as an entire paper, a so-called “review paper”. This subchapter focuses on writing a chapter in your dissertation, whereas the next subchapter focuses on writing a review paper.

If you need to write a literature review chapter for your dissertation, the challenge lies in taking your information from the literature review report, and condensing it into an overview of 10–20 pages. A literature review chapter is a summary of the literature review report, and can refer to this report for further details. Compare the outline of Figs. 4.7 and 4.8: the general outline of the chapter follows the outline of the report, but the information is more condensed. In your literature review report, it is generally accepted[8] to use printscreens of figures from the different literature sources you read. In your dissertation chapter, however, you will need to redraw and reinterpret the most important figures, so that the quality is high enough for printing.

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[8] When in doubt, ask your supervisor, library, and/or office of academic affairs.

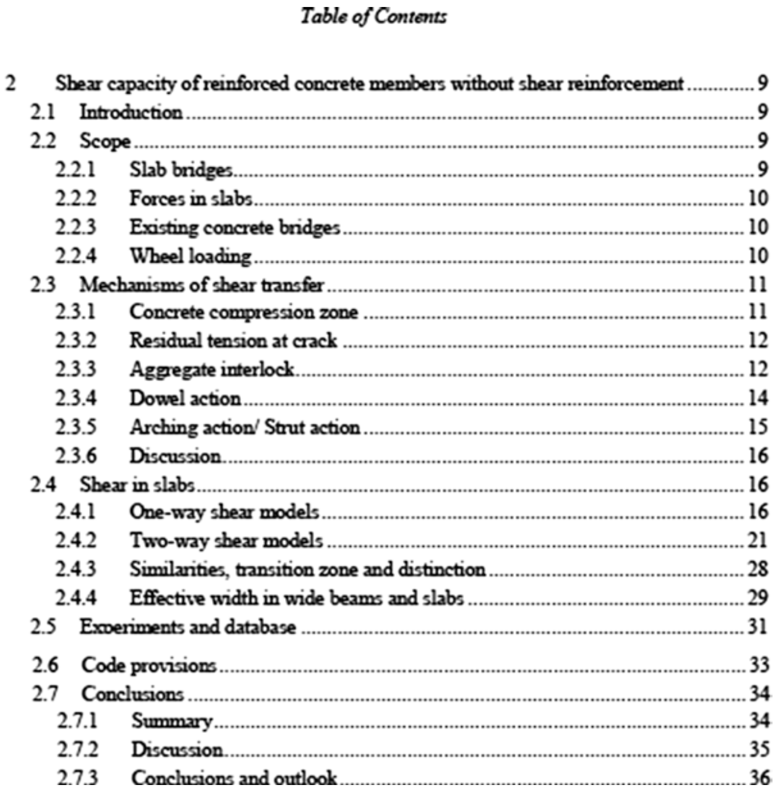

Table of Contents

2 Shear capacity of reinforced concrete members without shear reinforcement 9
  2.1 Introduction 9
  2.2 Scope 9
    2.2.1 Slab bridges 9
    2.2.2 Forces in slabs 10
    2.2.3 Existing concrete bridges 10
    2.2.4 Wheel loading 10
  2.3 Mechanisms of shear transfer 11
    2.3.1 Concrete compression zone 11
    2.3.2 Residual tension at crack 12
    2.3.3 Aggregate interlock 12
    2.3.4 Dowel action 14
    2.3.5 Arching action/ Strut action 15
    2.3.6 Discussion 16
  2.4 Shear in slabs 16
    2.4.1 One-way shear models 16
    2.4.2 Two-way shear models 21
    2.4.3 Similarities, transition zone and distinction 28
    2.4.4 Effective width in wide beams and slabs 29
  2.5 Experiments and database 31
  2.6 Code provisions 33
  2.7 Conclusions 34
    2.7.1 Summary 34
    2.7.2 Discussion 35
    2.7.3 Conclusions and outlook 36

Fig. 4.8 Example of literature review chapter in dissertation

4.5.2 Turning Your Literature Review into a Journal Paper

When your requirement for graduation is a certain number of journal papers, you can develop a review paper as you get closer to graduation. While review papers are usually written by an authority (an emeritus professor looking back on the past decades of work in a certain field), writing a review paper is not impossible. I would not recommend that the first paper you write is a review paper, since writing a review paper requires writing with authority about your topic. You can tackle this challenge towards the end of your PhD. Alternatively, you can coauthor the paper with your PhD supervisor, and ask for his/her critical input and guidance on your review paper, so that you can submit a well-written draft that brings together the major important thoughts and theories from your field of study. Even if your requirement for graduation is a big book thesis, I would recommend you to develop the literature review chapter from your dissertation into a journal paper [17]. From the overview in Fig. 4.8, I developed a review paper on the existing theories for one-way and two-way shear, their similarities and differences [18], as well as a paper about the database of experiments I collected from the literature, with some additional calculations [19].

To write a review paper, you have to go a step further than summarizing your literature review report. You need to make sure you have something new to say, or something that warrants publication. A collection of discussions of papers you read is not enough. If your research is interdisciplinary, you can discuss the main ideas in the fields you study, and then provide a discussion on how these fields can be combined, and how you see the convergence or divergence between the fields. If you engaged with the literature by compiling a database of experimental results, by analyzing the effect of a number of parameters, or by comparing experiments to predictions according to a certain theory, then you can show this analysis in a paper. Granted, such an analysis is already one step ahead of an overview of the current literature, but it does not involve your own experiments or modeling yet, and it flows right out of the results from your literature review.

4.6 Summary

In this chapter, we covered the process of the literature review: from reading your first articles, to writing your dissertation chapter about the literature and/or writing a review paper. You've learned how to find references, and how your reading changes as you gain more understanding of your research topic. We've discussed what to do with your references in terms of storage and engaging with the literature. Then, the question "When am I ready to write my literature review?" is discussed: we've seen how you can bring everything together into a literature review report, and how, after finishing the report, you can remain up-to-date with the scientific output in your field. Finally, we discussed how to develop the literature review chapter for your dissertation, and how your literature review can serve as a starting point for a review paper.

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Chapter 5
Formulating Your Research Question

Abstract In this chapter, the research question is studied. We focus on how to find a research question that is specific enough, so that you are not tempted to explore paths that are only tangentially related to your research question. The literature review identifies gaps in the current knowledge, and you will learn how to frame a research question within these gaps. We then explore how to subdivide the research question into subquestions. These subquestions become the chapters of your dissertation. We also look at creative thinking, a skill necessary to think out of the box to formulate your research question. This chapter discusses how to convince your supervisor of your research question. It can happen that your supervisor already has an idea of the direction in which your research should be going, but if you can provide technically sound arguments based on your literature review why this approach is not ideal, and why you propose a different road, you should be able to have the freedom to explore your proposed option. Once you have outlined your research question, it is necessary to turn the question and subquestions into practical actions. These practical actions link back to the planning skills you learned in Chap. 3.

Keywords Research question · Research methods · Creativity · Research design

5.1 Introduction and Learning Goals

The goal for this chapter is to develop your research question. Your research question follows from what you learned from your literature review, and from engaging with the scientific literature. There are a number of standard requirements for your research question. You will learn about these, so that you can analyze for yourself if your research question is ready for discussion with your supervisor. Developing a research question is a creative endeavor. Therefore, we look at the skill of creativity in this chapter.

Once you have identified your research question and subquestions, take your research question and turn it into actionable steps. We look at the relation between the research question and the dissertation, as well as the relation between the research question and the actions required to solve the question. These actions are elements that can be scheduled.

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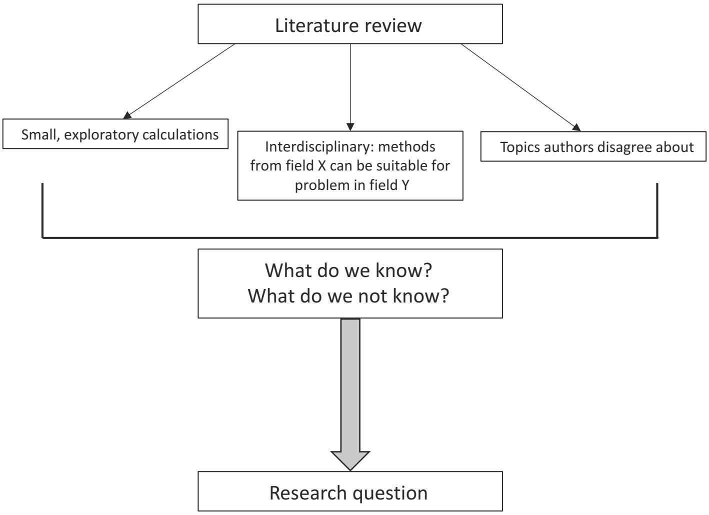
Literature review
Small, exploratory calculations
Interdisciplinary: methods from field X can be suitable for problem in field Y
Topics authors disagree about
What do we know?
What do we not know?
Research question

Fig. 5.1 From literature review to the research question

5.2 From Literature Review to Research Question

5.2.1 Identifying Gaps in the Knowledge

Before you define your research question, you need to have a broad and deep understanding of your research field. In Chap. 4, you learned how to develop the literature review as your starting point for understanding, and then engaging with, the scientific output in your field. When you have read broadly and deeply in your field and tangentially related fields, you will start to see the open opportunities. This process is illustrated in Fig. 5.1.

Granted, very often you will not be left entirely on your own when you are developing your research question. Your PhD supervisor probably already has an idea of a topic he/she wants you to work on, perhaps related to the project you were hired on. If you were hired on a funded project, there will already be an idea and a direction of what you will need to do and which deliverables are expected from you. Discussions with your supervisor and colleagues in your research group are important to see the broader context of the work in your research group, and to see how your work fits in the work of your research group. Don't make the mistake of isolating yourself with only the literature – the interaction with your peers and supervisor is important.

Your research question is not something you write one morning after a god-sent dream. It's the result of reading, thinking about what you read, and discussing these thoughts with your peers and supervisor. It's a highly iterative procedure, and often your research question gets molded and shaped along your PhD trajectory.

While reading the literature, there are a number of different empty spots you can identify. Here are a few examples to get your started:

- Cases where the boundary conditions of the usually applied theories are not valid anymore.
- In experimental work: parameters that have not been tested.
- Applying methods from field X to problems in field Y (for example: using artificial intelligence programming tools to the application of experimental results from your field).
- Application of new materials and new technologies.
- Computational analysis and simulation of physical phenomena.

If you think you have an idea for your research question, prepare a short document outlining the gaps you found in the literature, or the open options to explore that you identified from your literature review. Briefly discuss the key references, and how you see your first idea of a research question framed inside the literature. Have something on paper to discuss with your supervisor, and to show him/her the main references on which you plan to base your work. It is always better to sketch the background to your idea than to go to your supervisor and say: “Hey, what if I do This Thing for my PhD thesis?” I bet you won’t get the in-depth discussion you want (and need, to move forward) if you don’t provide sufficient background and depth on the how and why of coming to your first idea of a research question.

There are a number of technical requirements your research question needs to fulfill [1], for it to actually be a research question. Dr. Helen Kara, an independent researcher and writer, summarizes these technical requirements as follows [2]:

- **Your research question should be specific.** Avoid general questions like “How do we cure cancer?” and phrase a research question that is specific. If you have done your homework for the literature review, making sure the question is specific and follows from situating your intended work in the body of knowledge that you looked at.
- **Your research question should have its limits.** Keep in mind that you will need to answer your research question during the course of your PhD trajectory. If you’ve come across, or are participating in solving a large question, know that you have your entire career in front of you to delve into related topics, so that you can contribute to the solution of this large question throughout your entire career. You are allowed to dream big and set big goals, but make sure that you tackle a realistic and delimited topic during your PhD.
- **Your research question should not show bias or an opinion.** Your research question should not show a bias or opinion towards the expected outcome of your research. Be prepared to look at your research question from various angles, and to step away from the thoughts you initially developed about the possible outcomes of your research. Be willing to question yourself and your tendencies and assumptions at all times. You eventually want to write a dissertation, not an op-ed.

5.2.2 Self-Assessing Your Research Question

Once you have crafted a first attempt at your research question, and have outlined in a short document how your research question fits in the general body of knowledge, it is time to self-assess your first attempt. Do this before you send your first ideas to your supervisor; this step helps you to be ahead of some questions your supervisor may have. Self-evaluating your research question will improve your research question and document before you send it out for discussion. When self-assessing your research question, use the following criteria as outlined by Dr. Helen Kara [2]:

- **Originality**. At the end of your dissertation, you need to show which original contributions to your field you have made. You have to develop work that has not been done before. This does not mean you have to reinvent the wheel, but it means that you need to find your little corner of interest and knowledge in your field, and make a novel contribution inside that little corner.
- **Practicality.** Do you have an idea of the method(s) that you want to use to investigate your research question? Are these methods possible from a practical point of view? Do you have all the tools available in your laboratory for using these methods, or does your funding allow the purchase of the required instrumentation or tools?
- **Feasibility**. Given that you have the tools and practical possibilities for using a certain method to tackle your research question, is it feasible? Can you finish it within the required time? Will you need specific training before you can apply a certain method, which will reduce your available time? Do you need to share lab space with others, reducing the amount of time you can spend on your setup? Keep the overall planning of your PhD trajectory from Chap. 3 in mind, and consider the link between your subquestions and planning that we will discuss later in this chapter.
- **Ethics.** Grant applications and dissertation proposals nowadays include a standard question to ask if there could be ethical concerns with regard to your work. Ask yourself if there could be such implications. Ethics are particularly important when you work with tissue, plants, animals, or humans, or with harmful substances. If you think there are ethical implications to your work, discuss the issue at length with your supervisor.

5.2.3 Creative Thinking

As I mentioned before, you will not wake up one glorious spring morning, see the light shine into your room, and know your research question. You will need to creatively play around with the concepts in your field. If your previous education was rigid and did not encourage playfulness and exploration, the idea of reaching the highest level of education and being asked to “go and play in the sandbox” may sound strange. But fundamentally, scientific research is an extended endeavor of creativity, and formulating your research question will be your first creative exercise in this regard. If you haven’t been flexing your creativity muscle in a while, this section is here to help you.

One of the key elements to creative thinking is to learn to ask yourself questions. Questions are the best tool for actually pointing out a lack in our knowledge. When carrying out your literature review, it is important to ask yourself why certain assumptions are at the basis of a theory, and if these assumptions are always valid. The reason why questions are so quintessential to creative thinking are the following [3]:

1. **Mindset**: If you are just playing around, and raising questions, you are typically more in a relaxed mode. When you need to provide answers, you feel inner resistance caused by the burden of having to prove that you are perfectly capable of coming up with answers. The right mindset for creative work is an open, inquiring mind, asking questions along the way, without feeling pressure to perform.
2. **Breaking down a problem**: When you ask questions, you elegantly find a way to identify what you need to know precisely. As you make your questions more specific, you can find the precise pieces that you need to study more in depth. Having more specific and smaller subquestions helps you plan. Start by solving your subquestions and use this information as building blocks to solve your main research question. Solving a smaller question places your mind in a more relaxed mode than when you need to tackle one large question.
3. **Identifying key points**: When you ask yourself questions, you identify what you still need to know and do – the key points from which to start your research. When you carry out creative scientific work, you start from a few key points. Sit down with these starting points, think deeply, and play around with the concepts. Formulating questions can help you identify those particular key points for which you need to unleash your analytical spirit.

The next topic to discuss related to creative thinking, is how to get yourself into that state of flow in which you can focus deeply and do your creative work. What are the conditions we need for creative work? As Feynman [4] pointed out: you don't need the perfect conditions to do creative work. You don't need a cabin in the woods and all the time in the world to come up with good ideas. In fact, you need very little to deliver creative work. If you think you need to be in a special place, you are fooling yourself. Moreover, if you are postponing your creative work because you think you need to go sit in a cabin in the woods, you are wasting time and are procrastinating. You don't need much at all to do creative work, so how can you make it happen? Here are the ingredients to create optimal conditions for creative work:

1. **Scheduled time**: Don't fool yourself saying you have time to sit and think. In Chap. 3, you learned how to take control of your time. If you need to do creative work, you need to schedule it. You don't need weeks of uninterrupted time – focus on blocks of about 2 hours or sessions of three pomodoros.[1] Claim those slots of time for yourself and your research. Commit to start working on something, as small as it may be, and write down your task and goals. If you want to solve problems, you need to put in the time. Use that scheduled time for your research, and nothing but your research. No phone calls, no meetings, no e-mail should creep into your research timeslot.

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[1] Time blocks of 25 minutes during which you concentrate on one single task. You can find more information about the Pomodoro technique in the glossary of Part II.

2. **Comfort**: You don't need the seclusion of a cabin in the woods to do your work, but it helps to make yourself comfortable at the beginning of your designated timeslot. Depending on how you like working, you might want to make sure that you have space on your desk, with only the material that you need to look at, that you have sharpened your pencil, and that you have brewed a cup of coffee. Make sure your desk and your chair are comfortable, and if you like, play some music or use white noise to block out the sounds around you.[2] Don't take 20 minutes at the beginning of your designated timeslot to set up your creative space. If necessary, block off an hour before your first creative timeslot to clean up your desk and get everything out of your way. Just make sure you don't confuse preparing yourself for creative work with the actual doing of the creative work.
3. **Mindset**: Keep that open and inquiring mind of asking questions when you need to do creative work. Ask yourself with genuine curiosity: "What would happen if I try this out?" Don't put pressure on yourself about having to develop a new and big theory. See it as something small and playful. If you need to do creative work, and there is a lot of pressure from your supervisor to deliver results, you might feel anxiety and a closed mind. To move forward, you need an open mind that is free to explore options. If you formulated the challenges in terms of questions and subquestions, tell yourself you are just going to look for an answer to a small subquestion. Work on a subquestion, and if necessary, ask yourself smaller and smaller questions to the point where you feel that you can start dealing with the question. When Feynman [4] got stuck, he just started to work on something small, and took it from there. Avoid staring at blank pages and not doing anything – play around, try out things, and see where it takes you. Connect with your inner child, with the feeling of exploring the world in an unbiased way.

A last step in discussing creative thinking, is acknowledging that creativity is a skill [5]. You are not born creative or not creative – you can learn how to think creatively. Developing creativity is a skill that may need time, so you need to think long-term if you want to grow your creativity muscle. While some people are naturally more drawn towards creative endeavors, everybody can learn to be creative by fostering a creative mind. If you want to train your mind to learn how to think out of the box, you can develop your creativity in the following ways:

1. **The whole spectrum of creativity**: Come out of your narrow field of research, and explore some more of the world. Pick up a hobby that requires creativity, start blogging and journaling, draw, read widely, or pick up an interest in fashion, art shows, modern or classic literature – anything that helps you come out of the bubble of your research. Hang out with friends and debate politics and current affairs in an open and inquiring way, and read up on history. Listen to inspiring podcasts (I love 15 minute history from the University of Texas at Austin [6], for example), make friends with scientists from other disciplines and ask them to tell you about their research, or engage on Twitter with scientists from other disciplines. Make sure you get your grey mass working. Be open to learning from all

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[2] I often work with noise-cancelling headphones.

sources (see the course "Learning how to learn" on Coursera and the associated book [7] to learn more).[3]

2. **Practice creativity**: Just like you would train your muscles by lifting weights a number of times a week, it is important you train your creativity regularly. Break out of the confinement of your research and lab, and schedule activities that develop your creativity. You can enroll in music classes, dancing classes, learn photography or attend a painting workshop. University campuses often offer such activities at very reduced prices. If the financial aspect is preventing you from attending regular courses, look for free courses online, check out artistic course books from the library, or set up a challenge (for example, a 365 day photography project, or try to write a set of poems within six months).
3. **List ideas**: When you are solving a research problem, don't use the first approach you can think of. Sit down, and list all possible solution methods. Revise related literature sources, and analyze them critically: what other options did the researchers have to tackle this problem? Analyze the problem at hand from every possible angle. Make this approach a habit: once you get used to start thinking about different possibilities to solve a problem, you will be able to generate more ideas on how to approach the problem. Your mindset is important: you don't need to delve into solving the question right away, but you can sit, reflect, and explore all possibilities with your open and inquiring mind. If you find it hard to think of different options, discuss possible solutions with your colleagues.
4. **Mindmap**[4]: The practice of developing mindmaps is a creative practice, as it involves sketching and drawing. When you set up a mindmap, try to explore all the tentacles of your mindmap spider, and reflect on them for a moment: can you go a bit deeper and develop some additional thoughts and ideas?
5. **Courses on creative thinking**. If you don't see how painting or learning Russian is going to help you directly with your research, you can join a course on creative thinking. Depending on the method used by the instructor, you might learn standard ways to develop creative thinking. Some universities or funding bodies and governmental agencies for science offer courses on creative thinking for their scientists. Inform within your university about the options to learn and/or get financial support to learn if such a course could be beneficial for you.

Exercises

Practice your creativity by practicing the art of formulating questions:

1. Read an article, jot down your summary, but also come up with three questions you think need some further exploration.
2. When you attend a presentation, lecture, or meeting, try to form two questions in your mind.
3. Solve a problem by breaking it down in a set of questions you need to answer.

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[3] The course is sweet and short, and runs frequently. I highly recommend it!

[4] Refer to Chap. 4 for examples on how I use mindmaps to structure documents, such as a literature review report.

5.2.4 Convincing Your Supervisor of Your Research Question

Your research question should be something you feel passionate about. If you feel a surge in curiosity on what the answer would be when you state your research question, you are on to something that you will be able to work on for an extended amount of time (three years, four years, or more, depending on the regulations of your program). If you don't feel too interested in the topic and the research question, evaluate your motivation. If you don't love your topic and research, it will be hard to recall why you started this research journey in the first place when the going gets tough.

You need to feel convinced and passionate about your research question to keep yourself motivated. If your supervisor is not too sure about your research question or your proposed methods, you will need to tap into that enthusiasm to get your supervisor on board. Of course, your literature review and your identification of the gaps in the knowledge in your field should provide the evidence of why your proposed approach is worth a shot. But even if your documents show that you could be on to something, it is often the emotional quality and the enthusiasm you convey about the topic that can help you change your supervisor's mind.

If your supervisor already has an idea for the direction in which your research should be going, and you don't feel that is the right approach, make sure you have all the arguments why you need to do things differently. Your arguments should be sound and technical, and based on your literature review. "I think it is too difficult!" is not an argument. Remember that the goal of your PhD studies is to become an independent researcher. If you find sound technical arguments to select a direction that is different from what your supervisor had in mind, it should be possible to discuss this. If your supervisor is not open to such a discussion and orders you to do as you are told, reassess your working relation with your supervisor. If you don't get the freedom to develop your thoughts, or if there is no opening to even discuss options, see if you can change supervisors. It is a red flag for trouble down the road.

5.3 Putting Your Research Question to Action

5.3.1 From Research Question to Subquestions

Once you have determined your research question, it is time to subdivide the main question into subquestions. Practicing the art of asking questions and developing your creative thought processes as discussed previously prepares you for taking your research question and splitting it up into subquestions.

To develop the subquestions of your research question, sit down to write out all questions that come to your mind when you read your research question. Try to identify about 20 questions. Explore the depth and breadth of your research question through the subquestions. Include different approaches and methods and perspectives to formulate subquestions. Then, make a mindmap to organize these questions into different categories. When analyzing these subquestions in a mind-map, jot down some first ideas that you have regarding the methods that are suitable to solve these subquestions. Identify the similarities between the different subquestions. Analyze which subquestions take you too far away from your main research question, and give them lower priority. If you have found the important subquestions and the similarities between subquestions, you can group subquestions together into larger chunks of work. At the end, you should have about five main subquestions – each with a number of smaller related questions, and possible methods for looking at the problem. These five main subquestions will become chapters of your dissertation. This process is illustrated in Fig. 5.2.

Your subquestions identify the next actions you need to take. Each subquestion should be something for which you will select one method to solve it. Before you select the method, list all possible ways to solve the question. A subquestion should

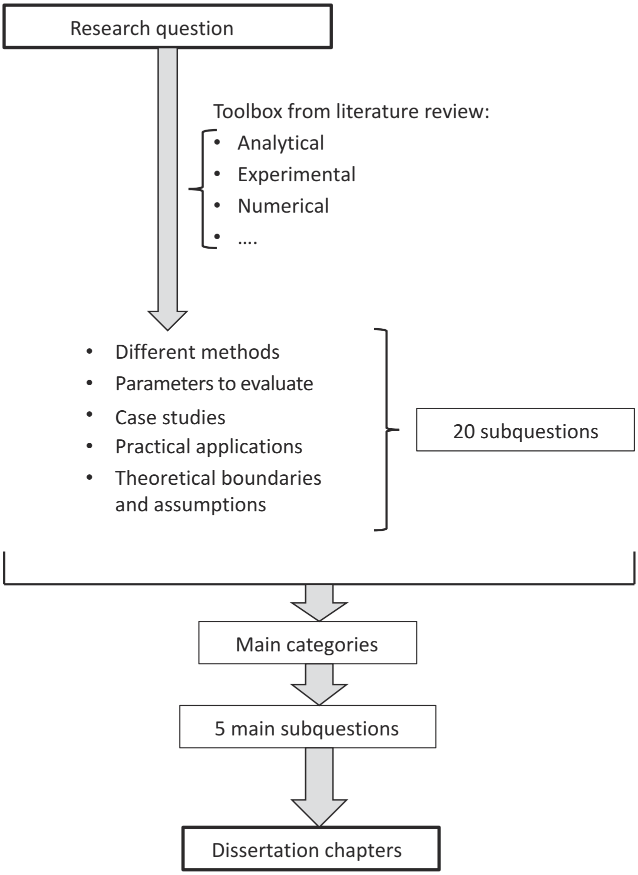
Research question
Toolbox from literature review:
• Analytical
• Experimental
• Numerical
• ....
• Different methods
• Parameters to evaluate
• Case studies
• Practical applications
• Theoretical boundaries and assumptions
20 subquestions
Main categories
5 main subquestions
Dissertation chapters

Fig. 5.2 From research question to subquestions to dissertation chapters

not involve more than one method. It should be delimited in such a way that the question is directly related to the type of action you need to take.

Since your subquestions are directly related to the required action, your set of subquestions will outline the work you carry out for the next few years. At the same time, you will not be tempted to delve into problems that are only tangentially related to your research question when you have your subquestions outlined for you.

5.3.2 From Research Subquestions to Dissertation Chapters

Your main subquestions, which bring together a number of smaller questions and ideas of methods, become your dissertation chapters. Your chapters will typically be organized around a method: one chapter could be experiments, whereas another chapter develops your theory or analytical work [8]. If you need a discussion of different research methods, there are a bounty of textbooks, often subdivided into books about either qualitative or quantitative methods.

A good introduction to research methods can be found in [9], which discusses information in research (what are you looking for?), methods of primary information collection (how do you look for it?), and organization and analysis of surveys (what do I learn from my data?) from a perspective of the social sciences and qualitative data, and then discusses the research question and the research dissertation, and how these elements are related. You can also find a broad overview of research methods in [1]. If you need further information about a certain method, look up the references given in a book to go more in depth. Remember that your methods are secondary to your research question – never develop your research question as a function of the methods you want to use.

When you use your subquestions to outline your dissertation chapters, keep in the back of your mind the red thread that will go through your text. That red thread is your research question itself, and how you engaged with this question. Sit down with your research question, and sketch how your subquestions answer your research question. Identify the logic that ties together the different subquestions [10].

To visualize this relation, make a simple diagram to show how you organize these subquestions that result in the chapters of your dissertation. You can see in Fig. 5.3 how I developed a small sketch to start the organization of my dissertation. It's quite simple indeed: showing that I used both analytical and experimental methods to approach the research question, and how these fundamental aspects tie back to practice: the use of codes for assessment and the application to case studies of existing bridges. In the end, all information ties back together to the conclusions of the entire document.

Keep in mind that you can have an idea for your thesis outline [1] when you set out your research question and subquestions, but that at the end of the day, after doing all the research, you find you have answered an entirely different question. If

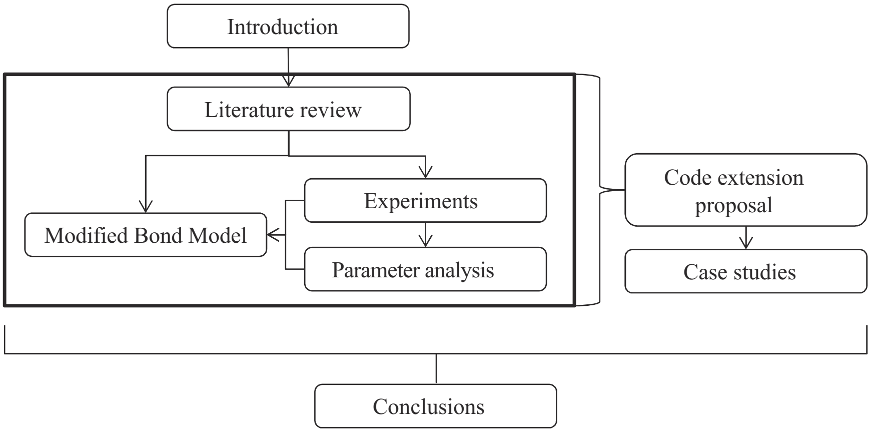

Fig. 5.3 Scheme to outline dissertation

that is the case, explain your journey from original to final research question in the introduction chapter of your thesis. Discuss what you learned and what you would do differently to answer your original research question.

5.3.3 From Research Subquestions to Actions and Planning

Let's go back to all the small subquestions you identified while brainstorming your research question. You have organized these small questions into main subquestions and their methods, which become your dissertation chapters. Since the small subquestions are the most defined, they are the cornerstone for your planning. Frame the main subquestions into your planning for all the years towards your defense, so that you have a broad idea of how much time you can spend fleshing out each main subquestion. Think about which subquestion needs information from the research you do for another subquestion. This dictates the chronology of when you work on the different subquestions. Lab availability may require you to be flexible in your planning and/or tackle several subquestions in parallel. Then, take the first main subquestion that you will start to work on. Identify the smaller subquestions, and see how you will tackle these smaller questions.

Start with the first small question, and list all the actions you need to undertake to answer it. Schedule time for these actions. Figure 5.4 shows this method. Use your research journal to reflect on these questions, so that you already get started with solving the small question. In general, solving a small question should not take more than two weeks. If you need more time to actively solve the small question, subdivide this question into smaller pieces. An exception for when solving a small question can take more than two weeks, is when you need to wait for your experi-

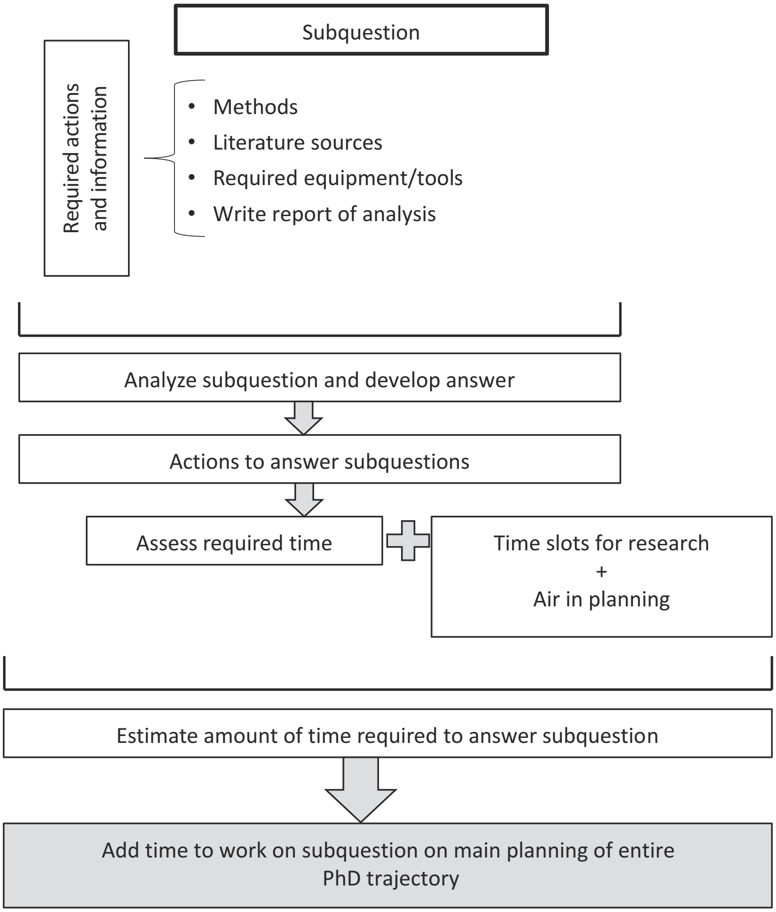
Subquestion
Required actions and information
• Methods
• Literature sources
• Required equipment/tools
• Write report of analysis
Analyze subquestion and develop answer
Actions to answer subquestions
Assess required time
Time slots for research + Air in planning
Estimate amount of time required to answer subquestion
Add time to work on subquestion on main planning of entire PhD trajectory

Fig. 5.4 From research subquestions to actions and planning

ment – but in that case you are not actively working on the topic, you are awaiting further information.

Exercises

1. Divide your research question into subquestions. Group your subquestions together, and work towards a main outline of your dissertation.
2. Take your planning, and determine when you will work on the different subquestions. Then, take the subquestion you will work on first, and go to the most detailed level. Plan time to start working on the different action points you have outlined.

5.4 Summary

In this chapter, you learned how to define your research question based on what you learned from the literature review. You learned the requirements for a good research question. If you have difficulties coming up with a research question, improve your creative thinking skills.

Break up your abstract research question into actionable parts. Larger subquestions are grouped together and form the chapters of your dissertation. At a smaller level, the subquestions are directly related to the actions you need to take to solve them. These actions are the building blocks of your planning. Remember, what gets planned, gets done – so make sure you walk away from this chapter with your first next actions written down in your planning.

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Chapter 6
Preparing and Executing Experiments

Abstract This chapter follows the steps you should take when planning experiments. The focus of this chapter is on experiments in STEM, in a research laboratory. You start by revisiting the literature review. Based on the literature review, and the experience reported by other researchers, you can design your first test setup. Next comes planning of experiments and the necessary logistics, linking the experiments to the chapter on planning. We touch upon project management techniques to develop a Gantt chart for a series of experiments. Revisiting ideas from Chap. 2, we discuss the importance of a lab book and research diary. For the execution of experiments, we discuss the value of senior PhD students and lab personnel, and their experience. Then, we discuss the importance of developing processing and storage protocols, linking back once more to Chap. 2. A final topic of this chapter is on reporting experiments. Start documenting your experiments in a report before the end of the experiments. Then we look at how you can turn your research report into a dissertation chapter or journal paper.

Keywords Experiments · Research design · STEM · Laboratory · Reporting experiments · Writing · Planning · Workflow

6.1 Introduction and Learning Goals

The learning goal for this chapter is understanding all the facets of experimental work. Experimental work is not just the time you spend in the laboratory, executing the experiments. You also need to factor in the time required to prepare your first experiment. Can you sketch how the experimental work you want to carry out fits in the current body of knowledge? Can you use the information from the literature and the experience of your peers in the lab to avoid common newbie mistakes? With these elements in mind, you learn how to plan towards your first experiment, and then how to plan the entire series of experiments that you want to carry out.

We discussed the lab book in Chap. 2, and revisit the topic here. You will learn how to organize your lab book, and how to develop the entries about your experiments. Along the same lines of keeping track of what you are doing in the laboratory, you will learn how to develop your post-processing checklist. After an

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E. O. L. Lantsoght, *The A-Z of the PhD Trajectory*, Springer Texts in Education,
https://doi.org/10.1007/978-3-319-77425-1_6

experiment, what do you need to do in order to have all data required for documenting them in your experimental report?

The importance of staying motivated in the laboratory is discussed. We emphasize the importance of taking good care of yourself during the stressful times of laboratory work, and how to keep your head cool when things don't go as planned.

Finally, we discuss the different types of deliverables from experimental work: the laboratory report, a dissertation chapter about your experiments, and a journal paper about your experiments.

6.2 Towards Your First Test Setup

6.2.1 Using the Literature Review to Define What You Want to Test

The main focus of this chapter is on physical experiments in a research laboratory setting. The general concepts of planning your time also hold true for when you run numerical experiments, or when you obtain qualitative data through questionnaires. However, the design of questionnaires, selection of populations, and the analysis of qualitative data is a separate field, for which I refer you to guidebooks on this topic [1, 2]. Since this chapter deals with experiments in a laboratory, the logistics of ordering and buying material is something that needs to be discussed. This topic is often less relevant for numerical experiments.

A large part of designing your first experimental setup ties back to the literature review [3]: which experiments have been done in the past, and how were they executed? Unless you think a classical set of experiments contained something strange, and you want to challenge that, you should avoid reproducing experiments that were already reported in the literature. On the other hand, unless you want to study something that has not been studied in the past, you can get a lot of ideas for developing your test setup from the literature. Are there codes and standards that you need to follow when carrying out experiments? If so, make sure your literature review includes sufficient information about the provisions that professionals in your field should abide to.

Before you run off enthusiastically to build your first experimental setup, you need to define, based on the literature, what you want to study specifically. This question ties back to what we discussed in Chap. 5 about the research question. Your experiments should be directly related to your main subquestions. Make sure the experiments you envision are geared at directly answering one of your main subquestions, and that you can gain all required information from the measurements you apply.

When you have an idea of what you want to test (i.e. what your specimen looks like), make sure you run the numbers before you start designing your test setup. Compare your envisioned specimen with the results in the literature. What behavior can you expect based on the results from the literature? Can you use a few existing theories, and see what the outcome should be if these theories can be extended to your specimen? Make sure you understand very well what can happen to your specimen when you test it, so that you can prepare accordingly. Of course, surprises in the lab are possible (and common).

Typically, the description of experimental work in papers is limited because of the space constraints. If you find a paper that seems particularly relevant for your experiments, see if the authors wrote a full experimental report. In the full report, you can often find photographs of all the steps that involved developing the specimens and the test setup. If the report is difficult to find, but the paper was published recently, don't be afraid of looking up the author (often, the former PhD student who did the work) and send an e-mail with a few questions on the practical aspects – I still need to come across the first scientist who is not genuinely happy to talk about his/her work.

6.2.2 Designing Experimental Setups

Once you feel like you have a good idea of what you need to test (the type of specimen you will test, which parameters you will vary, and which responses you need to measure), you need to ask yourself how you will test it. Designing experimental test setups is not something you learn in class. Test setups also depend very much on your field of study. As a starting researcher, you are not expected to know how to come up with a working setup right away. Developing test setups is a trial-and-error process, and you can avoid some of the trials and associated errors by learning from the senior researchers and technicians in your lab.

Before you attempt at designing your test setup, make sure you know the possibilities of your lab. If you haven't done so yet (see Chap. 2), ask a senior researcher or lab technician to take you on a tour and show you what is inside every cupboard, what is hiding in the basement, and what every machine in the lab is capable of doing. Seeing the options of what can be done in your lab helps you think more practically about your experimental setup. Perhaps you don't know about the machines that lay dormant in the lab basement, so make sure you get to visit all of the laboratory, especially the parts that are currently not used. If it's not used and you can use it, you already know you don't have to coordinate with anybody else who needs the machine. When you get a tour of the laboratory, take notes of the available products and machines, and where they are stored to assist your memory. You can scribble down your notes on a notepad, or use your smartphone to snap pictures and store them with annotations in a note-taking app like Evernote or Onenote. Don't be the new kid in the lab who has to ask the post-doc five times a week where you store a certain chemical. After your tour, take a moment to write down the ideas you had while seeing the options of your lab in your research journal.

If you are going to do experimental work, and your office space is not in the lab or close to the lab, don't wait until you actually start your experiments to start hanging out in the lab. If your office is away from the lab, try to go to the lab at least three times a week to catch up with colleagues, learn from what they are doing, and form your ideas about your options for an experimental setup. Don't disturb your colleagues if they are carrying out an experiment, but be there, have your eyes open, and if you see someone is ready to take a coffee break and talk with you, take that moment to learn. Spend some time discussing with them what could possibly go wrong with the specimen or test setup you have in mind. Learn from the mistakes others have made before you, and have a plan B in case something breaks or doesn't work. If your specimen will need to be at a constant temperature, or at constant humidity, and there is a risk of having a power cut, make sure you have a backup system in place (e.g. diesel generators [4]). Ask one of the senior researchers if you can work alongside with them for a few days to learn from his/her routines.

If you are joining a new laboratory formed around a new faculty member, you will need to help develop this new laboratory. In this case, there may be very few machines and cupboards with material, but your supervisor will have a larger budget to start bringing machines and products [5]. You can be trusted with figuring out what you need, how much it will cost, and from which company to buy. If you can shop as you please, ask local representatives of companies fabricating laboratory equipment for their catalogues, and an in-person meeting, so they can share their insights with you. An in-person meeting will also help you determine if the local representative is a salesperson or a person with technical knowledge. Go with the latter, so that you can rely on him/her for the periodical maintenance and/or calibration of your equipment. A salesperson may not have the technical background needed to install your new piece of equipment.

Once you have formed your ideas about an experimental setup based on the literature, the options of your research laboratory, and from talking to senior colleagues and technicians, it is time to write a short document describing what you want to test, and how you want to test it. Include the references to the most important papers and research reports that you read. Provide sketches of the specimens you want to test, and how you plan to test them. Aim for five to ten pages of text. Make sure it is concise enough so your supervisor can read it quickly prior to the meeting to discuss your plan. Focus on what and how you want to test, why you want to do these tests (i.e. how the experimental work relates to your research question), and what your possible outcomes are.[1]

6.2.3 Planning and Logistics for Your First Test

After you have discussed with your supervisor what you want to test, and how you want to test it, and gone back and forth a few times to finetune your ideas, it is time to think practically. Here, the planning skills you trained in Chap. 3 kick into gear. Ask yourself the following questions: which materials are necessary to build the test

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[1] If you are working at a North American institution, and have to write and defend a proposal, the description of your proposed experiments can be the starting point for your proposal.

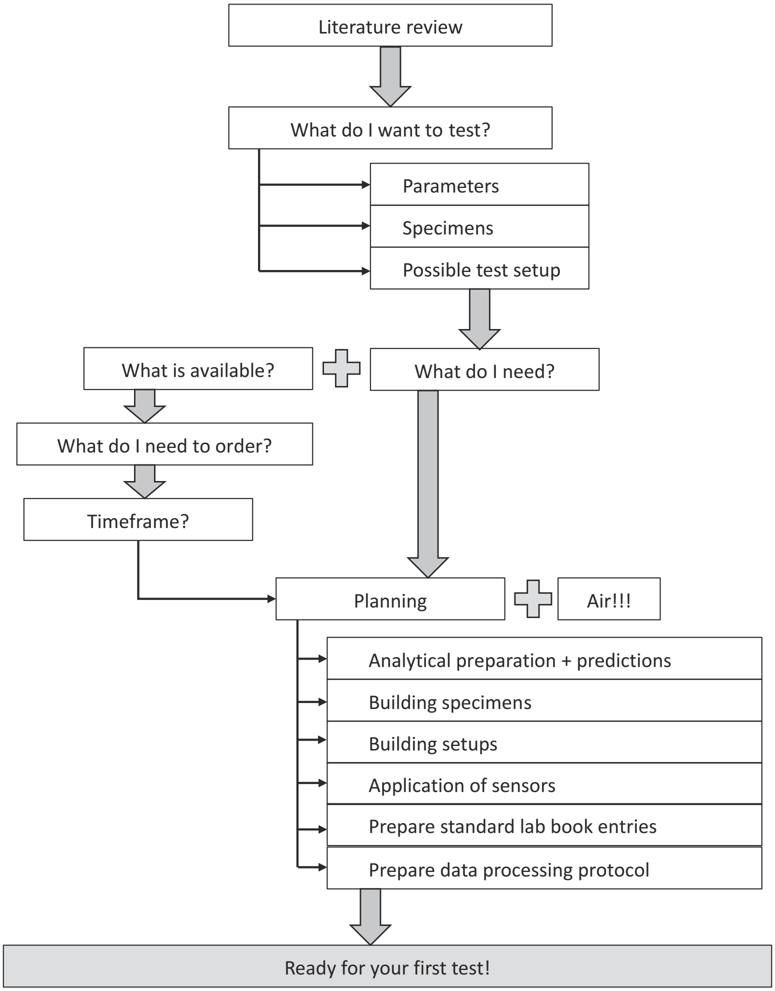

Literature review
What do I want to test?
Parameters
Specimens
Possible test setup
What is available?
What do I need?
What do I need to order?
Timeframe?
Planning
Air!!!
Analytical preparation + predictions
Building specimens
Building setups
Application of sensors
Prepare standard lab book entries
Prepare data processing protocol
Ready for your first test!

Fig. 6.1 Steps to be taken from the literature review to your first experiment

setup and run a first benchmark test, possibly to compare results from the literature with the functioning of your setup? Which materials do you need to build your specimens? Do you need to take special care of the storage of these materials (dry, away from light, at a constant temperature)? If you have to order materials, how much time will it take until these materials arrive? Can you immediately have space in the lab for your setup and to store your materials, or do you need to wait until someone else finishes his/her tests first? How does the availability of lab space, materials, and personnel affect your planning [3]? You can find an overview of how you go from the literature review to your first experiment in Fig. 6.1.

Plan how you will go from the conceptual phase with the design of your setup, to the execution of the first experiment. Planning is an essential part of your experimental work: it guarantees that you have thought through all steps, and that you order and receive your material before starting your experiments. List the material and equipment that you need for your experiments. Go to the lab to take stock of what is available. Ask the person responsible for the lab orders to place an order of the materials you need, or of the general products from the lab if you see they are missing or almost running out. If you need something more specialized, you and your supervisor should negotiate directly with the representative of a lab equipment company.

While you are going from a sketch on paper to an actual test setup, take some time to get acquainted with the etiquette of your lab. Sit around in the lab even though you are not working there yet (just remember, don't bother anybody who is trying to work in full concentration). Figure out how your lab works: who helps who, and what is expected from you? When do people start working, and when do they sit down and have their coffee break? When do you clean up after experiments? How and where do you sort certain waste products? Learn about the customs and habits of the lab, and stick to the unwritten rules of your lab. Use your research journal to record your impressions. Remember that, once you start working in the lab, you are joining a team. Be a good sport, and help a hand where needed, whether it be in going out for fieldwork, moving heavier pieces, or cleaning up the space.

Once the glorious day of your first experiment arrives, don't walk into the lab empty-handed [6]. Bring a report with you in which you have your predictions for the behavior of the specimen during the test. Don't forget to take your lab book to take notes. Make a template for your lab book to fill in your observations at the different stages at which you take measurements. Take a photo camera and perhaps a video camera (or your smartphone) to document what happens during the experiment. If the test will take a long time, and your lab rules allow it, bring a snack and some water. After the first test, write an entry in your lab book and your research journal.

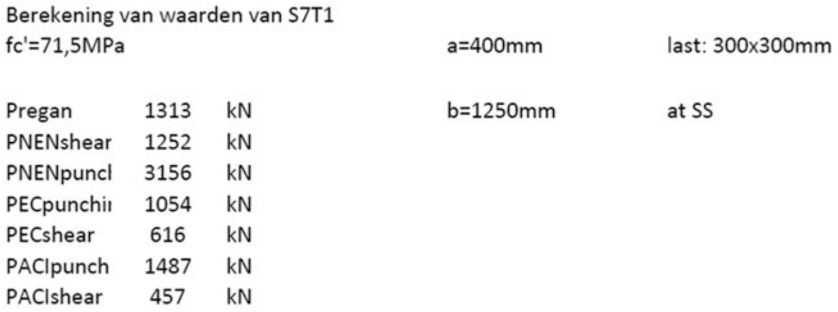
Exercises

1. Take your literature review, and identify the interesting papers discussing experimental work. Pay special attention to the test setups and specimens the authors used.
2. If you haven't been to the lab yet, ask one of the senior researchers or technicians to give you the full tour. Afterwards, use your research journal to write out your impressions and ideas that came to your mind for your work.

6.3 Managing a Series of Experiments

6.3.1 The Importance of Your Lab Book

In Chap. 2, we looked at the importance of starting a research journal and lab book at the beginning of your PhD trajectory. By the time you are laying out your experiments and setting foot in the lab, you should have already a fair number of entries



Berekening van waarden van S7T1				
fc'=71,5MPa			a=400mm	last: 300x300mm
Pregan	1313	kN	b=1250mm	at SS
PNENshear	1252	kN		
PNENpuncl	3156	kN		
PECpunchi	1054	kN		
PECshear	616	kN		
PACIpunch	1487	kN		
PACIshear	457	kN		

Fig. 6.2 Example brief overview of main predictions, taken to the lab during experiments

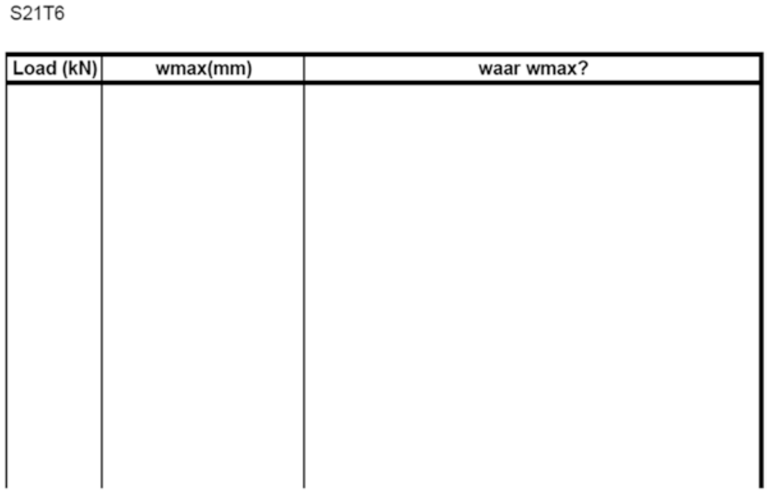
in your research journal. But perhaps you have not added much material to your lab book yet, given that you were in the library or behind your computer to scout articles for your literature review previously.

Let's look at your lab book in more detail. If your lab book is going to be analog (a notebook, or a binder with sheets of paper), make an outline of how and where in your lab book you will write what. You can use tabs to separate different categories. The front of your lab book should contain the general information of your experiments, and a discussion of your test setup. The middle should contain the nitty-gritty of all your experiments. Fill out this part as you move through your series of experiments. The final part should contain important references and reference drawings, so you can access them quickly whenever you need them.

I used a binder with loose sheets of paper. Digital was not an option for me, as I work in a very dusty (cement dust) and dirty (oil, grease…) lab environment. The advantage of the loose sheets was that I did not have to carry the whole binder every time. What I also liked about having loose sheets in a binder is that I could combine printed documents and my own entries. My lab book binder had the following general structure:

- the research proposal to remind myself of the necessary deliverables of the experiments,
- the calculations and general information about the specimens and test setup,
- my entries of all the tests and the measurements for each tested specimen,
- printed AutoCad drawings of the setup, specimens, and sensor locations, to refer to while analyzing my results.

My entries for each test followed a standard layout. I made a brief overview with the main properties and predictions to take with me in the lab, to have an idea of what to expect, see Fig. 6.2. I also took an empty table to note down the load steps, measured crack widths and their positions, and additional observations, see Fig. 6.3. The sheet with the predictions and main parameters helped when somebody would drop by during the test and ask: "So, how high do you think your load will go today?" The disadvantage of loose sheets is that they get lost more easily. When you take



S21T6

Load (kN)	wmax(mm)	waar wmax?

Fig. 6.3 Layout of blank entry for lab book, to be filled out during experiment

loose sheets to the lab, you miss the information from previous experiments if you want to look these up during a test.

If you choose a digital approach for your lab book, select the software you want to use, and make sure that this software or app syncs on all your devices. An obvious choice are programs such as Evernote, Onenote, and Google Docs or Sheets. Before you chose your software, see how many devices you want to use, and if the software allows you to connect all of them for free. Evernote used to sync on all your devices, but now only offers syncing two devices for non-paying members. I, for example, need software that syncs on my two smartphones, tablet, three desktop computers and two laptops, and if you work at different institutions, you may have a similar syncing challenge.

Once you have decided on your software, set up the general outline of your digital lab book. Have a folder containing your general information and what you used to prepare the experiments, a folder with your entries for each test separately, and a folder with reference material. Rearranging your material is easier on a digital device than in a notebook. Make sure all the elements and files you want to sync can be opened through the app or program of your choice. For example: can you open AutoCad drawings on your smartphone and tablet? Consider how you will take notes in the lab: photographs and voice recordings, or will you type out your observations? For typing out your observations, a laptop or tablet would be the device of your choice, whereas for photographs and voice recordings, a smartphone is sufficient. Always make sure your devices are charged and will last for the entire duration of your experiment.

As an additional note of caution: if you will be doing field work for your experiments, make sure that your lab book is portable and can withstand all weather conditions. You don't want to be out in the soaking rain, seeing your pieces of paper getting washed away, or having your laptop damaged. Think ahead, and make sure your choice of lab book is suitable for the purpose.

In the months (or years?) that you will spend in the lab, you will do most of your scribbling in your lab book. Don't forget about your research diary. Use no more than 15 minutes at the end of the day, or some quiet time after dinner, to reflect on your day and research insights. It can feel good to do a brain dump and write down those tangential thoughts that cross your mind during the day. Reflect on what you are doing, and try to take some distance from the work in the lab by thinking about the general state of your work and understanding of your research question.

6.3.2 Project Management Essentials

At the risk of sounding like a broken record, don't walk into the magic world of experiments without a map (i.e. your planning) in your pocket. Remember that you need to plan much more [6] than the time you need to carry out the experiment. Think about the ordering and delivery of material and equipment, fabrication of specimens (if needed), side testing (measurements of material properties, calibration of your sensors), and then the experimental program itself. As we discussed in Chap. 3, make sure there is enough air in your planning. If your experiments depend on a number of people and involve complex operations, the chance that something will go wrong is quite high. People can get sick for an extended period of time, leave for a sabbatical, equipment can break down… You might throw your hands in the air and say: "If there are so many uncertainties, why would I even plan!" Well, you still need a planning to make sure you don't forget any of the actions you or someone on your team needs to do, and to estimate the time every step will take. If you get derailed for a long time for reasons out of your power, you need to be able to communicate openly to your funding body, and inform them about your revised, realistic planning.

If you notice that your planning needs to be rearranged almost every six weeks, don't despair. Make sure your general planning has plenty of buffer time to absorb the punches of misfortune. As a rule of thumb, you should double the time you think it will take you to carry out the experiments. You also want to have a bit of extra time to play around with something "interesting" that comes up along the way.

When you need to carry out a series of experiments, make sure you design the series based on the following requirements:

- Which parameters do you need to test? This question should be supported by your literature review.
- To test these parameters, how many different values of the parameter should you test?
- How many repeat tests do you need to get an idea of the statistical variability of this parameter?
- Do you need to schedule backup tests and specimens in case something goes wrong with a test, so you can have the number of repeat tests you need?

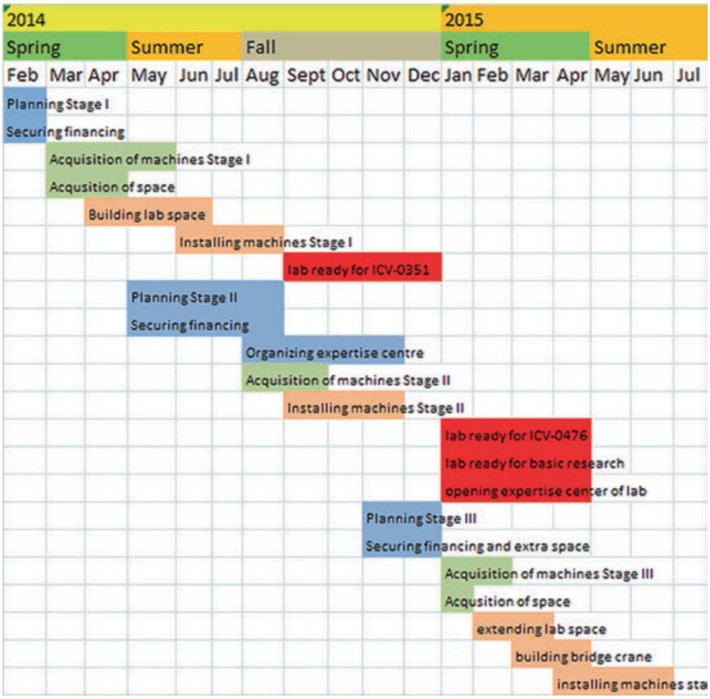


Fig. 6.4 Example Gantt chart for setting up laboratory space

When discussing the parameters that you need to test and the values you need to measure, rank them by priority. Which parameters are absolutely essential to vary, and which values do you absolutely need to measure? Which parameters are nice to test if you have extra time, and which measurements could be helpful? When asking yourself these questions, link back to your research question, and, if applicable, to the deliverables for your funding body.

Once you have an idea of the entire series of experiments you need to carry out, you can develop a planning by using a Gantt chart. If you have access to a full MS Office package, you can use Project. If not, you can use colored outlines in MS Excel or Google Sheets to develop a Gantt chart. The advantage of a software package is that you can identify which task needs to be completed before you can start another task. If you change the length of task X, the software will automatically update when you can start task Y and all other tasks that depend on it.

You can see a basic example of a Gantt chart in Fig. 6.4. Why do you need such a chart besides your planning tools? The reason is simple: having an overview, of perhaps no more than an A3 page, helps you to keep the bigger picture in mind. If you have this overview, you can print it out, hang it in your office, and take it to your supervisor to discuss the broader scope of things. Plan in more detail for yourself.

Use your Gantt chart as an overview of the essence of your work and to see the tasks that need to run in parallel.

Prepare yourself mentally for some busy days once you are ready to do your experiments. David A. Russler-Germain, an MD/PhD candidate at Washington University in St. Louis, Missouri, comments on the many tasks he juggles on a regular day in the lab [7]: “For all of these projects, there is a wide range of tasks needing to be done each day, including: running western blots and protein biochemistry assays, DNA cloning, maintaining and manipulating in vitro cell cultures, keeping an eye on and analyzing a retroviral mouse model of leukemia, and computational analyses of genomics data. After a few years in lab, I’ve gotten better at multitasking. A typical morning this week involved selecting bacterial colonies from eight ligation reactions, starting two western blots using samples prepared earlier in the week, splitting two cell lines, and starting a flow cytometry stain on samples isolated from mice the previous day. I can almost always find at least 20 minutes between 11 AM and 2 PM to have lunch (I know some PhD students whose experiments truly don’t allow for even 15 minutes of downtime many days).”

Exercises

1. Did you make an outline of your lab book entries in Chap. 2? Now, outline your entire lab book. Which different sections will go into your lab book? How will you organize your lab book?
2. Make a preliminary Gantt chart for your experiments. Try using different colors, for example:

   a. red for deadlines (deliverables as requested by your funding body, for example),
   b. blue for desk research you need to do to prepare experiments,
   c. green for stages where you need to discuss with your supervisor,
   d. purple for the preparations in the lab,
   e. orange for the actual lab work.

6.4 Thriving in the Lab

6.4.1 Making Friends

As I mentioned before, lab work is team work. You may be all alone, slaving away at your test setup, but you are not the only one working in the lab. You’re part of the gang, and you are going through the same motions as your peers in the lab. Keep that in mind, and try to be a good sport. Try to integrate, respect the lab etiquette, learn from the senior researchers and technicians, and keep an open and inquiring mind. Joke around, share some candies, enjoy the opportunity of working in a lab, and smile.

One mistake I have observed in the past, is that sometimes beginning PhD students look down on the laboratory technicians. Remember that, even though these people are not pursuing a doctoral degree, they are highly skilled and knowledgeable. When you have an appointment to work together with a technician, respect their time. It's not because they are "always around" that you should have them wait for you until you feel like setting foot into the lab. If they volunteered to help you and give some of their time to you, treat their compromise as you would treat every other appointment. Two people were most crucial to the success of my PhD trajectory: my co-promotor/daily supervisor and the technician with whom I worked side-by-side for all my experiments.

If you are an introvert, and working side-by-side with people the entire day is not an appealing idea, don't panic. You typically won't get swallowed up in large groups, and remember that your work is still mostly an intellectual endeavor. If you need some quiet downtime during the day, try to see if you can schedule a short break in the morning and afternoon to have your coffee with just a few people, or to go out and get some fresh air by yourself.

On the other hand, if working away in relative solitude at your test setup seems an unattractive prospect, see if you can involve MSc. or BSc. students. Involving students and teaching them the ropes of some of your work prepares you for working with students in the future, and is a great way of learning how to communicate your research to somebody who is new to the topic. You might have developed a special lingo with your labmates and your supervisor, but when explaining your work to a student who is just starting, take a step back and explain the bigger picture and basic principles first. If you have a smaller side question spinning off from your research question, that makes for a perfect topic for an MSc. thesis. Rebecca Pollet [8], a PhD candidate in Biochemistry, whom we met already in Chap. 3, draws her motivation from having the opportunity to teach undergraduate students projects in the laboratory.

Similarly, if the daily grind of the lab feels asphyxiating, branch out and get involved with professional organizations. Enroll in student chapters of professional organizations, see if your lab can host certain certification exams, or invite parties from the industry to come and see what you are doing. If your future career lies outside of academia, start reaching out to the industry and connect to local practitioners.

Another word of caution when you start working in a lab: you'd be surprised how physically taxing lab work can be. Being on your feet and running around the entire day is one thing. If your work involves large experiments, be prepared to carry some weights and maybe do movements that you are not used to. As an example, one of the main activities during my experiments consisted of going under my specimen, shining a lamp on the bottom of my specimen and marking the cracks, as you can see in Fig. 6.5. Ever had a very sore shoulder after painting a ceiling? Well, try doing that every day for an extended period of time… Don't try to overload yourself until you get accustomed to working in the lab, and schedule downtime in the evening to recover.

Fig. 6.5 Working on getting a sore shoulder…

6.4.2 *Staying Calm in the Face of Adversity*

There are a lot of uncertainties related to working in a laboratory. If suddenly everything seems to turn against you, and your funding body is breathing down your neck for results, don't despair. Don't panic. Chewing through your difficulties by sharing your struggles in a troubles talk with your peers can feel relieving, and may even help building community with your peers [9]. Try not to fall for the trap of staying later and later and getting more and more exhausted. If you need to make a major push forward during a short period of time, that is OK – it is part of doing science. But if you are continuously trying to catch up and feel like you are chasing your own tail, sit down and assess the situation. Ask yourself the following questions:

- What is the most important task I currently need to focus on? Make sure it is precise, don't just say "finish my experiments".
- Is there something I can postpone or delegate?
- Can I get help, from a colleague or a student, until I get back to calmer waters?

Identify what you need to focus on to get your deliverables to your funding body, and see which interesting but not-so-important side projects you can drop for a moment. See if you can optimize your time, and batch-process a number of things at the same time.

When all seems like a drag, remember that having the opportunity to touch science with your own hands is unique. When you get stuck and feel overwhelmed by the vast amount of experimental work that needs to be done, remember how privileged you are. Above all, remember that science is fun.

6.4.3 Processing Your Data

When you are carrying out a large number of experiments, you need to think about your protocols for processing and storing your experimental data. Remember our discussions in Chap. 2 about your storage protocols. Flesh out a storage protocol for your experiments in particular. How will you make sure that, in a few years, when you are writing about your experiments, you will be able to access the information from a particular experiment right away? How are you going to organize your storage or your hard drive: will you make a folder per experiment, or will you group information per parameter? Set up a protocol and stick to it, so you can easily find information while you are in the midst of your experiments, or five years later if you need to go back and check something. Include protocols and habits (and cloud storage options) for your data. Nothing is as terrible as being that PhD student who is writing his/her thesis and loses all data in a hardware crash. Consider these steps for processing your data swiftly:

- **Store your data right after the experiment**. Don't wait until you finish your experiments to organize your data and store the notes from your lab book in a permanent way (backing up information from your analog lab book into the folder with all your experimental information, for example). Save the raw data of your experiment, your notes, and your photographs and videos. Make sure you have a storage architecture on your computer, and a backup protocol. Guarantee your data is safe and accessible at all times. Develop overview tables of your experiments, and add the information of each test right after finishing. Store your results when they are still "warm". Take action right after you finish a test to keep your information organized.
- **Automatic processing**. Try to make your data processing as much automatic as possible. Programming a file to do the post-processing of your experiments can take some time, but having a clean code that is free of errors and that can process ten, a hundred, or a thousand experiments, is worth the effort. Avoid programming anything in MS Excel, since it does not provide clean code. You need to be able to print out your code and go line by line and check for errors. If programming is not an option, develop a checklist of actions of programs to run, files to copy, and entries to type out after every experiment. Programmed routines and checklist help you develop standard procedures, so you don't forget to take a certain action after your experiment. If the mere thought of having to program something scares you, don't be afraid: your PhD trajectory is a good time during your career to learn new skills, and programming could be one of them.
- **Don't postpone writing**. Start developing your experimental report while you are still working in the lab. Don't wait until you finish your last experiment to start writing. Set up a standard entry in your experimental report, highlighting the most important parameters of the test and discussing the main observations. Try to group as much information into overview tables in the conclusions and summary sections. Complete the entry of each test in your report right after finishing the test. As you start to move through your experiments, you might forget

details of tests you did a few weeks ago. Your lab book and your report are the references you can return to if needed.

Exercises

Identify how you will process your data, how you will store your data, and how often you will back up your data.

6.5 Reporting Experiments

6.5.1 Developing Your Experimental Report

Drafting your report is part of processing your data: it is an action that happens during testing, not after testing. Prior to your experiments, you can build the structure of your report. A typical test report contains the following parts:

- Introduction and goal of the experiments.
- Test setup, with reference to the papers and research reports you used to develop your setup. You can use your preparation documents for this part. Refer to standards and guidelines you used for executing standardized tests where needed.
- Description of materials and/or equipment used for executing the experiment.
- Description of samples.
- Results of standardized tests that support your experiments (where applicable).
- Description of experiments:
  - Date, number of specimen, number of test
  - Description of most important parameters
  - Photographs
  - Observations during experiment
  - Post-processed data, for example in the form of plots or overview tables
- Recap/overview of all experiments, for example in the form of tables that summarize the most important findings and parameters of all tests.
- Summary and conclusions.
- References.

You can write the first topics of your report before your experiments. I'd recommend you to write as much as possible before hitting the lab (and the exhaustion that comes with it), and update it as you go, by adding photographs and/or last-minute changes to the descriptions of your test setup, specimens, and materials. The part with the description of the experiments is an element of processing your data: generate all plots after each experiment, and keep your report and test series moving forward together. Finally, the recap and/or overview and summary and conclusions parts are typically written towards the end of your experiment. The recap with overview tables is something you can draft as you go along. You can change your opinion on what you want to show in such tables as your experiments move along. As you go back and forth between ideas, save intermediate versions of your overview table(s).

You can deliver two types of experimental reports: a report of the experiments, and a report and analysis of the experiments. In our research group in Delft, it is common practice to separate the experimental report from the analysis report, i.e., separate pure observations from computations based on the test results. This practice typically also relates to the time frame of the deliverables: an experimental report is usually due right after the end of the experiments (another reason for keeping on track with updating the report during the test series), whereas the analytical report can be delivered months after the experimental report. I have focused here only on how to report your experiments. If you need to add the analysis of your results, you will need to show all your parameter studies, develop recommendations, and draw conclusions. All this work should fit in the framework of the existing body of knowledge that you outlined in your literature review. Link back to your research subquestions here, and use your analysis report to answer these questions.

6.5.2 From Experimental Report to Dissertation Chapter

In your dissertation, you will typically outline your experiments and results in one chapter, and then discuss the analysis and interpretation of your results in another chapter. This approach follows the logic of writing an experimental report separately from the analytical report. If you did a large number of experiments, keep the information in your dissertation chapter concise. Refer to the experimental report for all the details. Focus in your dissertation on giving an overview of what you did, and on the information you need to answer your research question. Remember those overview tables or recaps and other forms of summarizing your data we discussed when looking at your experimental report? These tables are particularly suitable for your dissertation. Their background can then be found in your experimental report. Don't show pictures of each specimen you tested and how it behaved; categorize your observations instead, and show a representative image of each category together with their definition. In the overview table, you can then add a column to identify the category in which the test could be placed.

If your lab does not publish research reports, you can develop the report for yourself, and then add it as an Annex to your dissertation. The idea here is to keep your thesis concise. Of course, there are 800-page theses out there, but they are not the most accessible documents to read. Sometimes, these monster theses contain a narrative of "This is what I've done over the past X years." Your thesis should be a document that outlines how you answered your research question. You can find an overview of how you go from your experimental results to a dissertation chapter in Fig. 6.6.

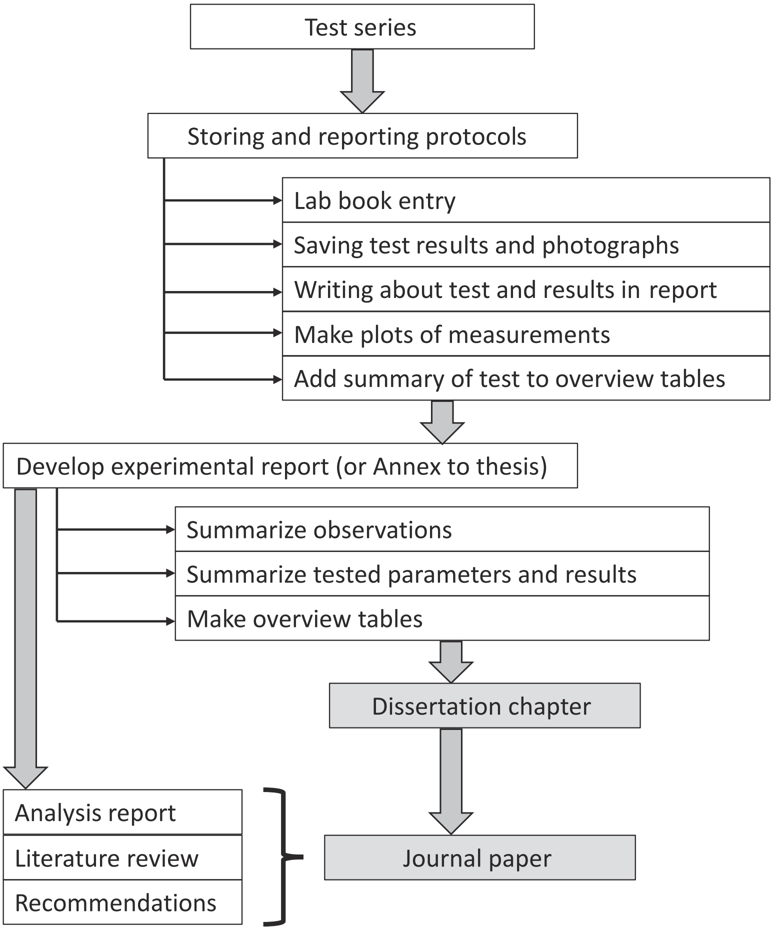

Test series
Storing and reporting protocols
Lab book entry
Saving test results and photographs
Writing about test and results in report
Make plots of measurements
Add summary of test to overview tables
Develop experimental report (or Annex to thesis)
Summarize observations
Summarize tested parameters and results
Make overview tables
Dissertation chapter
Analysis report
Literature review
Recommendations
Journal paper

Fig. 6.6 From experimental results to dissertation chapter and journal paper

6.5.3 From Experimental Report to Journal Paper

In a journal paper, you need to discuss your experiments and results together with the analysis and interpretation thereof. You cannot write a paper that simply reports your experiments. You need to frame your experiments within the literature, and for that reason you will need to compare your experimental results to existing theories, existing provisions, or previously reported experiments. As you can see, writing a journal paper from your experiments is a different exercise than preparing a dissertation chapter about your experiments. Whether you turn your experimental report into a dissertation chapter or a journal paper depends on the requirements for graduation of your institution. If you graduate based on a big book thesis, I still recommend you to publish your experimental results in a journal paper. The timing can be different; you can develop this paper shortly after you finish your dissertation, as it is not a requirement for your graduation.

The description of your experiments will only be a part of the journal paper, see Fig. 6.6. You will need to include a literature review (or section with an overview of existing methods, previous experiments, or similar). You will need to add the analysis of the experimental results. This analysis needs to result in recommendations, and novel conclusions.

For the description of the experiments, use the overview tables or other types of recap that you developed for your experimental report. Focus on clear overview figures that convey what you tested and how you tested it. The maximum word count of journal papers is limited, so carefully select what you show and for which elements you can refer to the full experimental report. Keep in mind that the paper needs to read as a document that stands on itself. If you constantly refer to the full experimental report, the reader will not be able to follow the main gist of your experiments without needing to look up the experimental report. You can find an overview of how you go from your experimental results to a journal paper in Fig. 6.6. Think of the following rule: 95% of all readers should get the information they need from reading your paper. That last 5% (or even less), the people that need to go and look up your experimental report, are the happy few who will continue your work in their research, and who may replicate one of your experiments to set their benchmark.

6.6 Summary

In this chapter, we discussed experimental work in a research laboratory from the first preparations to writing up your results in your dissertation or a journal paper. In terms of preparing for the first experiment, we learned how designing a test setup and identifying the specimen(s) that you need to test can be based on your literature review. Moreover, it is a good idea to exchange ideas with your supervisor, lab technicians, and senior colleagues once you have identified what you want to test and how you want to test it. Their practical experience can help you avoid making mistakes. Make sure as well that your plans fit within the possibilities of your lab – have a clear idea what is available in terms of materials, equipment, and space. Once you have outlined your test setup and specimens, plan how you will go from your sketches on paper to the realization of your first test.

In the next part, we discussed being in the swing of experimental work. You need some basic project management skills to keep an overview on your series of experiments: material needs to come in at the right time, you need to carry out side experiments (material characterization, or equipment calibration), and you need to make sure you take note of what you are doing in the lab. To keep a record of your work, your lab book is your best friend. Sometimes there seems to be no light at the end of the tunnel when you are in the full swing of lab work. We talked about finding your space in the lab, inside the team with your peers, and how to face difficult times. Another practical aspect necessary to thrive in the lab is to have a protocol for storing and processing your data. We learned that you should do your post-processing as soon as possible after you finish an experiment.

Finally, we discussed how to report your results. First of all, there is the report with your experimental results, that contains all the descriptions, observations, and photographs of each test separately. As we discussed, you don't want to dump all this information into your dissertation. You can show overview tables or other elements summarizing your experimental work in your dissertation, and refer for all the details to the experimental report. The same holds true for the development of a journal paper about your experiments. The caveat here is that your journal paper needs to stand on its own, so you need to include the results of the analysis of the experiments as well, and formulate recommendations.

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Chapter 7
Honing Your Academic Writing Skills

Abstract This chapter on academic writing serves as a reference for a number of topics discussed throughout the textbook. Instructors can decide to teach this topic before talking about the literature review. This chapter is subdivided into the following topics: structuring writing, finding your voice, tips for non-native English speakers, and tips for productive academic writing. The first topic, on structuring writing, deals with the main questions you need to ask yourself before starting. The next topic, on finding your voice in writing, deals with writing styles, scholarly identity, and how different writing styles relate to different types of articles. Since the majority of scientific publications nowadays are in English, and many PhD candidates are non-native English speakers, we focus on the typical pitfalls for non-native speakers. We also discuss how, as a non-native speaker, you can work on improving your English, and how you can find your writing voice and scholarly identity in a language that is not your own. Finally, this chapter contains a series of tips for productive academic writing. Best practices are shared, and anecdotes from researchers worldwide illustrate how they manage to fit academic writing into their busy schedules.

Keywords Academic writing · Productive writing · Authority · Academic voice · Productivity · Writing

7.1 Introduction and Learning Goals

This chapter on academic writing serves as a reference for a number of topics discussed throughout the textbook. Writing is often considered as your most important academic skill. Honing your academic writing skills, and eventually writing your dissertation is a crucial part of your PhD trajectory, and is intrinsically related to your research and finding your scholarly identity. As such, it is a very personal process. This chapter aims at giving you food for thought about writing, and offering you tools to try out – but keep in mind that this is your unique PhD trajectory.

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E. O. L. Lantsoght, *The A-Z of the PhD Trajectory*, Springer Texts in Education,
https://doi.org/10.1007/978-3-319-77425-1_7

7.2 Structuring Writing

7.2.1 Determining What You Need to Convey

Before you start to write anything at all, you need to ask yourself a number of questions [1]. There's not a single approach to writing for every possible written document out there. Imagine a world in which a newspaper article would be written in the exact same way as a technical paper… Can you see that this wouldn't really work? To set the tone of your writing, you need to ask yourself a number of questions:

- **What's the goal of this work?** Why am I writing this document in the first place? What do I want to tell people? Do I want my readers to learn about a new methodology, about theoretical developments, about a new experimental observation,…?
- **Who is my audience?** Who will read this document? Where is this report or article going to be published? What information are the readers of this type of publication looking for? Do my readers want to get a general idea of what I have done so far and where my research is taking me (for example, for a conference paper)? Do my readers want to learn about the background and evidence for a new theory I developed (for example, in a journal paper)? Do my readers want to know all the details of my experiments, so that they can continue my work, perhaps with a benchmark test to calibrate their results with mine (for example, in a detailed technical report)?
- **What writing style do I need?** Do I want to convince people of something (such as funding my research), or do I want to inform peers about my findings? Your writing style will be different depending on your audience: you can use a different voice for a conference paper as compared to an industry publication that will be read by industry partners instead of by researchers. For such an industry publication, highlight the practical importance of your work, give clear recommendations, and avoid jargon.
- **What is the main message I want to convey?** If someone reads my paper, what is the main message that I want him/her to remember? Identify the core message of your article or other type of document, and use this as a red thread throughout your writing. Think about how you need to provide a proof or support for this main message, in such a way that it will be loud and clear for the reader. If you can't put it on paper right away, try practicing your elevator pitch of the article verbally. A similar approach that you can use is to "talk it out": grab a friend, colleague, or, if all else fails, talk to your computer screen, and say the following: "The article that I am preparing is about XXX and I show how YYY works based on results from ZZZ" (as an example). For a larger piece of writing, such as a book or dissertation, a mindmap or diagram of the contents can be helpful, to understand how the different chapters are related, and how you link evidence and proof of hypothesis together.

7.2.2 *Outlining Your Writing*

Once you have answered the previous questions and have a better grasp of what you want to tell, it's time to delve into the nitty-gritty: the outline of your document, and then your planning for writing (which we'll discuss in the next section). Outlines in the traditional sense are experienced as too static and unmanipulable by many writers [2]. Since writing is an act of creativity, it's important to keep in mind that your outline is not a rigid scheme, but a first idea to bring structure and planning to your writing endeavor. For some writers, outlining does not work at all. Learn to understand yourself and your optimal way of working.

If outlines of some kind are helpful for you, this paragraph is for you. Before you start writing, ask yourself how you will structure your writing. The outline of your article is an extended table of contents. First, of course, you need to set up the table of contents. There are different outlines that are possible, depending on the type of document. If you are writing a paper based on experimental work, you can use the following typical outline:

1. **Introduction**: In this section, you address the background of the problem. What are the practical implications of the topic you analyze theoretically or experimentally in this paper? Why do we even care about the problem you are studying?
2. **Literature review**: How is your work related to the literature? In this section, you need to review the existing literature in a limited number of paragraphs, so return to the red thread, and see which references really matter. Don't cite everything you've ever read on the topic, but stick to making your point by framing your work inside the relevant state-of-the-art.
3. **Experiments**: If you've used experiments to study the problem you outlined in the introduction and framed inside the literature in your literature review, then the description of the experiments goes here. If you did laboratory experiments, describe the test setup and all properties of the specimens. If you did computer simulations, describe the assumptions used in the program, and your input. If you used qualitative experiments such as questionnaires, describe how you determined your sample population and questions.
4. **Results**: First, you need to report on the measured results: the tested values in the laboratory, or an overview of the data you collected from a questionnaire. In a second step, you can analyze these results, show graphs with the relation between your results and a parameter that was varied, or show other forms of post-processing your data.
5. **Discussion**: Here, you can link back your results to your introduction. Which practical applications follow from your results? Did you find something odd that needs further research? How do your results fit into the broader scope and the literature?
6. **Summary and conclusions**: No new information goes here. You can only summarize what you have shown in your previous paragraphs.

If you are writing a paper for a mathematical proof, or a paper in which you show support for a certain hypothesis, you can use the following outline:

1. **Introduction**: As before, this section allows you to frame your work within the broader scope of things. If you are providing a mathematical proof, then you can mention in which fields this part of mathematics is applied (for example: medicine, aerospace applications…).
2. **Theorem**: What is the theorem you are going to prove? Here, you simply introduce the theorem, and, if needed, you can add a discussion of where in the literature attempts were made to solve it.
3. **Proof**: Here, you outline your proof for the theorem introduced before. The proof can be purely analytical, or, if you are proving a hypothesis instead of a theorem, it can be based on experiments or numerical work.
4. **Discussion**: How does the work you presented fit in the broader scope of things? It is unlikely that you will have been able to suddenly come up with the proof to a mathematical theorem that nobody has been able to solve before, but you might have done a step in the right direction and advanced your field.
5. **Summary and conclusions**: This section simply restates and summarizes the contents you have shown in the paper. No new information goes here.

Depending on the goal of your document, or the requirements from the institution where you will submit your work, other elements might be required. Additional elements can be:

- **Research significance**: Some journals require you to describe in one paragraph why your work is significant and original, and how it will impact your field.
- **Acknowledgement**: Here you can thank your funders, but also anybody who helped you with your research. You can thank colleagues who came to help you a hand in the lab, or maybe senior colleagues who revised your work and gave their input.
- **List of notations**: Many journals require you to give an overview of all notations and abbreviations you used. Typically, this list is organized as Latin lowercase, Latin uppercase, Greek lowercase, Greek uppercase. Within each list, organize your notations alphabetically. If necessary, revise your Greek alphabet.
- **References**: References are not optional, but are also not a part of the general structure of a paper. At the end of your paper, list the works cited in the text. Make sure, again, that you know and understand the formatting rules for the references of the institution where you are submitting your work. More and more, with the formatting guidelines you will receive a file to use in combination with a digital paper management system (Endnote, Zotero, Mendeley, …), to facilitate citing and compiling the list of references.

A next step to outlining your writing is finding a suitable title for your work. Take into account the following tips:

- **Check the guidelines**: Many journals have a limit to the maximum number of characters or words that you can use for the title. This requirement ensures that your title is short and impactful. A number of journals also ask you not to start your title with “On...” or “Towards a …”

- **Say what you did:** Is your work mostly experimental, then have “experimental study” or “experiments” or something similar in the title. Is your work a literature review, then add “review”, “survey”, or “state-of-the-art” to the title. Did you come up with practical recommendations, then mention the word “recommendations” in the title.
- **Check other titles**: If you are stuck in finding a good title, browse the journal or previous editions of the conference you are submitting your work to. Briefly skim the article, and see how the title and the article are related. Try to apply the same relation to your outline to draft a title.

Once you have a title and outline, you can choose to use your momentum and write your abstract. You can find tips for writing abstracts in Chap. 10. The benefit of going ahead and writing the abstract right away, is that you can use the sentences of the abstract, and copy-paste them into the different sections of your outline. Once you add the contents of the different parts of your outline, having a brief reminder from your abstract in place will help you to get started and to know exactly what to discuss. If you are limited to a word count or maximum number of pages, add your estimated word count or size of the section to your outline. This practice will help you avoid writing an epic length introduction and literature review, only then to see that you have very limited space left for the core of your work: your experiments and results, for example. If figures and tables add up to the total word count, note down which figures and tables you absolutely need in your outline. Examples of such essential figures and tables are for example a sketch of your test setup, an overview of your test results, and the main graphs showing your results.[1]

7.2.3 *Planning Your Writing*

Once you have your outline ready, you know what to write. The next step then is to know when to write it. Planning is essential in getting work done. If you want to revise the elements of planning, please check out Chap. 3. Don’t get started without a plan. If you are a few hours away from a submission deadline, and still have to write an entire article, then something is wrong with your overall planning. Always start on time - a good paper needs time to rest.

When you start planning your writing, two elements are key:

1. you need to know how much time per day you can spend on writing, and
2. you need to know all the elements you need to plan time for.

The first question can be directly linked to your weekly template. If you are well ahead of a deadline, you can simply decide to spend two hours every day to move your writing project forward. If your only task at the moment is to finish your dissertation, then you may want to carve out four hours for writing, and perhaps some additional time for revising older work, or for making drawings. Remember that if you force yourself to write for long periods of time, you'll see diminishing returns as the invested time increases. It's better to start on time, get enough time to work through your project and digest everything well, and have enough time for proofreading. The next part you need to consider is the list of all the elements you need to plan time for. These elements can include, but are not limited to:

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[1] I invite you to try this method out, but it may not work for you, just like writing in MS Word does not work for everybody and many academics sing the praises of Scrivener.

- **Writing the first draft:** Often, students tend to think that only this part requires time in your planning. To know how many time slots you need to reserve in your calendar for this step, estimate the amount of time you need to write a certain amount of words. Now, consider your target word count, and calculate the focused hours of writing you need. Take into account disturbances by dividing these hours by 0.75 to give you a first estimate of the number of hours you need to write your first draft. If you track your time and work, you can have a starting point for this estimate. Another approach you can follow is to estimate the number of hours you will need for each section, and to plan your time accordingly. Keep in mind that you can keep your introduction and summary sections for last.
- **Making drawings and tables**: If you don't have all drawings and tables ready, you need to plan time for working on your drawings and tables. Even when you think your drawings and tables are ready to plug straight into a manuscript, check if they fulfill all the formatting requirements of the institution where you are submitting your work. Even changing the font in all your drawings and tables, or adding dual units can be time-consuming.
- **Formatting your reference list**: Make sure you understand the formatting guidelines of the institution you are submitting to. Even when you have all the tools for citing and compiling a list of references, you still need to go through your reference list and check if all references are in the right format. If that's not the case, you need to make some changes manually.
- **Thoroughly revising your draft:** A first draft often looks quite different from the version you will eventually submit. If you are writing your first article, you will rewrite your article a few times to learn how to do this. Always pay due attention to your main idea when you revise your draft. Omit sections that take you too far from your main idea, rearrange the order of paragraphs, and critically revise to see that your story flows naturally.
- **Proofreading your final draft:** In a final round of revising, after going through different versions of the paper, you need to check for typing errors, check if you followed all the formatting guidelines, check if your list of notations is complete, and verify if all references to figures and tables and citations have been done correctly.
- **Giving your coauthors time to revise:** If you send an article to your coauthors for feedback or approval, or for them to write sections of the manuscript, you

need to give them sufficient time to react. A reasonable stretch of time would be two to three weeks for feedback, and longer if they need to draft sections.

- **Implement the comments of your coauthors**: If your coauthors mostly provide feedback, plan time to implement their comments. If your coauthors write entire sections of the manuscript, you might want to revise their work, see if it aligns correctly with what you wrote before, and perhaps send it back to them with comments or clarification requests. If that's the case, you need to, again, give them sufficient time to work on this, and you might need to go back and forth a few times, in the same way you went back and forth with yourself and your writing until you got to your final draft.
- **Submit your manuscript:** Sometimes, submission simply means sending a file as an attachment to an e-mail, and you are ready. However, for many journals, you need to swim through an entire system for submission, which takes time as well. Perhaps you need to write a cover letter. You might need to register yourself and your coauthors in the system of the journal. The actual uploading of your work can take time. Plan sufficient time for submission, especially if you will be using an online submission system of a journal for the first time and you need to register all your information.

If you are in the first year of your PhD, you should be working on your writing, to learn the skill and to start wrestling with your scholarly identity. You can practice this skill by writing reports as we discussed in Chaps. 4, 5, and 6. If you are in the next years of your PhD, work towards conference papers, and perhaps journal papers (especially if a given number of journal papers is a requirement for graduation). If you are in the final year(s) of your PhD, work on your dissertation. If you are an early career researcher, you should be getting your journal papers out. If you are a senior professor, you write your own work, as well as supervise the writing of your students. Remember that getting a lot of publications, and getting citations from these, are the most important factors for a successful academic career [3]. In short: writing is your most important academic skill.

Academic writing is not a talent you are born with (or not): it is a skill that you can (and should) learn, and that must be practiced. It is part of your PhD trajectory, and of finding your identity as a researcher. Start practicing early during your PhD, schedule time for writing in your weekly template (see Chap. 3), and honor this time. Don't drop a writing project because you don't have time – if you can, drop something else instead from your work load, or see if you can work more efficiently and effectively. Plan time for your writing projects ahead of time. Make writing your priority. Work on improving your writing constantly. Show your writing to others and ask for feedback. Check with senior researchers in your field to see if you are writing the "right" things: does your work fulfil a research need? Then, when all is said and done, get writing again.

As you progress through your career, you can start to juggle different writing projects – as long as you can plan for them and keep a good overview of how your work is progressing at all times. You can find an overview on how to structure, outline, and plan your writing in Fig. 7.1.

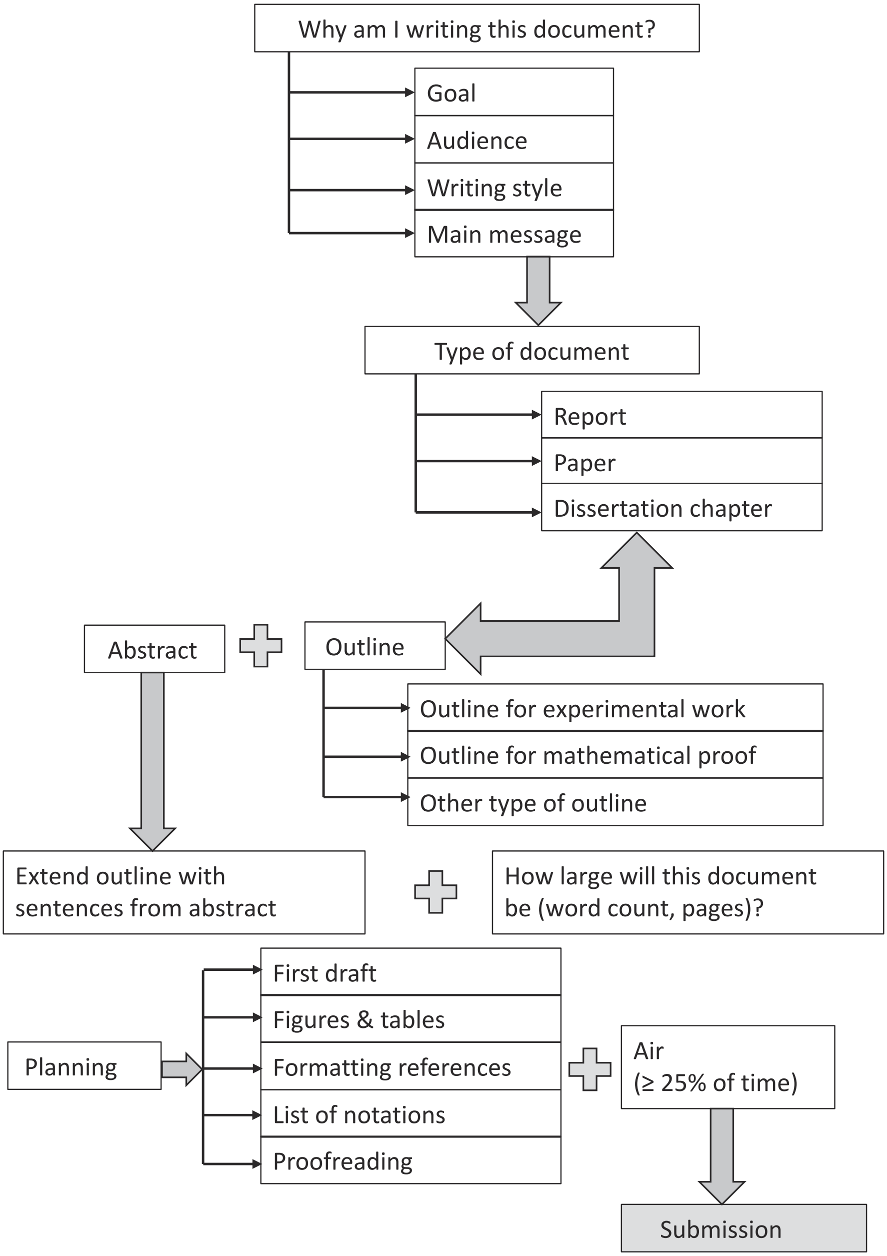
Why am I writing this document?
Goal
Audience
Writing style
Main message
Type of document
Report
Paper
Dissertation chapter
Abstract
Outline
Outline for experimental work
Outline for mathematical proof
Other type of outline
Extend outline with sentences from abstract
How large will this document be (word count, pages)?
Planning
First draft
Figures & tables
Formatting references
List of notations
Proofreading
Air (≥ 25% of time)
Submission

Fig. 7.1 Steps to be taken to outline and plan your writing. If outlining does not work for you, you can replace this step with any other method to start organizing your writing

7.3 Finding Your Voice

7.3.1 Writing Styles and Document Types

There is no such thing as a single voice that you will use for all your writing projects. Part of your writing practice and PhD trajectory is finding your voice across different writing styles, and to find authority in your writing. In this part, we focus on two different writing styles: writing persuasive content, and writing informative content. Keep in mind that a typical journal article is a combination of both: you want to inform your reader about the work you did, and then persuade the reader of the conclusions that you draw from the work you did.

Let's start by looking at writing persuasive content [4]. In persuasive writing, you want to convince the reader, and make sure the reader does something with your ideas. This activity can range from applying your recommendations, to trying out a new planning tool, to further explore your experimental results. You want your reader not just to archive your paper, but to take action. For example, if I write a blog post with tips on achieving better concentration [5], my goal for the readers is that they will read the post, try out the tips, and ultimately be more concentrated. If I write a paper about my experimental work [6], my goal for the reader is that he/she will look at my data, test my results against their theories, find something, and get back to me to discuss. For all writers, the process from reading towards implementing ideas is interesting. Typically, this content is discussed within the more narrow scope of using persuasive content in sales and marketing, but the basic ideas hold true across disciplines.

When you write a journal paper, your sole focus could be on getting another publication. But in order to advance your field of research, and even to score citations to increase your h-index,[2] the most important goal of publishing becomes sharing ideas and data, and enticing other researcher to look at your results from their perspective. Your field only advances through the interaction that follows from a publication.

To understand the process from reading your work to acting upon it, let's have a look at the five basic steps a reader goes through during this process:

1. **Content:** This first step is the most basic and obvious step in the process. As a writer, you are responsible for reporting all your data and required content in your publication. This content should be presented in a clear and understandable way, the reader should be able to find the important information right away. The reader simply needs to distill the necessary information from the writing – this step requires no direct action from the reader.
2. **Context:** Context is about showing the relevance of your results. Your job as a writer is to discuss the larger impact of your work. You can discuss this in the introduction or discussion section of your document, or use a research significance paragraph. You need to point the reader to the further possibilities of your

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[2] I don't think we should be publishing for the sole reason of getting citations and improving our metrics.

work, for example in a discussion section. The reader can now hear a little bell ringing in his/her mind, and may get interested in the work. This step is the "call to action" from the writer to the reader. The reader goes from a passive to an active stance.

3. **Acceptance:** In the stage of acceptance, the reader understands that the material of the writer presents an opportunity to the reader. The writer makes acceptance possible by placing emphasis on context, and to present clear results. In this step, the reader accepts the idea that he/she should do something with the paper he/she just read. In this stage, the reader decides to take a piece of paper and sharpen his/her pencil to get going. The action has now fully shifted from the writer to the reader.
4. **Action:** In the stage of action, the reader implements the ideas from the writer. The reader uses the published data and explores their possibilities. The writer is now passive, and this step lies within the expected outcomes of the writer. The active role is now for the reader. The reader can carry out a parameter analysis based on the published data, test a theory, or explore the boundaries and assumptions of the work presented by the writer.
5. **Final goal:** In sales, the final goal is the step when the reader "buys into the contents" of the writer. In an academic context, the final goal is an advancement, modest as it may be, of your field of research. This step involves the interaction between the writer, who published his/her results, and the reader, who might have found something odd or interesting when further analyzing the results. When experts in a research field find something odd, research moves forward: we get to sharpen our assumptions and discover the boundaries of our theories.

Let's now look at informative content. Essentially, in terms of academic writing, we have discussed this as the first part of the previously described five-step process. Informative content is the step of providing clear and transparent information to your readers. If you report results in an experimental report, see Chap. 6, you provide only informative content. The discussion and analysis can then be placed in a separate analysis report. An overview of activities as a report to a funding organization or your supervisor is another example of only informative content.

7.3.2 Finding Your Voice Through Blogging

We've discussed the typical scholarly document types in the previous section, and in this section we will focus on how you can use blogging as a practice for developing your writing style and voice [7]. Blogging can be a way to gain confidence and experience in writing about your scholarly work [8]. Popular writing can make us better academic writers: being able to write about your work in an accessible way, leaving out the jargon, is excellent practice to develop a more transparent writing style. If you train popular writing by researching for an article and bringing material from different sources together, you are prepared to write about multidisciplinary research by combining material from two different fields of study, with each their own vocabulary.

Blogging and popular writing also teach us to look widely and broadly for information, which links to the act of reading like a mongrel from Chap. 4. This observation also confirms my hypothesis that reading sparks creativity [9]. Grazing around in the literature, and wandering off onto roads less traveled might lead us to unexpected goldmines for our research. Crossing over the borders of different fields is what a blogger does on a frequent basis. In her piece about why graduate students should blog, Maria Konnikova proposes [7] to incentivize students to blog and write for a popular audience on topics beyond their immediate area of interest. This activity encourages the students to explore research fields beyond their own, and to find a useful voice and vocabulary for this work. We will discuss blogging further in Chap. 9.

One step further is to recommend multidisciplinary research teams to write posts on a group blog, and to practice writing in a style and language that is accessible to researchers from different backgrounds involved in the project. This exercise invites groups to learn how to speak each other's language, by building a narrative on a shared platform.

7.3.3 Practicing Writing to Develop Your Voice

Once you've understood that writing is the single most important skill to learn during your PhD trajectory, you can start to think about additional types of writing you can practice to hone your writing skills, and to find a writing voice that is suitable for each different occasion. When I understood I had to work hard on my writing, I decided to come up with a plan to improve my writing. I was going to practice as much as I could, as often as I could, and in as many different ways as I could. In short, I decided to put myself on a writing diet [10]. And this diet would not be about restriction and cutting, but instead about bulking. You can't lean back and assume that one glorious spring morning, you will open a new file, and start typing your dissertation as if you've never done anything else. You can't get a decent journal article published without practicing your writing. If you are not a native English speaker, you need to go the extra mile to get to the level of a native speaker. Reading a few papers in English is not enough. A Netflix marathon does not count as practice for your English writing. One of the best decisions I took for my academic career, was to take my writing very seriously. Remember that your dissertation (and thus your graduation) will depend on your writing, as well as your publications.

I had been an enthusiastic reader (reading a little less than 700 papers during my PhD), and I vowed to become an even more enthusiastic writer. One action I took, was to set up the Writers' Lab on my blog PhD Talk, in which I'd host guest authors to talk about their writing practices, as well as share my own experiences and reflections on the topic of writing. For my personal practice, I decided to write as much as I could, about as many different things as I could, including:

1. **Test reports:** I reported everything I did in a very detailed way about every single experiment I did, and reported on the material properties as well.
2. **Background reports:** A common practice in my research group, is to keep our doctoral theses limited in length, but to provide all the details in additional background reports.
3. **Paper summaries:** As I mentioned in Chap. 4, you can write short reports with summaries, critiques, and comparisons between papers. I also developed docu-

ments in which I added all information about a certain parameter that I varied in my experiments.

4. **Analysis reports:** Another good practice of my research group in Delft, is that we deliver the experimental results in one report, without any interpretation, and then do all interpretation, analysis, and discussions in a separate report. These reports also contain parameter studies and comparisons to code predictions.
5. **Meeting preparations:** You can use the template from Chap. 2 to help you have effective meetings with your supervisor, and you can also write small progress reports to keep your supervisor up-to-date with your progress.
6. **Conference papers:** I wrote a fair share of conference papers during my PhD, and they were an excellent preparation for writing journal papers and my dissertation.
7. **Journal papers:** I did not publish many journal papers during my PhD, but left the publication of journal papers to after my defense. My main focus was on writing my dissertation. If you have to publish a certain number of journal papers to graduate, you need to focus more on these papers. I turned the material from my dissertation into a number of journal papers after my graduation.
8. **The dissertation:** I wanted to graduate before my funding ended, so I had to move forward. I started halfway during my third year, submitted the first draft to my supervisor at the beginning of my fourth year, and defended and graduated 2.5 months before my funding ended. Mission accomplished.
9. **Blog posts:** I started blogging for real at the beginning of the second year of my PhD. I had been blogging here and there before, but never managed to get my momentum going. Things changed when I started PhD Talk, and I have still not ran out of topics to write about.
10. **Guest posts:** During my PhD, I wrote for other websites regularly. Nowadays, I do much less guest blogging, as I have other writing projects to vie for my attention. However, at the height of my writing diet, I tried to write a guest post every week.
11. **CD reviews:** Something totally different, but I was a staff writer for Grave Concerns from 2012 to 2014 and I've been a writer for Darkview.be since 2015. Music journalism is a different skill, and I noticed a learning curve in finding my voice in writing reviews.
12. **Journaling:** I switched between 750words and a pretty Moleskine during my PhD, just to let off some thoughts and steams. Journaling is a private practice – nobody will "review" your work. But being able to bleed your thoughts onto paper can be immensely healing and liberating, especially in moments of writer's block or when you grapple with your identity as a scholar.

As with every diet, you can't start without a plan. So I got my writing plan as a meal plan, and made sure I could set aside time on a weekly basis for the following:

- two hours of writing for research every workday
- daily journaling

- two CD reviews per week
- three posts for PhD Talk per week
- one guest post per week

While the details of my daily and weekly planning have changed since the days of my PhD, I still make sure I reserve time for research writing every weekday, and I still schedule time for blogging and writing reviews in the evening hours.[3]

As I mentioned in Chap. 2, it is good practice to start writing from the beginning of your PhD trajectory [11]. Haters of writing from the beginning of your PhD say that it is a waste of time, because none of your initial writing will end up in your dissertation. On the other hand, we can't ignore the fact that you need to practice writing before you are ready to tackle the task of writing your dissertation (or writing your first journal paper, if your degree is by publication). So instead of focusing on whether writing from day one is the right thing to do, I discussed in Chap. 2 how you can practice your writing from the very beginning. Remember that even though what you write in those first months typically won't end up in your dissertation, it can be useful material to discuss during meetings with your supervisor, to start shaping the direction of your research. In Chap. 2, I've given a list of ideas of reports and documents that you can start to develop at the beginning of your PhD, to train your writing. Revise this list, check if you are already implementing some of these recommendations, and if not, decide which type of report you'd like to develop before your next meeting with your supervisor.

While you start writing your first documents, you can practice a few technical elements. Become aware of where you use passive voice, and see if you can rewrite the sentence into active voice. Try to vary sentence length [12]. Good academic writing is easy to read and understand. This implies avoiding jargon, and avoiding sentences that are an entire paragraph long (unless you are Julius Caesar). One thing you can do, is identify, among the papers you read for your literature review, which ones you consider written in the most accessible way. One of the things you might notice, is that these texts typically vary sentence length. They're not a sequence of short bullet-like sentences. A paragraph full of short sentences will give you the impression that the narrative is not flowing, but instead is cut short by the accumulation of short sentences, creating a stop-and-go feeling in the reading. To practice variable sentence length, you can do the following:

1. Write your paragraph using sentences that are as short as possible.
2. Revise, and vary sentence length by combining some of the shorter sentences.
3. Reread your paragraph to check if all sentences follow in a logical manner. In a flowing narrative, a sentence links to the one before and after the considered sentence.
4. Finally, verify if your entire paragraph forms one integrated text. Is it jumping on two ideas? Rewrite into two paragraphs. Does it feel too short? Combine paragraphs on the same topic.
5. Repeat this method for every single paragraph in a section.

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[3] Even with a baby in the mix.

6. Now, revise the section to check if you have variation in paragraph length, and to check if each paragraph is connected to what comes before and after.

This section aims by no means to work as a cookbook. I recommend that you read these suggestions, use what resonates with you, and happily ignore what feels irrelevant for you and your writing practice. Learn to become your own master through self-reflection.

If you have a background in creative writing, you might think that academic writing is just the same old, same old. You'd be surprised to learn that academic writing is a different skill, and that you need different practice from what you are used to. If you want to improve your academic writing on a daily basis, pay attention to the following [13]:

- **Brevity and clarity:** Communicating research and writing non-fiction require a style that is in stark contrast to the hyperboles and metaphors used in creative writing. For academic writing, you need to practice the opposite. Learning to describe a (physical) process in a succinct manner can be a learning experience.
- **Practice makes perfect**: The key to successful writing (which leads to a successful academic career) is enough practice to master the skill of writing. As discussed before, all writing practice, including blogging, journaling, creative writing, and academic writing helps you develop the broad skill of writing.
- **Structure:** Scientific publications follow a logical structure that functions as the clothing hanger on which you dress your piece of writing. If you have difficulties structuring your writing, use targeted approaches to developing your outline and identify the key idea of each paragraph. If the ideas don't follow logically, and don't fit within the structure revise and rework. Practice identifying if an idea belongs to the introduction, literature review, methods, results, or discussion section of a document. This practice will teach you to think deeper about the relationship between text structure and the clarity of a message, a skill that will help you across writing disciplines.
- **Summarize:** For most conference papers, the abstract is written and reviewed before the paper. Often authors go back to tweak and improve their abstract after writing the paper. This circle of going from summary to full text to summary is interesting for all writers: fiction writers, academic writers, bloggers, and others. Revising your abstract after writing the full paper helps you analyze if you held on to the main idea of your paper, or if your ideas have started to wander and your message became more blurred. Remember the red thread we've talked about a number of times. If you lose this red thread, you need to jump into the swamp, get dirty, and save your writing.
- **Take the reader by the hand:** When we identified the five steps a reader goes through from reading an article to taking action and working on the results, we learned the importance of presenting the main idea in such a way that it almost jumps out of the page to the reader. Take the reader by the hand, and guide him/her through the development of a new idea. Show him/her over and over again your main idea, and the support for this idea, and why this idea matters (thus, why the reader should take action). If you as a writer fail to keep your red thread

clear, or miss steps in the development of the proof or experimental evidence for your idea, the reader might fall behind, and the author loses the opportunity to convey a novel idea.

- **Review process**: All the Reviewer 2 memes aside, the review process is an inherent part of academic writing. Submitting a paper for review can feel the same as sending in poems to a contest, or pitching a guest post idea to editors of webpages – you don't really know who is sitting on the other side, enjoying or quietly ripping apart your work. At times, you will be met with complete incomprehension, and find a reviewer who simply talks about another topic. Sometimes, a reviewer will consider your work complete utter nonsense, and convey that message clearly, so that you'll want to go home and stay in bed for the next two weeks. A good review, on the other hand, will be fair, point at the strengths and weaknesses of your work, and will help you grow as a writer.
- **Coauthors**: Almost all papers are a joint effort of authors. At the beginning of your PhD trajectory, your supervisor will coauthor with you, and -ideally- teach you the ropes of writing. As you gain more confidence and practice, the coauthoring role of your supervisor(s) becomes smaller. For a thoroughly coauthored piece, where different authors write different sections, you as a writer will learn how to write with others, discuss your ideas, merge writing styles, and plan to deliver the joint effort on time.

7.3.4 On Expertise and Authority

When you want to improve your writing, and find a voice that speaks with authority, ask yourself: "What am I doing that does not contribute to my writing, and how can I eliminate it?" [14]. For me, during my PhD, it was the passive attitude I took towards my writing. I used to write a draft paper in a few full days. Then, I would leave a printed draft paper on my desk for about a week, after which I'd thoroughly revise the draft. This revision typically meant considerable changes, especially to the structure and organization of the paper. After that, I'd submit my work to my supervisors, and wait for their input. At that time, I didn't feel confident about my scientific writing, and craved feedback from my supervisors. However, their time was limited, and they typically only caught a few typing errors, smaller lacks in the text, and minor problems with the figures. I missed receiving feedback on how to actually structure a paper, or what I should focus on in the discussion section. When I realized this type of feedback was not going to come, I decided to teach myself. I'd look through the papers I read for my literature review, and identified papers that I found particularly well-written. I sat down with the paper, and tried to learn from the writing style of the author by implementing elements into my own style. By paying attention to the work of others and their writing style, I suddenly felt as if I had a whole number of senior scientists showing me (silently) how to write.

When doubting our authority, we sometimes get stuck and wrestle with our scholarly identity. The voices in our head saying that it's not good enough become so loud that they drown out our own thinking necessary to write a paper. We feel utterly stuck – it's the well-known writer's block problem. When you face writer's block, you need to have a conversation with yourself. Why are you not enjoying your writing? What is limiting you? Which fears and doubts do you need to address? You can use your research diary to assess what is happening. If these fears and doubts are structural, tell your supervisor.

Remember that there are a lot of people out there who write in their evening hours as a hobby – writing is actually fun, and being able to write, mastering the skill of writing, is a blessing. For me, acknowledging that writing is fun was one of the first steps in overcoming my fear of an empty white screen.

Another element that can help you overcome writer's block is to simply write without feeling pressure. Just develop documents for discussion with your supervisor – these documents won't go into your dissertation, so there's no pressure on them to be "good enough". Writing these little documents, as insignificant as they may seem, has an important psychological benefit: you'll never have to start from an empty sheet once you want to write a (conference) paper. You'll have something to pull contents from. You might still need to develop large parts of the paper, but you have a starting point. And once you get started and get rolling, it's much easier to gain momentum than when you need to start from scratch. You can also track your writing, set goals for a certain output in terms of a word count for the day, and then reward yourself once you meet your goal. As always, it helps to have your time well-planned, so that you don't have to do last-minute work, which can induce a whole new level of anxiety.

Exercises

1. Practice your academic writing as compared to creative writing. Start by writing a short story, in your personal (creative) writing style. Then, write a revised version, in which you replace all metaphors by factual descriptions. Finally, write a version in which you replace all descriptions, movements, and objects in a creative new way. This exercise helps you develop different writing styles, as well as your creativity.
2. Coauthor. If you usually write the entire paper by yourself, and get only an "OK" back from your supervisor because he/she is too busy to pay a lot of attention to your writing, look for a collaboration with another PhD student in your research group or outside to really coauthor a piece. You will learn from their writing practice, and you will be faced with the blind spots in your writing practice.
3. Take your research journal, and ask yourself the question: "What am I doing that does not contribute to my writing, and how can I eliminate it?" Simply let your ideas flow on paper to identify the weak spots in your writing.

7.4 Tips for Non-native Speakers of English

7.4.1 *Typical Pitfalls for Non-native Speakers*

Writing is an essential skill for academic success. If you are not a native speaker of English, you are faced with the added challenge of writing in a language that is not yours. In this section, we will first look at some common pitfalls for non-native speakers. This list is never complete, as the typical mistakes depend on your native language. A great reference work that deals with all aspects of scholarly publishing in English from the perspective of different European researchers is available [15] as well as a guidebook [16].

Depending on your native language, you will make typical mistakes in English, and have different deflections here and there in your pronunciation. Since setting up a list of common errors for each and every language is not the goal of this book, I recommend you to take an active stance. If you feel like your grammar is poor, take a course on improving your English grammar. Most universities offer English courses. You can look for MOOCs or other online learning platforms to support your learning. If you have a good basic understanding of English grammar, you can start to analyze the common mistakes that are typical for your native language. You can start to compile your personal list of the most common errors you find in your own writing when you proofread your work [17]. Actively looking for your own errors gives you insight in your writing, helps you identify areas of improvement, and is a first step towards eliminating these errors. Some typical errors can include, but are not limited to:

- **Tenses**: When you read through your own work, make sure you don't shift back and forth between present and past tense. Select one and stick to your tense of choice.
- **Singular versus plural**: When the subject of a sentence becomes relatively long, you can lose sight of the actual subject, and make mistakes against the proper use of singular or plural. When proofreading your work, identify the verb and subject and check if these correspond.
- **Typing errors:** Besides errors in grammar, you can also make typical typing errors that result from tripping over your fingers. For me, a classic mistake is "strenght", but there are also the more obscure errors that make you wonder what you were trying to type in the first place. If you are in the proofreading stage, and really can't make sense of a completely misspelled word, try to see which letters on the keyboard are close to the ones you typed – your hand can have drifted slightly to one side while you were typing. If that's the case, you can often find out which word you wanted to type by looking at the letters on the keyboard.
- **Prepositions:** Selecting the right preposition can be a challenge for non-native writers. When in doubt, look it up in the dictionary or online.
- **Passive versus active voice:** Boring academic texts are chockfull of passive voice. If you want to make your writing more engaging, try to focus on the active

voice. If you find a sentence with passive voice during proofreading, ask yourself if you can rewrite it using active voice.

7.4.2 Improving Your (Technical) English

A next tip especially for non-native writers relates to how you can improve your English on your own [18]. Suppose you just had your first abstract accepted, and you need to write your first conference paper in good, academic English. You might have already prepared some documents for discussion with your supervisor, but you've never sent anything out to peer review. What should you do to improve your technical English? If you're not a native English speaker, and perhaps your institution or funding body require documents in another language, how do you advance your technical English? You can't simply "opt out". As a grown researcher, ready to graduate and receive your doctoral degree, you'll need to have mastered the skill of publishing in English. Here are a few steps you can take to actively work towards this goal:

- **Take a course**: As mentioned before, most universities offer courses that can help you brush up your English skills, as universities realize that the majority of high-impact journals are English-only. If you have the opportunity to take such a course, don't doubt for a moment and enroll as soon as possible. You'll be glad you took this course when a paper deadline is approaching quickly.[4] If taking a course is not an option, you can look for a MOOC. You can also find great information and exercises on the website of the University of Warwick [19]. If you consider you are already getting more than enough screen time, learn from a book. Just remember that when you pick up a book, your goal is to learn; not to sit back and relax and read a book. Actively study the book, and immediately practice the insights you gained while reading. Don't wait until you finish reading, start working while you read this book. Treat the book like a course, and spend time and effort on improving your writing.
- **Master the technical vocabulary**: Learn the correct English terms for all technical concepts in your field. If you have all your lecture notes in your native language, you may not be fully aware of the subtleties in technical terms in English in your field. If that's the case, look for an English textbook and review the technical terms. Study the terms used in technical papers. Don't directly translate terms from your native language to English without checking if this term even exists in English.
- **Know the pitfalls**: As discussed in the previous section, become aware of your own mistakes. Check Copyblogger's list of grammar goofs [20] to find the errors you should never make. Subscribe to the blog of Grammar Girl [21] to improve

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[4] Which of course won't happen, because you've learned in this book to plan so that you can always finish your drafts on time.

your writing, and to Doctoral Writing SIG [22] for all discussions on academic writing. Look for a list of false friends between your language and English.

- **Learn from examples**: We'll repeat this tip from before here as well: select papers from your literature review that you consider good examples of technical writing. Study how the narrative flows, what makes the sentences clear, and how the general concepts in the paper are explained. Study the structure of the sentences, the paragraph transitions, the use of past and present tense, and the use of active and passive voice. You now have a standard in your hands you should try to live up to.
- **Practice makes perfect**: Even if you use your native language to communicate with your supervisor, don't wait until you have to write a paper to write in English. If English is not your native language, you'll have to do an extra effort on mastering technical English. Practice your writing from the first day. Remember you can develop small documents, such as a paper summary, or a preparation report, or even an overview of your goals and planning to practice your writing. Additionally, consider starting your own research blog, or writing guest posts.
- **Surround yourself with English**: Besides the practice of writing, your general language skills will improve if you expose yourself more and more to English. Reach out to the international students for conversations in English. Read technical papers, online news (just stay away from the clickbait), blogs, and fiction… everything you can lay your eyes on. For spoken English, switch to an English channel, listen to YouTube videos, podcasts, TED Talks, MOOCs… presented by native speakers.
- **Ask for advice**: You are not alone in research. When you are writing your first publication, don't be afraid to ask a senior researcher for advice. Check if your university has a service to support your writing by providing feedback. Your research group may rely on a native English speaker that is under contract for checking work developed by your group. Sit together with the senior PhD students for a coffee and listen to their advice on writing. All of us at the beginning of our research journey are faced with the task of learning how to become an independent researcher, which includes learning how to write technical English. Senior researchers are aware of the doubts and challenges of their starting colleagues, and will be happy to give you a helping hand.

7.4.3 Finding Your Voice in a Foreign Language

Finding your voice and writing with expertise is a topic many beginning researchers struggle with. This identity crisis can even be intensified when we need to find our voice in a foreign language. Aside from wondering if you are still you when you think and write in a language outside of your native language, you need to acknowledge the fact that you will always be more limited in a foreign language. Your vocabulary will almost never be as complete in a foreign language as in your own.

One way to develop your voice, as mentioned earlier in this chapter, is by practicing writing (and practicing it a lot!), and possibly by blogging. Don't shy away from these exercises, nor from practicing your writing in English when you are a non-native speaker. If you need to regularly write in more than one language, it can be beneficial to practice in all these languages. Consider the reality of your situation: you will need to publish and present in English at conferences, publish in English in good journals, and perhaps report to your supervisor and funding body in your native language. What are the requirements of your institution with regard to the publication language of your PhD thesis? Almost everywhere, your thesis and defense will need to be in English. Don't think you can escape academic English if you stay in your home country and speak your native language on a day-to-day basis. Take a proactive stance and start improving your technical English right at the start of your PhD trajectory.

Exercises

1. Take a document you recently wrote in English. Carefully proofread this document with extra attention to the grammar. Make a list of your mistakes.
2. What are you going to do to improve your technical English? Select three steps you will take, discuss how your writing will improve based on these steps, and plan for them. How long will this experiment last? Decide when and how you want to evaluate if and how much your writing has improved by implementing these steps.
3. Make an overview of the languages you use. If you navigate the research world in more than one language, think about the steps you can take to improve your academic writing in all languages you need to use.

7.5 Tips for Productive Academic Writing

7.5.1 Best Practices for Productive Academic Writing

In this section you can find some suggestions for increasing your productivity in writing.[5] You might for example find yourself in the flow of your writing, but when you need to generate a table and get input values from another document or program, you start to slow down. The actual activity of switching between programs can be a distraction. You might feel tempted to quickly check something on the internet now that you are out of your writing program anyway. And before you realize, you'll be stuck in the rabbit hole of clicking on pages and not working on your writing [23]. If this happens over and over again, it's time to get a second screen. Sounds weird? Here's the idea: if you use two screens, you can use two programs that are both equally important for your work at the same time, without having to switch. For example, if you want to discuss results in a paper and you have stored these results in a spreadsheet, simply open your word processing software in one screen and the spreadsheet in another screen. No need to switch between views anymore, and you'll be able to easily discuss the results from your spreadsheet in your paper. Try it out, perhaps you find that it makes all the difference. One word of caution: once you are used to working with two screens, you won't ever feel like going back to a single screen.[6]

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[5] This section is a toolbox – use these tools on an as-needed basis.

A second essential tip is to learn how to use keyboard shortcuts to write faster [24]. If you don't want to be browsing the menu of your word processing software all the time to select text that has to be in superscript or that has to be italic, make sure you can do these formatting steps right from your keyboard. If you don't need to use your mouse to select formatting elements, then you can simply keep on typing, without needing to pause and lose your train of thought. For MS Word and MathType, I've compiled a list of common keyboard shortcuts that I use all the time [24]. If you use different software, you can easily find lists of keyboard shortcuts online. Most software also offers you the option to customize the shortcuts to your preferences.

Besides these golden tips of adding a second screen and using keyboard shortcuts, I'd like to share my best practices for productive academic writing with you [25, 26]. If you want more information on the topic, please refer to "Becoming an academic writer" [27]. Here are my best practices for productive academic writing:

- **Schedule time**: Do I start to sound like a broken record to you? Plan your time for writing. Plan the time you need to write the documents, papers, and dissertation chapters you need to write. Make sure that writing is on your daily planning, just like eating your veggies and drinking enough water. Research [28] has shown that academic writers who write steadily for a certain amount of time every day have a larger academic output than those who go for binge-writing. As mentioned before, for PhD students, continuous writing means reporting your work (for yourself, and in short summaries to your supervisor). For an early career researcher, this means setting time aside every day to work on your publications. If you only have a limited amount of time available each day, make it count. Vow to concentrate deeply for the allotted time, say one hour, and go full throttle. Make the time you spend on writing count. Close your mailbox, stow away your phone, put your noise-cancelling headset, and give it your all. If you want to give your focus an extra boost, explore the Pomodoro technique [29], which means working in bursts of 25 minutes.
- **Have a writing planning**: Especially as you reach the second half of your PhD trajectory, you don't only need a planning to finish that conference paper in time. You need to know what you want to be writing from week to week and from

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[6] One of my workplaces does not have a second screen. There, I often print out the article I am developing into a literature review section or of which I am analyzing the data.

month to month. Make an overview of the reports, dissertation chapters, conference papers, and journal papers that you need to deliver, and figure out when you will work on this. As a PhD student, you need to know which dissertation chapter you will develop in which months, and have additional space in your planning to write the required background reports, and keep working on your papers. For early career researchers, you need to figure out which journal papers you want to write, and during which months you will be working on these. As a rule of thumb, it takes about two to three months after you have finished the research to write a first version for submission of a journal paper. Once you start publishing and submitting papers, you will need a system to keep track of your papers: which papers are in review, which ones are you working on, and which ones are in press? If you are a starting professor, and you need to suddenly teach three new courses in a semester, life will be tough. But prioritize your writing. Before anything else, write one or two hours a day, so you can keep developing your publications and advance your career.

- **Write a lot**: I described my writing diet previously. Identify the different writing practices you want to develop, and add them to your planning. Work actively on your writing, so that you don’t only teach yourself to churn out a lot of words, but also increase your chances of having your work published in high impact journals. Work on your writing style. Improve your technical English if you are a non-native speaker and you feel that your limited English places a barrier between yourself and parts of academia.
- **Learn from examples**: Identify your favorite papers, and learn from the clear writing of your seniors. As mentioned before, analyze these papers for their writing style. How is the sentence length? How much or how little jargon did the author use? How is the structure of the paper? Learn from such examples, and apply these lessons to your own work.
- **Manage your references**: We’ve discussed the importance of managing your references in Chap. 4. Managing your references in a software package of your choice is important when you need to write and cite these references. You don’t want to scramble through an enormous pile of random papers on your desk while you are writing to look up a reference. Have everything at your fingertips, so that your reference management doesn’t stand in the way of your writing.
- **Document your work**: Add a “version management” tab to your spreadsheets, in which you write down why and when you made changes. Add comments to your programmed code. It can happen that you write about your calculations years after you made these calculations, and you won’t remember what you did. Use your research journal to document how you formed your ideas on certain topics. Compile dry and boring laboratory reports in which you describe step-by-step the procedures you followed in the lab. Make sure you have all your information accessible, so that when you write about your work, you don’t have to go back and scratch you head, wondering what you did.
- **Become you own critic:** Another element we discussed previously: at the PhD level, nobody has the time to take out a red pen and correct your writing. Perhaps your supervisor will help you out a bit at the beginning of your PhD trajectory,

but afterwards poor writing will just end up on the "reject" pile of a journal. Learn to become your own critic. Analyze your sentences, the flow of your paragraphs, and the structure of your chapter or paper. Check the visual clarity of your figures. Check if you followed all formatting requirements. Make sure you have enough time when you need to submit something: let your draft rest for a few weeks, and then proofread it with a fresh mind.

- **Figures**: We associate writing with producing words and sentences. Academic writing, however, is about more than the actual text. What catches your attention first when you skim through a paper? Typically, that would be the abstract, the introduction, the conclusions, and the illustrations. You can't submit a journal paper without being able to produce figures. Learn how to draw figures. For further information on how to present information visually, check out the books of Edward Tufte [30–33].
- **Revise profoundly**: Writing is an iterative process. Revising your work is something that needs to be scheduled too. Plan time for editing, for letting your work rest, and for discussing with others. Revising can take twice as much time as writing a first draft! When the flow of your writing is not coming along, erase an entire paragraph, and think about the message you want to convey. Talk out loud: "I want this paragraph to describe A and B based on X and Y", and then structure your paragraph so that it delivers this message. Ask yourself if A and B really belong together or if you should describe them in separate paragraphs. Don't be afraid to erase text and start over again – it is part of the process.
- **Seek coauthors**: Break out of your regular group of coauthors, which typically are your supervisors. Talk to people at conferences to see if you can write a paper together. When you are exposed to other writing styles, coming from authors from different institutions, you will not only broaden your horizon, but your own writing will mature as well.
- **Measure your progress**: Set a goal for a certain number of words, and see if you can meet this goal on a daily basis. Use a tracking sheet in which you write down each day how many words you've been writing. Remember that what gets measured gets done [34, 35], so having a sheet in which you report every day how many words you have written can work as a great motivator. If some days are spent on developing figures or proofreading, don't get upset by a low word count. A great tool for counting your words is the PhDometer from PhD2Published [36].
- **Explore tools**: If MS Word does not feel like the right software for your writing, change software. Unless you are limited to submitting your work as a .doc file, there are plenty of software packages you can explore. Many academics love Scrivener. I wrote my first master's thesis in Open Office. Many STEM folks prefer writing in LaTex.
- **Celebrate your successes**: Here's a reminder to party! Don't just keep grinding and grinding all the time. Don't force yourself to work deep into the night without decent food or exercise – your motivation will end up somewhere in the basement. Set realistic goals, such as writing 1000 words a day, and reward yourself when you meet your goal. Go home on time for some well-deserved rest and relaxation.

7.5.2 Dealing with Writer's Block

The fear of the blank page and the blinking cursor… who has not been confronted with this devil? Or that phase when you start to write something, and erase the sentence every single time to start over again and produce less than a paragraph in an entire day [37]? If you've been staring at a blank page for too long, close the document and go do something else. Get some fresh air and reorganize your thoughts. Go out and play, and maybe take the rest of the day off if you are feeling particularly down. Get a good night of rest, and then start fresh the next day. Think of it like a bout of insomnia: you are in bed and you can't fall asleep. The best thing to do then is to get out of bed, read something until you feel sleepy, and then try to sleep again. So far for first aid remedies - but what can you do in the long term to be faced less often with writer's block? Here are some tips:

- **Don't postpone writing:** It's all about planning! Don't wait until the last year of your PhD to start writing your thesis. You will only feel increasing pressure from the short amount of remaining time. More pressure and more panic means less space and freedom in your brain to relax and focus on your writing.
- **Get inspired by your examples:** As mentioned before, you can learn a lot by observing the writing of a great paper or a very clear thesis. To get yourself started, you can apply the same outline to your work, as a starting point, and then adapt it as needed. Once you have your structure, you have a good starting point to keep rolling and start adding information to the document you're writing. If you are inspired by another researcher's work, don't feel like you are copying anybody's work: your final product will look very different.
- **Pull from existing material:** Do you have the little summaries of papers and discussions, the preparation documents for meetings, and your research journal? Take some loose ideas from these documents, and paste them into your draft. You are not generating text yet here, but you are focusing your ideas and sharpening your pencil to get ready for productive writing. You can select important citations from papers you read if you will discuss these in your document. And by doing so, the white screen will be gone.
- **Body first:** Do you tend to think about the opening sentence for your paper and dissertation as something that needs to be perfect and ready to grab the attention of the reader? Leave your introduction for later. Start with the body of your document: describe the literature, and then move to your own contributions. Once you have your thoughts on these topics in the paper, you can reread this information, and ask yourself how this information fits into the broader scope of things. The answer to this question will be your introduction.
- **Let your ideas flow:** Don't continuously try to edit your own writing. Let your ideas flow, generate the first draft of your text, and just focus on getting your ideas onto paper. The editing and correcting will come later. If you write without a break, you'll be able to develop your ideas more coherently. If you stop every time to improve your sentence, you are too focused on the details. For a first

draft, you need that helicopter view, that ability to have a story that flows and is logically connected. Focus on getting the flow of the story in your first draft, not a collection of perfectly crafted sentences.

- **Use your research diary:** If you can't seem to get the right words onto paper, use your research diary to tell yourself about what is happening. What do you want to write about? Which topics do you want to discuss? Where are your thoughts going? Why do you feel stuck? If you want to have a private rant in a secluded part of the internet, have a look at 750 words (750words.com), a page where you can have a diary. As an added bonus: 750 words will provide you with stats[7] on how fast you type, and on the emotions you describe.
- **Go to a side project:** If you feel really stuck writing one project, move to a side project for a moment. Don't use this side project to procrastinate, but use it as a creative outlet that you can use that get your writing muscle warmed up. Try to learn how to like writing by exploring different ways of writing – writing can be lots of fun once you've learned to appreciate its beauty.
- **Try getting in the zone [38]:** Once you get into the zone, that focused state of uninterrupted writing, you will enjoy your writing more and accomplish more. You can spend an entire day fidgeting with a paragraph, but when it comes to make a serious push forward, you need to find that zone of concentration. Once you are in the zone, writing becomes effortless. Clear away all distractions, so you can focus on nothing but your writing. Have your goal in mind: what do you need to write first according to your planning? If you need to pull information from other documents, have them within reach, so that you don't lose momentum as you look for them. If you want to keep going, don't get slowed down by the need to add references, figures, or finding the right word when you can't think of it. Just refer to XXX and keep going. Before you revise, you can look for all XXX in your document, and replace these with the right figure reference, or the word you couldn't remember. Look for a quiet spot. If necessary, use earphones or earplugs to block out distractions.

7.5.3 Fitting Writing into Your Schedule

If you find it hard to fit writing into your schedule [39], even after careful planning and scheduling, because of the endless number of more urgent tasks, then look for other options. When I was still spending long days in the laboratory, but really needed to get started on my dissertation, I decided to write in the evenings and on Sundays. I knew that my evening hours are not my best writing hours because of feeling tired after running around the lab an entire day, but anything is better than nothing. I could not free hours in the morning for writing, as I often had to start at 8 am in the laboratory. Know what works for yourself within the limitations of laboratory work and working with other people.

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[7] And don't we all love stats in the shape of pretty visuals?

Dr. Amber Davis, a political scientist and PhD coach, [40] recommends you optimize your workday around your writing. She compares writers to top athletes, who never train from nine-to-five. As a mental top athlete, a writer can sustain about four to six hours of intensive work. After that, it is time to rest and relax. She recommends the following: "Choose how many hours you want to devote to working on your thesis today. Be a minimalist: less is more. Do not work continuously. Instead, work in intervals. Work for 30–90 minutes (maximum!), followed by a break. Repeat until your hours are up. That's it. Productivity saved! Now you have time to relax, exercise and meditate."

Dr. William Alexander, a former postdoctoral research associate at the University of Wisconsin-Madison and now senior scientist at Muse Biotechnology in Boulder, CO, [41] found during his postdoc writing in the lab too disturbing, so he preferred to write in the morning from his home office. After lunch, he would go to his university office and laboratory for the afternoon and evening. He stresses that everybody is different, so experiment and figure out what works best for you.

Kristin Haase, a doctoral student in nursing in Canada, [42] had to readjust her schedule after her baby was born. She learned how to be very productive in short chunks of time. She mentions that she had to learn to focus on what needs to be done, and what reasonably can be done.

Dr. William Deyamport, III, an instructional technologist, connected educator, and digital learning consultant, [43] got his PhD through a distance-learning program. Practically, this meant long stretches of time spent working from home. What helped him set boundaries between work and home, even though both were in the same space, was to have a designated work space (a desk in the living room), and to treat his dissertation like a job, which meant reserving seven to eight hours a day for writing.

7.6 Summary

This chapter focused on all aspects of academic writing. We looked at how to organize your writing by laying out the structure of a document, and by planning your writing. A second topic was finding your voice. Finding your voice in academic writing comes with practice and expertise – so the best advice is to practice writing as much as you can. There are particular challenges for non-native speakers of English in terms of writing technical English. We discussed how you can work on improving your technical English and academic writing, so that you increase your chances of having your research published in high-impact journals. Finally, we looked at tips for productive academic writing: how to get a lot of writing done when you have a limited amount of time, and what you can do to avoid writer's block. Finally, I shared some experiences from different (former) PhD candidates on writing. You learned that everybody is different, and that you need to experiment to learn how you can find the right place and time for writing, and how you can make it a habit.

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Chapter 8
Presenting Your Work

Abstract In this chapter, we discuss technical presentations. The first topic talks about planning towards a presentation, and the different steps you need to think about when planning. Then, we discuss briefly the different formats that can be used to make a presentation. The second topic deals with the logical order of a presentation. Two styles are discussed. The first style contains the following major building blocks: motivation, research question, experiments, results of experiments, conclusions. The second style contains the following major building blocks: proposition, proof, conclusion. Both styles are suitable for technical presentations. A third topic looks at the different types of presentations. Depending on the audience the student presents to, different ways of presenting may be suitable. As in the chapter about academic writing, a special section is devoted to the difficulties non-native English speakers face when presenting in English. Following these tips for non-native speakers is a series of tips valid for all presenters on how to gain confidence in presenting, and how to give clear presentations. Finally, we discuss what to do with the material of a presentation after the actual presentation.

Keywords Presentation · Presenting · Communication · Slides

8.1 Introduction and Learning Goals

This chapter on presenting your research focuses on all aspects of technical presentations. Presentations form another important element of communicating science. At conferences, during meetings with your supervisors or funding body, and at industry events, you need to be able to present your research in a way that suits the topic and audience. We cover different presentation styles in this chapter, to give you the inspiration to find the right style for your next presentation.

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8.2 Preparing for a Presentation

8.2.1 Planning Towards a Presentation

One of the most important steps towards a clear and successful presentation is starting on time and planning sufficient time. If you start making your presentation the night before, you won't have enough time to practice and make sure you are within the time limitations. Keep in mind that your coauthors and/or supervisor(s) want to see your slides before you present, and that they will need some time before they can revise your presentation. As a rule of thumb, you should aim to make your slides about a month before your presentation. If your presentation requires a poster, you will need more time. Often event organizers will ask you to submit the poster for inclusion in the proceedings of the event. When you plan towards a presentation, keep in mind that you need to schedule time for the following steps:

1. **Revising material:** You don't blindly start to throw photographs on slides and hope for the best. Before a presentation, you first need to think about the material you want to present. If your presentation is linked to a paper, reread the paper, and think about the elements of the paper you want to focus on during your presentation. You typically don't have enough time to go through all the details of the paper. Focus on your main message, and building support for that message. Do you have photographs or videos of your work? Do you have small samples of what you are working on that you can pass along during your talk? Make sure to include these visual elements.
2. **Making your presentation:** The actual making of your presentation means making your slides or making your poster, depending on the type of presentation. In the paragraph about the logical order of a presentation, we will talk more about how you can structure your presentation to make your main idea clear. In terms of planning, you will need quite some time to make your first presentation: between 8 and 20 hours, depending on whether you have a (conference) paper written to accompany you in making slides. Once you've made a few presentations, and got the hang of preparing, and perhaps have some slides you can recycle, you will be able to do this faster. The minimum amount of time you need at any point during your career to compile slides into a decent presentation is about two hours. Before you send your presentation to your coauthors and/or supervisors, talk it through to check if your material is adequate for your given time. As a rule of thumb, you need between 1 and 1.5 minutes per slide. Do always check your timing with practice runs! If you have too much material, don't be tempted to "just go a bit faster". Focus on your main message and its justification, and leave out all additional content. If your presentation is too short, don't immediately make more slides. Instead, check which topics you can expand on a bit more during the presentation.
3. **Peer review:** Send your slides to your supervisor and/or coauthors, to ask if they agree with what you will present, and if they have suggestions for you. You should give them at least one or two weeks to react, so plan for this waiting time.

4. **Editing:** Once you receive feedback from your supervisors and/or coauthors, you will need some time to make changes to your presentation. This activity can take between 30 minutes and two hours.
5. **Practicing:** Practice your presentation until you meet two goals: (1) you feel confident about how to tell your story; and (2) you can present your story within the allotted time. Avoid preparing your presentation to the point where you know every word by heart – your presentation will look artificial. There's no rule of thumb for the number of times you need to practice a presentation, but for me personally the minimum is about three times. Even though I've presented my work numerous times, I still practice at least three times: once to check if my slides match the allotted time, once about a week before the presentation to check what I want to tell, and once the night before the presentation to have a final run through all my material.
6. **Internal presentation:** If possible, ask your supervisors and some PhD colleagues if they want to listen to your presentation before you give it at the event where you will be speaking. Organize a meeting room, bring coffee for everybody, or maybe even lunch to thank your colleagues for their time,[1] and allow sufficient time for feedback and discussion.

Even when you don't have to give a presentation in the near future, I'd recommend you to have some material ready. Don't wait until you have to present at an event to give an overview presentation to your supervisor. The benefit of always having some material handy is that it can be very valuable when you learn only last-minute that you will present somewhere. The following happened to me in the first year of my PhD trajectory [1]: I had signed up for a symposium, and ticked the box "I would like to give a presentation". Later on, I heard only PhD students of the third and fourth year would be presenting, so I wasn't expecting to present. The day before the event, I arrived to my office in the afternoon after a red-eye transatlantic flight. I went through my snail mail, and found the program of the event. And who had the honor of giving the very first presentation? Yours truly! I frantically pulled a presentation together, and I was so ill-prepared that I had to borrow a camera to take some pictures in the lab (in those days, I didn't have a smartphone with camera yet). Let's say that whole experience wasn't good for my stress levels… So be warned: always have some material available to show last-minute if needed.

An important element in preparing your presentation, is knowing your audience. Will you be presenting to researchers in exactly the same field, or from a broader field? Will your presentation be visited by industry partners, or policy makers? Make sure you have an understanding about the background of your audience. If your audience is very specialized, you can skip some of the introduction and dive straight into your results. If, on the other hand, you expect a mostly mixed audience, you will need more time to warm them up to your message: why is your research important, and what are some points you can use to connect your work to the daily practice of the people you are presenting for?

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[1] I recently learned that not everybody appreciates coffee and/or lunch – for some people, anything food-related causes anxiety.

Once you have identified your audience, figure out the key message of your presentation. If people remember one thing from your presentation, what do you want this message to be? You can take your audience by the hand by repeating this key message a number of times, and by perhaps showing this statement on a single slide in large font. This slide with your take-home message is something you can use a few times throughout your presentation.

8.2.2 Selecting Your Tools

Many times, the type of presentation that you give will dictate the audiovisual tools you use for the presentation. A typical lectern presentation uses slides, a poster presentation uses a poster, and other presentations might use only physical elements and lab equipment. When you need to give a lectern presentation, you still have the choice between a number of software packages. MS Powerpoint may be a standard choice, but you can also use Prezi, or any other software package. Just make sure you ask the event organizers which file type they can open. If you need an internet connection to access some material during your presentation, make sure this connection is available – in case of doubt, ask the event organizers. If you need sound during your presentation, make sure the room has speakers – again, in case of doubt, ask the conference organizers. Keep in mind that photographs, videos, and material to pass on can bring more life to your presentation. Other, more outdated tools, that you could use, but that are not common anymore (so check with the event organizers!), are physical slides (those that go into a slide machine) and overhead sheets, to be used with an overhead projector. Choose your tools wisely, in a way that is suitable for your audience, and that falls within the expectations and possibilities of the event organizers. Once you've chosen your tools, you can start to develop your presentation. You can find an overview of the preparation process in Fig. 8.1.

8.3 Types of Presentations

8.3.1 Lectern Presentations

For a lectern presentation on a research topic, there are a few basic elements that are the cornerstones of a good presentation [2]. These elements are the following:

1. **An overview slide**: Before you dive head-first into your introduction, give a brief overview of what you will cover in your presentation. Remember to always take your audience by the hand: tell them upfront what they can expect from your presentation. An outline helps the audience in placing the different slides

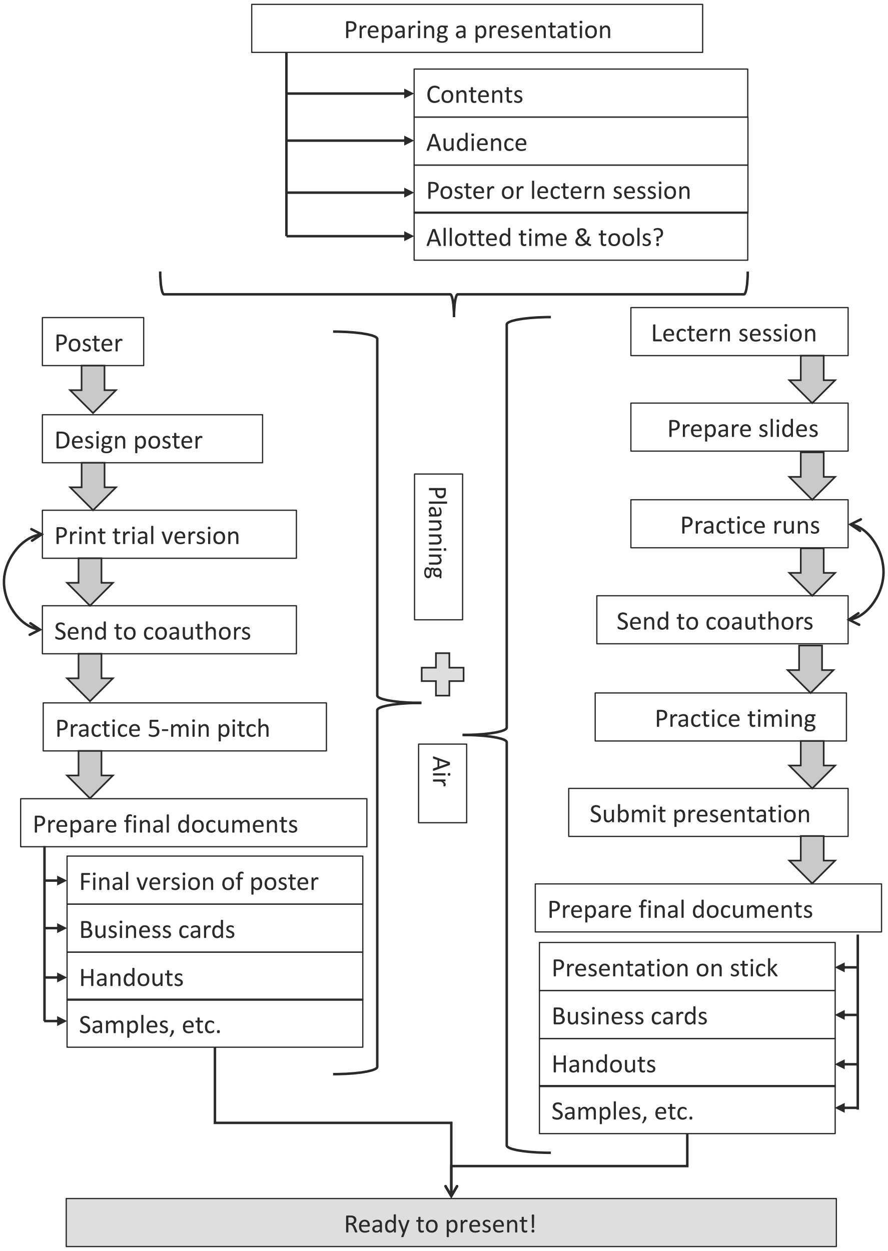

Preparing a presentation
Contents
Audience
Poster or lectern session
Allotted time & tools?
Poster
Design poster
Print trial version
Send to coauthors
Practice 5-min pitch
Prepare final documents
Final version of poster
Business cards
Handouts
Samples, etc.
Planning
Air
Lectern session
Prepare slides
Practice runs
Send to coauthors
Practice timing
Submit presentation
Prepare final documents
Presentation on stick
Business cards
Handouts
Samples, etc.
Ready to present!

Fig. 8.1 Steps to be taken to outline and plan your presentation

and elements that you will discuss within a certain framework. And that framework, of course, is the overview you showed at the beginning. If you are going to focus on one key message, mention that message already at the moment of giving the overview. You could for example say: "Today I want to convince you of My Key Message. For that reason, I will cover the following topics:… ". Replace "My Key Message" with your actual key message (keep it as short as possible, be gentle on the memory of your audience), and start to discuss your outline once you've introduced this.

2. **A clear introduction:** Know your audience and their background. You need to be able to identify elements in the background knowledge of your audience that you can start building your argument from. Gently introduce your research topic in a way that convinces your audience that your work matters to them. Sketch the bigger problem you try to tackle through your research. Don't make the mistake of thinking that you should focus on your actual work and rush into all the science and formulas. Remember that if somebody wants to know more about your work, this person will either read your paper (if there is a paper associated with the presentation), or will get in touch with you and ask questions. If your work is part of a larger project, take some time to discuss the other research topics in this project, and name your collaborators. As such, you do your collaborators the favor of getting their work introduced, and you show your audience the broader scope of the research project.
3. **Formulas:** At TEDxDelft in 2011 [3], Leo Kouwenhoven said: "With every formula you show, you lose half of your audience. On my first slide, there are two." Stay away from lots of formulas in your presentations. Nobody will remember them, and you typically will not have enough time to go over them in sufficient detail. If showing a formula is really important for supporting your key message, then be gentle on your audience. If you show a formula, take enough time to explain all the variables in the equation. You can use animations to circle the parameters and explain step by step why each parameter is in the considered formula. If you only want to focus on one single parameter, use a phrase like: "What I want you to notice here is the relation between This Parameter and Result of Equation." Again, you can use animations to circle the parameter to draw the attention of your audience to the important part of the equation.
4. **Graphs:** Has it happened to you that you are in a presentation, and somebody shows the graph with the results, accompanied only by: "and this graph shows the results," after which the presenter moves to the next slide? Remember that the results are the support for your key message, so give sufficient attention to these results and what they really tell us. Spend enough time on your graph: explain the variable on the x-axis and its units, explain the variable on the y-axis and its units, explain the data points (are these raw test results, or did you do an intermediate calculation?), explain the legend, and then state your conclusion, which is the lesson we can learn from the presented graph.
5. **The End:** Don't rush through your summary and conclusions slide, and then look awkwardly to the audience because you are done. Make sure you have a way to close off your speech and a way to close off your set of slides. You can

close your speech with a phrase like: "That concludes my presentation for today, and I'd welcome any questions you may have," if you know that there is indeed time for questions, or "That concludes my presentation for today, and I'd like to thank you for your attention," if there will be no time for questions. As a final slide, you can use a traditional "Thank You" slide, or you can opt for a more neutral slide with perhaps a photograph and your contact information.

Now that we've looked at the main elements of your presentation, we can focus on the body of your presentation, and how to structure this. The style and structure of presentation you chose depends, again, on your audience. If you give a presentation within your research group, you can go much more in detail, and need to spend less time on the background and literature review: your pals already know this. If you present to practitioners, you should focus on how your work influences their daily practice. If you present to your funding body, you might try a more persuasive style, to convince them of the value of the work and the need for further funding. If you present at a conference, you can either go for a persuasive style, in which you try to call your audience to action to start implementing some of your results, or you can focus on giving an informative presentation, to let your audience know about your work.

Generally, most presentations follow one of two styles: (1) overview - background/literature review – experiments – results – conclusions; or (2) overview – recommendations/hypothesis – tools used to prove hypothesis – actual proof – consequences – outlook [4]. These general ways of structuring a presentation are similar to the structures discussed for writing in Chap. 7. Here, we'll focus on how to present these elements. Let's start with the first presentation layout, which is illustrated in Fig. 8.2:

1. **Overview:** As mentioned before, you can use an overview slide to set the tone for your presentation, and to help your audience place the information within a structured framework. Only if you have very limited time, you should consider to leave out this slide.
2. **Background/Literature review:** In a presentation, you will not show a list of references. Instead, you should focus on why your research topic is important in the broader scope of things, and show what has been done before. Focus as much as possible on visual elements: graphs and photographs. Show material that links

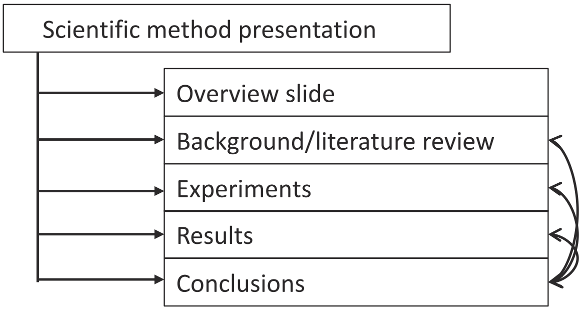


Fig. 8.2 Elements of presentation style that follows the scientific method

directly to your work. Unless you are presenting a literature review, the focus of your presentation is showing your work.

3. **Experiments:** Explain what you did, and keep it as visual as possible. If you have videos, use them – everybody loves watching a video. Consider making a timelapse of your experimental process, so you can talk your audience through all the steps. If your experiments are numerical, you can also use a number of tools available in software packages to show the effect you study on your model.
4. **Results:** Mention the output of your experiments, and then focus on the main results. Remember that you want to show the support for your key message in your presentation. If possible, show your results in graphs instead of tables, and talk your audience through all the elements in the graph.
5. **Conclusions:** Link back to all previous elements. Your background lays the foundation for your research and for your key message. Your experiments are the tools you used to support your key message. The result of these experiments are then the proof for your key message.

The second presentation layout, as shown in Fig. 8.3, is as follows:

1. **Overview:** An overview slide, as we've discussed before, is a great way to get started with a presentation.
2. **Recommendations/hypothesis:** In this presentation style, you follow the structure of a mathematical proof. You start with your key message, in the form of a set of recommendations or a hypothesis. Treat this information as a mathematical theorem that needs to be proven by what follows in your presentation.
3. **Tools used to prove hypothesis:** In this presentation style, we focus on the key message in a very clear way. In the section of showing the tools needed to prove the hypothesis, you can introduce material from the literature that you've used (for example, a database of experiments that you used to compare to your results), as well as your experiments. Focus on elements that are essential to building up the proof of your key message. Explain these concepts well, so that you can lean on them for the development of your proof in the upcoming slides.
4. **Actual proof:** This part will be the largest chunk of your presentation. Take the audience by the hand, and walk them through all evidence for the hypothesis and/or recommendations you want to proof. Link back to the tools you intro-

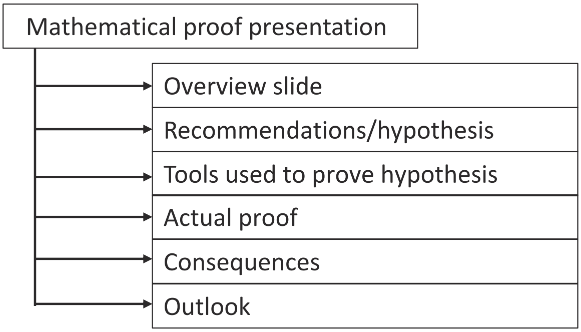

Mathematical proof presentation
Overview slide
Recommendations/hypothesis
Tools used to prove hypothesis
Actual proof
Consequences
Outlook

Fig. 8.3 Elements of presentation style that follows a mathematical proof

duced in the previous part. Focus on visuals: prefer graphs over tables or equations.

5. **Consequences:** In this part, you can show the broader scope of things. It's a little more difficult to keep the link to the daily practice of your audience to the end and then only show them the practical value of your work, but it is possible. Just make sure you focus on your key message, and on taking your audience by the hand. You might even sprinkle in a "after the proof, I will show you how these recommendations can be applied to your daily practice" to keep your audience curious. Show the effect of your recommendations or hypothesis on real case studies, so that the impact of your research on the "real" world becomes clear. If you think case studies are not academic, please reconsider – they can be a great connection between your research and practice. If you haven't worked out case studies yet, give a more general overview of how your results will influence your field and practice.
6. **Outlook:** Tell your audience which questions are still open, and what you currently are working on. Let your audience know what your future work looks like.

Your presentation is not over until you are back in your seat. It's not over when you thank your audience. The Q&A part [1] can be very important. If you don't get questions, it either means that people were not paying attention (which can happen right before or right after lunch for example), that everything was very clear (unlikely), or that the audience had no clue what you were talking about (don't blame yourself, they may have been too busy checking e-mail on their smartphone – it happens), or that the audience is filled with introverts who prefer to talk to you in person after the session (I myself fit into this category). If you do get questions, don't get nervous: it means someone is genuinely interested in your work – unless you get a "comment" that is not really a question and that is just a way of this person to let you know he/she has done work on this in the past and perhaps thinks he/she has it all figured out already. In that case, thank your commenter for the information and say you'd like to get in touch to learn more from his/her experience. If someone asks a question, take sufficient time to answer the question. If the audio in the room is an issue, restate the question through the microphone before you start to answer. Even if you think a question is irrelevant, don't go over it too quickly. Take sufficient time to explain why you focus on another aspect, so that the asker feels respected and considered. Avoid interrupting the asker to immediately start replying – have enough patience to wait until you hear the full question.

8.3.2 Poster Presentations

Poster presentations are a whole different beast than lectern presentations [5]. A poster presentation can take place during a certain timeslot at a conference. Unlike for a lectern presentation, you won't get the undivided attention of your audience. In a lectern presentation, your audience sits in the room and does not have the choice between you and somebody presenting at the same time (there can be a number of people presenting at the same time in another room, but then the audience has already selected a room based on the topic). For a poster presentation, you typically stand next to your poster in a large room, together with a number of poster presenters, and wait until people from the audience are attracted to your poster to come and learn more about your work. Often times, your poster can be in a hallway, with people passing through on their way to meetings or sessions, and just quickly glancing at your poster.

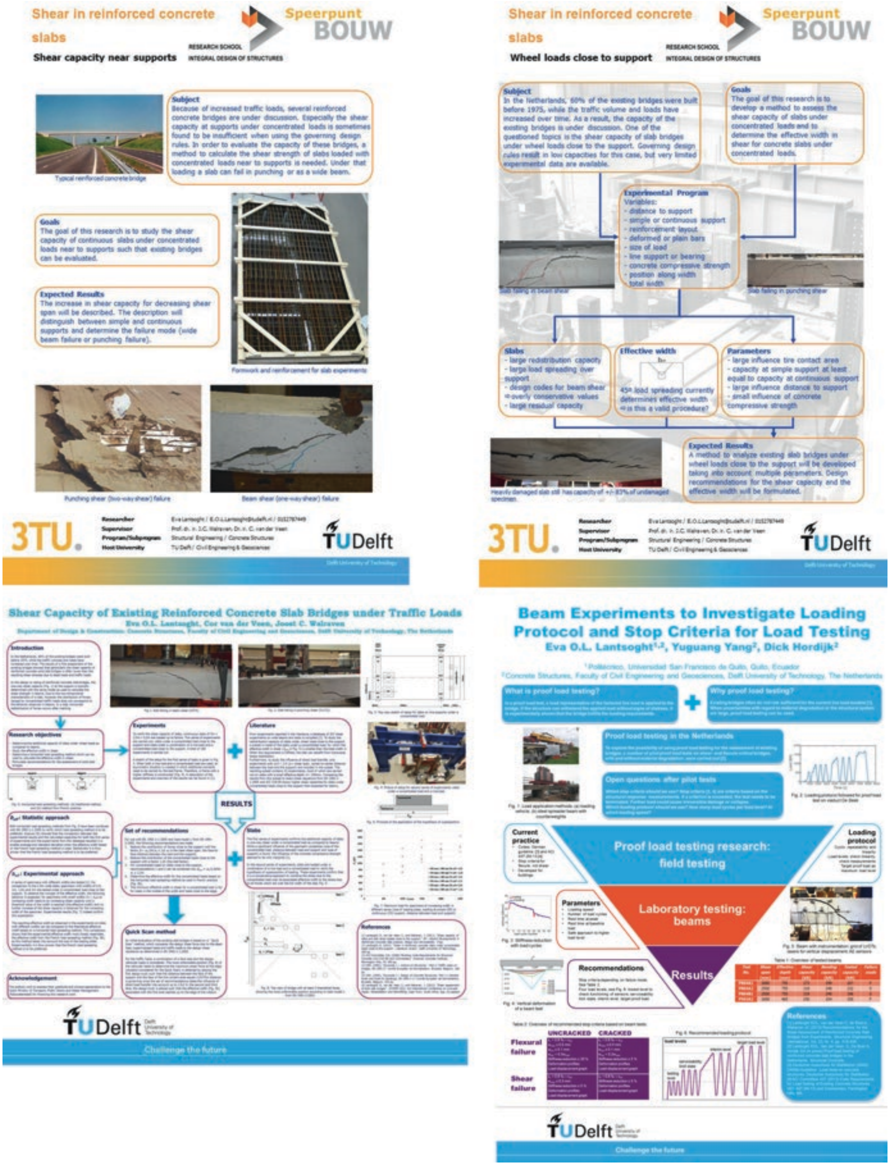
Since you don't know how much time somebody wants to spend on listening to your work, it is more difficult to practice for a poster presentation. Try to have an elevator pitch of a few minutes to give a brief overview of your work. If you see you got the attention of a visitor, then you can go more in depth.

A poster presentation is also very different from a lectern presentation in the way you interact with the audience. Unless your poster looks very attractive and everybody wants to learn about it, you'll mostly have one-on-one conversations with visitors to your poster. Tailor your talk to the person you talk to: focus on practical implications for practitioners, and focus on the research elements for fellow researchers in your field.

For poster presentations, it can be difficult to bring people to your poster. It can feel awkward to stand next to your poster, and stare at people passing by, trying to will them into coming over to talk to you. You don't want to be like a vendor on the market who is shouting that his/her product is the best and cheapest, but you also don't want to be overlooked. If you see somebody slowing down for your poster, you might try a friendly smile, and a "Would you like me to explain a bit more about My Research Topic?" If you get one-on-one visitors, take some time to get to know your visitor, and his/her interest in your work so you know what to focus on. If all else fails, you can always chat with the other people presenting posters and visit their poster. They might return you the favor and come over to your poster.

A crucial element in a poster presentation is of course the poster itself. As with any type of presentation, keep it as visual as possible. Avoid large amounts of text (nobody will ready the text anyway) and equations, and focus on graphs and photographs. If you have some material to pass around, take it with you, so you can hand it over to your visitors. Use the photographs and graphs you have to point at the poster while you explain the main ideas of your research. Limit your text to basic explanations that can serve visitors if you are not with your poster at some point, and of course, don't forget to place your contact details on the poster. You can pin business cards to your poster board for people to get in touch with you, and take printouts of the poster to give to people that visit you. As a digital tool, you can add a QR code to your poster for visitors to scan and get more information, a handout of your presentation, and your contact information.

Besides the information you have on your poster, you also need to pay attention to the overall look of your poster. Typical layouts are circular flows of elements, or flowchart-like layouts. If you're not sure how your overall layout will look like, then print it out on full size, pin it to the wall, and take a few steps back to judge the overall look of your poster. Don't get fooled by thinking you can get the same idea from printing it on A4 paper – it's simply not the same. Judge from a distance and identify



Shear in reinforced concrete slabs

Shear capacity near supports

Subject
Because of increased traffic loads, several reinforced concrete bridges are under discussion. Especially the shear capacity at supports under concentrated loads is sometimes found to be insufficient when using the governing design rules. In order to evaluate the capacity of these bridges, a method to calculate the shear strength of slabs loaded with concentrated loads near to supports is needed. Under that loading a slab can fail in punching or as a wide beam.

Typical reinforced concrete bridge

Goals
The goal of this research is to study the shear capacity of continuous slabs under concentrated loads near to supports such that existing bridges can be evaluated.

Expected Results
The increase in shear capacity for decreasing shear span will be described. The description will distinguish between simple and continuous supports and determine the failure mode (wide beam failure or punching failure).

Formwork and reinforcement for slab experiments

Punching shear (two-way shear) failure

Beam shear (one-way shear) failure

Researcher	Eva Lantsoght / E.O.L.Lantsoght@tudelft.nl / 0152787449
Supervisor	Prof. dr. ir. J.C. Walraven, Dr. ir. C. van der Veen
Program/Subprogram	Structural Engineering / Concrete Structures
Host University	TU Delft / Civil Engineering & Geosciences

Shear in reinforced concrete slabs

Wheel loads close to support

Subject
In the Netherlands, 60% of the existing bridges were built before 1975, while the traffic volume and loads have increased over time. As a result, the capacity of the existing bridges is under discussion. One of the questioned topics is the shear capacity of slab bridges under wheel loads close to the support. Governing design rules result in low capacities for this case, but very limited experimental data are available.

Goals
The goal of this research is to develop a method to assess the shear capacity of slabs under concentrated loads and to determine the effective width in shear for concrete slabs under concentrated loads.

Experimental Program
Variables:
- distance to support
- simple or continuous support
- reinforcement layout
- deformed or plain bars
- size of load
- line support or bearing
- concrete compressive strength
- position along width
- total width

Slab failing in beam shear

Slab failing in punching shear

Slabs
- large redistribution capacity
- large load spreading over support
- design codes for beam shear ⇒ overly conservative values
- large residual capacity

Effective width
45º load spreading currently determines effective width ⇒ is this a valid procedure?

Parameters
- large influence tire contact area
- capacity at simple support at least equal to capacity at continuous support
- large influence distance to support
- small influence of concrete compressive strength

Heavily damaged slab still has capacity of +/- 83% of undamaged specimen.

Expected Results
A method to analyze existing slab bridges under wheel loads close to the support will be developed taking into account multiple parameters. Design recommendations for the shear capacity and the effective width will be formulated.

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Supervisor	Prof. dr. ir. J.C. Walraven, Dr. ir. C. van der Veen
Program/Subprogram	Structural Engineering / Concrete Structures
Host University	TU Delft / Civil Engineering & Geosciences

Shear Capacity of Existing Reinforced Concrete Slab Bridges under Traffic Loads

Eva O.L. Lantsoght, Cor van der Veen, Joost C. Walraven

Department of Design & Construction: Concrete Structures, Faculty of Civil Engineering and Geosciences, Delft University of Technology, The Netherlands

Introduction

Research objectives

Experiments

Literature

RESULTS

Set of recommendations

Slabs

Quick Scan method

References

Acknowledgement

Challenge the future

Beam Experiments to Investigate Loading Protocol and Stop Criteria for Load Testing

Eva O.L. Lantsoght[1,2], Yuguang Yang[2], Dick Hordijk[2]

[1] Politécnico, Universidad San Francisco de Quito, Quito, Ecuador

[2] Concrete Structures, Faculty of Civil Engineering and Geosciences, Delft University of Technology, The Netherlands

What is proof load testing?

Why proof load testing?

Proof load testing in the Netherlands

Open questions after pilot tests

Current practice

Loading protocol

Proof load testing research: field testing

Laboratory testing: beams

Results

Parameters

Recommendations

UNCRACKED CRACKED

Flexural failure

Shear failure

References

Challenge the future

Fig. 8.4 Some examples of posters I used over the past years

the elements that catch your attention first. Are you seeing the most important things first? When in doubt, ask your fellow PhD students for their opinion. If you want to redo your general layout, you can have a look at examples of posters from other events, or you can wander the hallways of your university and look at the posters your colleagues have used in the past. Learn from the good and bad examples the way you learn from others' writing: what works very well, and what doesn't? Apply these concepts to your own work. You can find some examples in Fig. 8.4.

8.3.3 Presentations Without Slides

You may not think of a presentation without slides as a presentation [6, 7], but every now and then you need to give this type of presentation. A typical example includes when you need to give a presentation in the laboratory, with only the physical space and available running experiments and material as your tools. If you are asked to explain things in the lab for 15–20 minutes, you will need to prepare as well – don't expect that you can compile a coherent story out of the blue. Another type of presentation without slides would be when you are asked to give a speech. Since speeches typically have less technical contents, we will focus here on technical presentations where you use a physical space as the visual tool to support your talk. You might be able to take a few flashcards or a cheat sheet with you to help you structure your talk, but, if possible, I'd recommend you to avoid doing so and just talk from your memory. Here are a few ideas you can use to prepare for this type of presentation:

1. **Ask for advice:** If you have to show people around your lab, for example, ask a senior PhD student or staff member who has done this before about what works well. If you are presenting to a non-technical audience (for example, if your lab is giving tours for the general public every now and then), then avoid jargon and compare to examples and objects from everyday life. Have you seen those documentaries in which they compare areas to "this many soccer fields"? It may seem overly simple, but it immediately gives all of us an idea of the size. I usually link the loads that we use in the lab to the weight of a number of trucks on top of each other, I inform them about the tons of concrete we used in all experiments, and I explain the cost of replacing bridges to the audience. Keep your audience engaged by pointing at elements in the lab, and walking around with them when possible. Pass on things to feel, smell, and touch.
2. **Beginner's mind:** Imagine you walk into a factory or lab of a field completely unrelated to yours. Which would be the first questions you ask to familiarize yourself with your surroundings? Make sure you include this information in your talk. Answer the following questions for your audience: Where am I? Who is working here? What happens here? Why is this research necessary? What are these objects? How do these object work? How do these objects measure? How much time does a test or process take? What results are available so far? What have the researchers learned from these results?
3. **Mindmap:** Since you won't be able to take any material with you to structure your talk around, learn the structure of your talk by heart. Don't write a text and then memorize it word by word. Instead, prepare yourself by focusing on the logical sequence of what you want to discuss. A great method for visualizing a structure (of writing, a presentation, or even to answer broader questions in life) is to sit down and sketch a mindmap. You can use the questions from the previous point to see the contents you want to include in your talk.

Then, organize the facts that you want to mention, imagine where in the lab you need to be to answer which question, and include other interesting facts from the lab.

4. **Practice:** If you are used to just lectern presentations and poster presentations, you will need a bit of extra time to prepare for this different style of presentation. Practice in the physical space where you will present, to know what you can show or pass around. Try to keep the presentation interesting by focusing on the physical objects. See if you can make some parts interactive as well: if you don't have small pieces that you can pass around, then take people to touch something larger, to explore the texture of something, or to smell it. See if you can ask questions to your audience, for example to see if they can estimate certain sizes. If you're in doubt, ask a few fellow PhD students for a few minutes of their time, and practice with them as your audience.
5. **Enjoy the experience:** Don't get too stressed about the event. Instead, think about the privilege that you are given to show something as amazing as your lab space (or whatever the occasion for your demonstration is). There's no need for hiding your enthusiasm. Even though one of the main rules of presentations [8] is not to try to be funny, if your audience is the general public, insert a little joke and a smile here and there.

8.4 Tips for Non-native English Speakers and for Presenting in Different Languages

8.4.1 Improving Your Presenting Skills in Technical English

As a non-native English speaker, presenting can be particularly stressful; not just because of having to speak in front of an audience, but also for having to do this in technical English. Let's first look at the traps some students who are nervous about their English fall for:

- **Read everything from paper:** Sometimes, you see non-native English speakers who printed out sheets of paper with the text of their presentation. During the presentation, they simply read everything directly from the sheet. Avoid this error at all cost – your audience will thank you.
- **Put everything on your slides:** Another common mistake is to place virtually all the text you need to say on your slide, and then read it off. Your slides will be too full for your audience, and your presentation style will bore them to death.
- **Learn your presentation by heart:** Some students avoid reading their presentation from a sheet of paper or slides, but instead make sure they have memorized word for word what they will say. As a result, the presentation will feel very artificial.

- **Don’t be prepared to take questions:** You may think you can be prepared by having your presentation on paper or slides, or by memorizing your speech, but nothing is as embarrassing as not being able to answer a question during the Q&A because your English is at such a low level that you are unable to understand the question. If you’re in this situation, make sure you work on your conversational English, with foreign colleagues or through lunch meetups.

Now let’s talk about possible strategies for improving your spoken technical English:

- **Practice makes perfect:** If spoken English is your weakness, then work on improving it. Improve your conversational English through a course, or informally by talking as much as possible with your colleagues or through language lunch tables. Additionally, you can join a group that focuses on language practice, for example a Meetup group or a Toastmasters group.
- **Deliberate practice:** Identify the main weakness in your English. Do you have trouble with listening and deciphering the message of the person you are talking to? Start surrounding yourself with more spoken English: on TV, through audio books, by listening to podcasts and TED talks… Does your accent make you hard to understand? Practice conversations with non-native English speakers that don’t have the same native language as you. If it is a profound problem, get help from a speech therapist. Keep in mind that certain pronunciation problems stem from the position of your tongue in your mouth while you speak, which is different for each language. Notice that the exact mouth shape you need to pronounce vowels is different in each language too.
- **Don’t avoid unpleasant situations:** So you think you can sneak out the back door and just avoid having to give presentations? Time to grow up and face your demons. Presenting your work is part of life in academia and the PhD trajectory, so you better make sure you work on it. If you avoid presenting because you don’t feel comfortable speaking English, you simply will fall behind on the pack, and struggle at your defense.
- **Language immersion:** We all know that the best way to learn a language is to fully immerse ourselves in it. If you struggle with your spoken English, see if you can join an English-spoken summer school in your field, or if you can go to an institution that operates in English for a few months as an exchange PhD student. If you can’t be away from your home or lab for an extended amount of time, try to surround yourself with written and spoken English as much as you can.

8.4.2 Presenting in Another Language

Most conferences operate in English, but every now and then you need to present in another language. This language could be your native language, if you are pursuing your doctoral degree in your home country, or it could be in a third language if you are in a foreign non-English speaking country where you need to communicate your results with funders or the industry.

Presenting in your native language, if you don't do this often, might feel more challenging than presenting in English. You may be more familiar with the literature and the technical terms in English than in your native language, because the majority of high-impact journals are in English. If you present in your native language, your local accent influenced by the dialect of your region can make you feel uncomfortable. After one sentence in Dutch, people know that I am Belgian, which sometimes seems to take the attention from my message to my typical accent. When you present in English as a non-native speaker, you'll just be identified as someone with a mild and funny foreign accent.

Keep in mind that presenting in your native language or in a third language can be an added challenge. The best way to get properly prepared for such a presentation is to start on time, and practice often, so you feel comfortable with the language.

8.5 Best Practices for Successful Presentations

8.5.1 How to Gain Confidence in Presenting

Gaining confidence in presenting comes as you start to grow as a researcher and build your scholarly identity. It comes when you start to feel that you can write and speak with the level of expertise required. A good way to gain confidence in presenting is to actively work towards improving your presentation. You can do this by reflecting on a presentation [9] after the event. How did it go in general? What went well? What can you improve? How did you feel? Did you start to feel more nervous at some point? You can use your research diary for these reflections. Before you start to prepare your next presentation, revise your evaluation, and pay particular attention to what went well and what you can improve. Keep doing what went well, and think about how you can improve where necessary. If you follow this path of conscious development of your presentation skills, you will grow and get better every time you present. And once you get better, you will gain more confidence.

A part that is much more difficult to control is how you react to your audience, and how stressed you get before a presentation. While your stress levels may decrease as you gain experience in presenting, the interaction and reaction of the audience is something that is much less predictable. It has happened to me that during my presentation, a person who was sitting right in front of me, started talking to the people next to him, making fun of me and my gestures during my presentation, and, as a result, I felt very uncomfortable. If things like this happen, you can get thrown off balance, regardless how well-prepared you are. You also don't have much time nor room in your presentation to change your presentation style, or adjust to the uncomfortable situation. You simply have to roll with the punches. Try to ignore the disturbing element in the audience as much as you can. Focus on the people in the room who are listening to your talk.

You can try out powerposing [10] and see what it does for you. The idea was first presented by Amy Cuddy [11], who says that you can use more powerful body language to influence the way others see you. The claims go even further: Cuddy says that with a more powerful body language, we change the cortisol and testosterone levels in the brain, and influence our chances for success. While there has been a fair amount of controversy about this research, it sounds similar to the old adage "fake it until you make it", which Cuddy replaces with "fake it until you become it." Even though I'm not so much of a fan of faking and pretending to be different than who I am, a bit of internal pep-talk can go a long way. We all can feel intimidated by a room full of smart people at a conference ready to discover every flaw in our research. Just walk in, keep your back straight and your shoulders low, hold your chin up, and trust in your preparation.

Another quick trick that you can use when you feel the nerves washing over you before a presentation, is to simply focus on your breathing.[2] Try breathing from your diaphragm [12]. If you're not sure how this works, place a hand on your stomach. While you breathe in, you should feel your hand move outward, and while you breathe out, inward. If you focus on deep breathing before your presentation, you may feel more relaxed at the start of your presentation. Try it out and see if it helps you.

8.5.2 Presentation Aftermath

At the end of the day, after your presentation, what should you do? Rest and relax, of course, and have a cup of wine to celebrate, if you feel like. But what can you do with your presentation material after the actual talk? There's a number of things you can do. First of all, you can add the information about the presentation to your list of presentations. Start curating this list early in your career, so that you have this information available whenever you need to show your accomplishments or for future academic job applications.

The next thing you can do, is to make your presentation available online. Make sure there is no sensitive information in your presentation, and that you are allowed to share your results publicly. In case of doubt, ask your funding body and/or your supervisor. If you're all clear to disclose your presentation, you can

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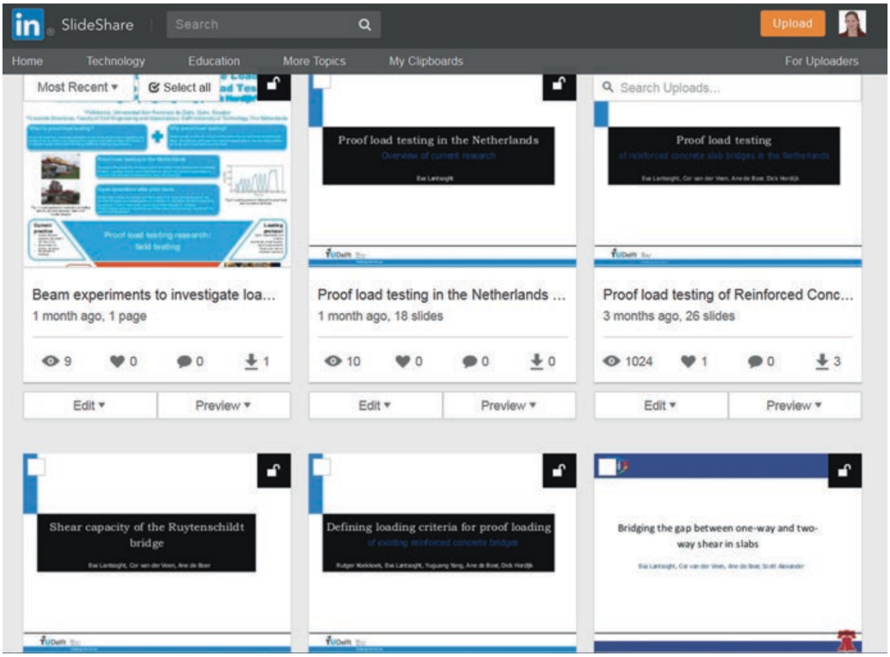
[2] Credit for this tip goes to my former classical singing teacher.



Beam experiments to investigate loa...
1 month ago, 1 page
9 0 0 1

Proof load testing in the Netherlands ...
1 month ago, 18 slides
10 0 0 0

Proof load testing of Reinforced Conc...
3 months ago, 26 slides
1024 1 0 3

Proof load testing in the Netherlands

Proof load testing

Shear capacity of the Ruytenschildt bridge

Defining loading criteria for proof loading

Bridging the gap between one-way and two-way shear in slabs

Fig. 8.5 Using Slideshare

use Slideshare, see Fig. 8.5 [13], to upload your presentation, which is perhaps the most straightforward website out there for uploading and sharing presentations. After uploading your presentation to Slideshare, you are one click away from sharing your slides on LinkedIn, Twitter, Facecbook, an internet forum, with an e-mail contact, or from embedding your post in a blog post. If you have an academic blog, which I recommended you to develop in Chap. 7 and which we will talk about more in Chap. 9, write a blog post about your presentation. In that post, embed the slides that are hosted on Slideshare.

You might think nobody is interested in your presentations. Once you start uploading presentations on Slideshare, you may be surprised by the number of views your presentations receive. My most viewed presentation currently has 5247 views and 306 downloads.[3] That's certainly a nice addition to the views of my blog posts and research articles. Through Slideshare, my research seems to have found an audience of its own. I don't have further insight into who gets to view and download my presentations, but I consider it a good way of sharing my research with scholars who do not have access to articles behind a paywall.

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[3] On January 5th 2018.

8.6 Summary

In this chapter, we focused on technical presentations. The first topic we discussed was how to prepare for a presentation. As always, we highlighted the importance of good planning. Equally important for preparing presentations is knowing your audience, and the boundary conditions of your presentation (time limits, available tools at the presentation location…). With this information, you can select the right software to develop your slides if you will give a lectern presentation, or you can start drafting your poster, if you will give a poster presentation. We discussed these presentation styles and their particularities separately, and also talked about giving technical presentations without slides, just by using laboratory specimens and/or the physical space around you. In the second section of the chapter, we focused on tips for successful presentations. We looked at the barriers non-native English speakers face when they need to give technical presentations in English, and how you can proactively improve your English speaking skills. Finally, we discussed how to gain confidence in presenting, which is similar to gaining authority and finding your voice in writing – these elements are part of academic maturity. The last section of the chapter looked at what you can do with your presentation material after a presentation, and how you can increase the exposure of your work by using online tools.

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Chapter 9

Communicating Science in the Twenty-First Century

Abstract In this chapter, we discuss science communication in the twenty-first century. We explore the opportunities the internet offers us to expand our research network and share our knowledge with a wider audience. A first topic is blogging as a researcher. The different ways of contributing with blog posts, as well as the different platforms for blogging are discussed, i.e. a blog as a single author, a blog as a research group, or other collaborative efforts. We highlight the benefits of blogging. A second topic is the use of Twitter as a microblogging platform and source of information for researchers. We discuss how to engage with an audience on Twitter and start a scientific conversation, and how to join the Twitter conversation about higher education. A final topic is online branding for scientists. We first explore how searchable you are, and how you can manage the information that shows up when you google your name. We then look at additional profiles, such as LinkedIn, Academia.edu, ResearchGate, Instagram, Facebook, and Storify to share information and to manage the information that is available about you on the internet.

Keywords Online branding · Branding · Science communication · LinkedIn · Blogging · Twitter · Internet tools · Public outreach

9.1 Introduction and Learning Goals

From the traditional tools of communicating research in Chaps. 7 (writing) and 8 (technical presentations), we now move to new tools available for researchers in the internet age. In this chapter, you will learn about blogging as a scientist, microblogging through Twitter, and how to curate your image on the internet. As blogging and Twitter are the most common online platforms to share research insights, we will focus on these tools. Other tools, such as Facebook, LinkedIn, ResearchGate, Academia.edu, Instagram, Storify etc will be discussed in a much shorter way.

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E. O. L. Lantsoght, *The A-Z of the PhD Trajectory*, Springer Texts in Education,
https://doi.org/10.1007/978-3-319-77425-1_9

9.2 Blogging as a Researcher

9.2.1 Single-Author Blogs

Let's take our science into the twenty-first century. Besides the traditional means of sharing research, i.e. academic writing and giving technical presentations (see Chaps. 7 and 8), we will now explore the opportunities the internet offers us to expand our research network and share our knowledge with a wider audience and our peers. We've talked about how blogging is good practice for your writing in Chap. 7. In this chapter, our focus is on using internet tools to share your research and increase your visibility. The first way of sharing research online is through blogging. The most common form of blogging is through single-author blogs. Research [1] has shown that the most popular topics to blog about for academics (based on an analysis of 100 academic blogs) are academic cultural critique (41%) and research dissemination (40%). The most common writing style has a scholarly tone, but is more relaxed, suggesting that blogs are part of a continuum of academic identity and publishing. Most academic bloggers seem to be writing for themselves, or an audience of people like themselves.

If you are fully unfamiliar with academic blogging, I recommend that you check out some blogs about higher education, research strategies, and from scholars in your field. If you enjoy reading these blogs, you might feel the urge to start sharing your insights with the world as well [2]. You could consider starting a blog to have an online presence; this topic will be further discussed in the paragraph about online branding. Perhaps you want to use the internet as a space to document your PhD trajectory, and to reflect upon what you have learned along the journey. Regardless of the reason why you would want to start your own blog, here are some steps to set up your blog and make it known to the world (see Fig. 9.1):

1. **Blogging tools:** When you are ready to start your blog, you first need to create the actual blog. Before you do so, think about the following: where do you want your blog to go? Do you want to use a regular blogging platform like Wordpress or Blogger, or do you want to build your own website? Do you want to have your own domain? Do you want to spend money on the hosting of your blog? Once you've selected your tools, you need to choose a name for your blog. Do you want to blog under your own name on a website with your name, or do you want to give your blog a separate name? Do you want to publish your blog posts under your name, or are you going to write under a pseudonym? Once you have answered these questions, you can sign up and register your little spot on the world wide web. You've made one big step forward – from now on, all you need to do is write your blog posts, and perhaps tinker with the layout of your blog every now and then.
2. **Write weekly updates:** If you find it hard to think about a topic for your first post, you can plan to write weekly updates about your research. You can write these posts as part of your Friday afternoon routines, in which you evaluate your week. You can use this post to show pictures of what you have been doing in the

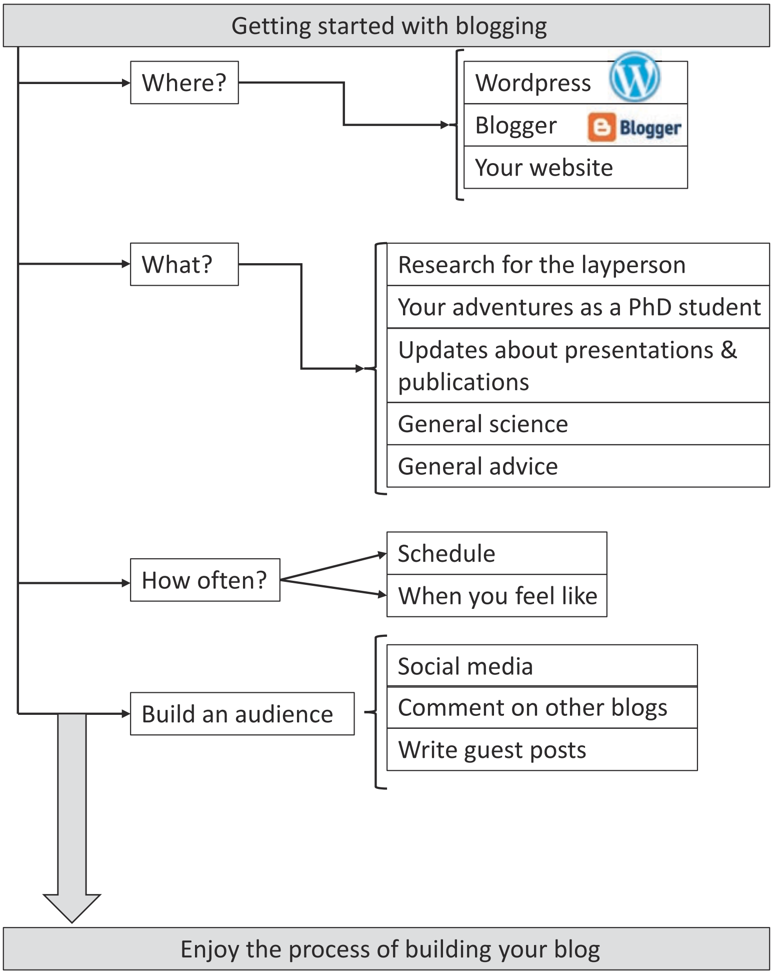
Getting started with blogging
Where?
Wordpress
Blogger
Your website
What?
Research for the layperson
Your adventures as a PhD student
Updates about presentations & publications
General science
General advice
How often?
Schedule
When you feel like
Build an audience
Social media
Comment on other blogs
Write guest posts
Enjoy the process of building your blog

Fig. 9.1 Steps for building your blog

lab, share general musings about the progress of your research, and/or share links to interesting blog posts that you read during the week. You can add a paragraph with comments to these posts as well. At PhD Talk, I don't keep weekly updates, but I enjoy reading these updates from researchers whose blogs I follow.

3. **Share your publications and presentations:** Remember that in Chap. 8 we discussed uploading your presentation to Slideshare and then possibly embedding it in a blog post? You can use a recent presentation to discuss it in a blog post. You can add your slides, some information about the event where you presented, and the abstract of your talk. A similar type of post can work for letting your readers know that you recently published a paper. Of course, an entire blog

in which you only write about your recent presentations and publications may be a little too static and niche for your readers, and feels more like a shopping list of achievements rather than an online log of your adventures in science, so try to vary the type of posts that you publish.

4. **Explain your research:** Your blog can be the perfect training ground for learning how to communicate your science to the public. Imagine you are at a family event, and your family members would like to know what your research is about. You may find it hard to answer this question directly and in an understandable way. With a blog post, you can practice discussing your research topic free of jargon. You can share a series of photographs from your lab work, and talk about what you are doing, and why. You can share videos of your experiments online. The added bonus is that you can't share this information in traditional journal papers.
5. **Share what you learned:** In a journal paper, we usually report only the method that worked. If you are testing something new, developing the right test setup may be an iterative process. Sharing with the research community what you tried and why it did not work can be incredibly valuable for the future research generations. Science can become more open if we find the right platform to not only discuss our results, but also our tools. And perhaps, these tactics can work to eradicate publication bias (we'll discuss this topic more when we talk about the benefits of blogging). If you feel uncomfortable about sharing your experiences and trials and errors in the laboratory, start by sharing little hacks on your blog. Did you find a handy way to do something in the lab? Did you program a little routine that could serve others? As you start to see that the online community is grateful and encouraging, you may feel more comfortable, and ready to discuss the larger topics.
6. **Discuss a blog post:** When you read a post from a researcher in another field, or a general post about higher education, you can write a post with your commentary. You can write a short paragraph in the comments section of the original post, but if you feel that you have more to share, you can dedicate an entire post on your blog to the topic. In that case, you can use your blog to argument why general practices are different in your field, or to discuss how your field can learn from the observations of a scholar in another field. Even when you think a post is complete nonsense, always remain polite and show good scholarship. Stay away from commenting on clickbait, fake news/propaganda, and other trolling websites – those sources are a waste of your time, and should be ignored.
7. **Describe how you implemented a post:** Did you read a little hack from a different field on a scholar's blog? How did it work for you? The answer is something you can discuss in a blog post. You can focus on your experience in applying the hack, and if it was useful for you, or you can discuss the changes you had to make to apply it to your field. In terms of productivity tricks, you can read about the planning methods of other scholars, and try these out. After trying the method out for three weeks[1], you should be ready to write your own reflection on the

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[1] Or any period of time after which it feels like you got used to the method.

topic. You may experience that some time management techniques are too strict for the creative nature of your research. If that's the case, you can discuss how you implemented the method, and how you learned to find space and time for creativity, or how you dealt with the messy reality of daily life.

8. **Curate content:** Did you film some of your experiments? Upload the video to YouTube, and write a post about what you were testing, why you were testing it, and what you learned from the test. Did you come across an interesting video online? Share it through your blog together with a discussion of how this video impacted you and what you learned from it. Did you have an interesting discussion on Twitter with fellow academics? Make a Storify[2] (more about Storify later in this chapter) and share this story on your blog.

If you do a quick search on the internet on "How to start a blog", you may find that you need to develop a business plan for your blog, a posting schedule, a mission statement, and that you already need to have a significant number of followers [3]. Of course, you are also advised to buy a domain, hire somebody to do the layout for your blog, and a coach to help you get started. If all this advice is true, I did everything wrong. In my opinion, this advice is valid if you want to develop an online business, which could come in the form of a blog. But if you just start blogging to share your research adventures, you don't need a business plan. You need to do the science, and write about it in an accessible way, and bit by bit like-minded nerds will find their way to your spot on the internet. If you're a scientist, don't expect blogging to be the gateway to a career switch – it's unlikely you'll ever make a lot of money as a blogging scientist – but the freebies here and there, free books for review, and occasional book store credit can be a nice little reward for sharing your work.

9.2.2 Guest Posting

If the idea of starting your own blog, and having to publish regularly gives you cold sweat, you can test the waters by writing a guest post for another blog. You might also decide to guest post every now and then if you are afraid you don't have enough time and material to have a blog of your own (tip: make time for blogging – it is an excellent way to invest in your writing skills). When you have an idea for a guest post for another blog, reach out to the editor of the blog, explain the topic you'd like to write about in the form of a short abstract, and how your post could benefit the readers of the blog you are reaching out to. A clear, concise e-mail could secure your little spot on the internet; just make sure you do your homework. Look for a blog that is suitable for the topic you want to write about. Typically, general lessons learnt will work better on general blogs about research strategies, whereas it may be more difficult to share a post about your experimental work on the blog of a researcher at another institution. If the editor of the blog you pitched your idea to

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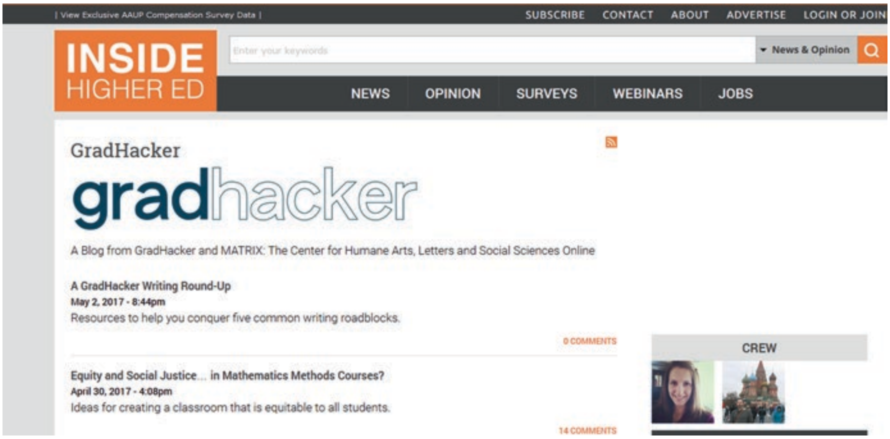
[2] Storify will go out of business mid-2018. Other options include Cyfe, Wakelet, Pearltrees.



GradHacker

gradhacker

A Blog from GradHacker and MATRIX: The Center for Humane Arts, Letters and Social Sciences Online

A GradHacker Writing Round-Up
May 2, 2017 - 8:44pm
Resources to help you conquer five common writing roadblocks.

Equity and Social Justice… in Mathematics Methods Courses?
April 30, 2017 - 4:08pm
Ideas for creating a classroom that is equitable to all students.

Fig. 9.2 Example of a multi-author blog

wants to invite you for writing a post, he/she will get back to you with some guidelines for posting on the blog. You can consider these guidelines as similar to the paper formatting guidelines for a publication. The editor can also give you some possible thoughts on how you can develop your topic further into a blog post, and perhaps indicate some posts on their blog that you can consider linking to in your post.

9.2.3 Multi-author Blogs

If you are in doubt about starting your own blog, you can always gather a group of friends to develop a blog together. A multi-author blog will require less commitment than a single-author blog, but still gives you the opportunity to write on a regular basis. You can join a shared blogging effort like GradHacker [4], see Fig. 9.2, or develop a collective blog for your research group or project. The benefit of starting a blog with your research group or project is that you can submit posts about recent publications and presentations, or share the processes you are using in the lab – topics that are usually more difficult to pitch to the editor of another blog. By sharing responsibilities your multi-author blog can grow without one person having to carry all the responsibilities. Some of your colleagues may be more into the layout of the website, whereas others prefer to focus on the actual writing. An even looser form of having a multi-author blog is when the blog of an institution decides to invite some of its scholars to share their views on a current hot topic.

9.2.4 *Benefits of Blogging*

Publication bias is a threat to scientific advancement [5]. In the medical field, negative results are not reported, or if they are reported, it is much harder to publish these results. As a result, money is spent on repeating the same trials that lead to more negative results, because researchers are unaware of what their colleagues in another lab tried that didn't work. In other fields, we don't know if applying a certain method or technique to our data won't work, because if somebody tried it and got negative results, he/she will not have been able to publish it. In all cases, a few weeks or months of work could be saved if we had a way to share our negative results publicly. One major benefit of blogging is that it could serve as a means to tackle publication bias. If you can't publish negative results in a journal, you can describe on your blog what you did, your negative results, and perhaps give some insight on why you think it didn't work. We need to have this discussion about failures and negative results if we want to move science forward. With that said, we need a system to catalogue these blog posts, otherwise it is still very difficult for your colleagues in another lab to learn about what did not work for you. Perhaps it is time for tighter and better linked networks of research blogs? Let's have this discussion, to see how the advancement of science can benefit from the currently available tools [6].

Besides the ways in which we can use scientific blogs to extend the tools we have to share our research, blogging also has a number of direct advantages [3, 7]. Here are some of the main advantages to blogging I've experienced over the past years for myself:

- **Visibility:** By using a blog to share conference abstracts and presentations, your research topic is visibly linked to your name (unless you decide the blog anonymously). If you start a blog, don't be surprised to receive e-mail messages from colleagues worldwide who are interested in your work, or ask you to share your recent publication with them. Conferences of course are a great way to meet researchers who work in your field, but not all scholars can travel everywhere. The internet can help us get in touch with those researchers you would generally not meet at conferences, and give an additional layer to the experience of knowledge exchange. If possible, add an extra tab to your blog in which you keep your publications listed, as well as an "About me" or "About the author" tab to introduce yourself to the world. You can also upload a recent version of your resume.
- **Learn about new topics:** As a guest author, I am sometimes asked to write an accessible piece about a research topic close to my field, but not exactly my field (for example, this post about sulfur concrete [8], which even ended up among my secondary documents in Scopus, as somebody cited it in a journal paper). For such posts, I need to do a short literature review. This practice helps me to quickly evaluate articles and take the information I need for writing a piece, a skill that immediately translates back to all academic writing.
- **Writing practice:** As we discussed at length in Chap. 7, writing requires practice and conscious effort. The more you write, the easier it becomes. Blogging is

one method to help you turn your thoughts into sentences faster. You'll also learn how to be less harsh on yourself. Blogging is a different writing style than dissertation writing. While you may have written the first paragraph of your thesis a few times, and erased it again, you will be less likely to erase your blog posts all the time, as there is less pressure to perform. Try to keep that attitude to your academic writing: avoid always deleting what you just wrote, keep it there, and revisit later for editing.

- **Find a community:** If you notice your blog posts are not getting noticed, do some Shameless Self-Promotion (it's not as bad as it sounds). Ask editors of larger blogs if you can write an article for them in exchange for having your byline with link to your blog with the article. Join the academic conversation on Twitter, and share your posts with fellow researchers. Blogs grow through interaction. Don't stay in your corner of the world, fiercely typing away the hours. Reach out and show what you are working on. Just do it all civilized – don't start spamming people with your posts.
- **Reflect on your progress:** A blog can be a great addition to your research journal. Your blog can be a place to reflect on your PhD trajectory. Whereas the details of your results and test setup are the typical contents of a journal paper, you can use your blog to reflect upon your adventures in the laboratory, and what you have learned from trying out certain planning or productivity techniques. Moreover, you'll be able to look back on your posts one or two years later and see how much progress you made. You may have completely dropped a certain approach, or you may have made tweaks and changes to your planning methods, for example. These reflections can form the basis of another post.

9.2.5 Barriers to Blogging

Blogging has many benefits, but many researchers feel certain barriers that prevent them from blogging. In general, the scientific community has not really embraced blogging. Instead, when I mention the potential of blogging, I'm often met with doubts and hesitation from my peers. There are as many forms of blogging as there are blogs (almost), so there can be a perfect fit out there for every single academic [9]. Let's have a closer look at the barriers to blogging that scare away some scholars, and how these can be avoided:

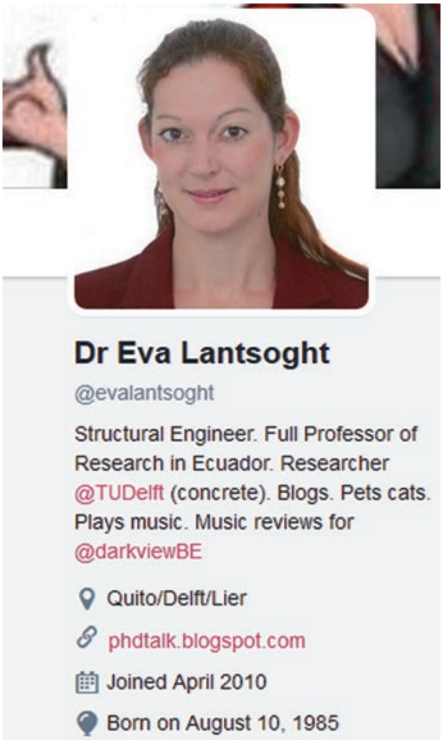
- **Privacy:** Online identity protection and safeguarding our privacy are a major concern for many scholars interested in blogging. However, as we will see later in the paragraph about online branding, you actually have more control over your online identity when you actively contribute contents than when you stay away from the internet. If you don't contribute with online content, your online image fully depends on others who may distribute contents that bear your name. If your main concern is related to sharing your personal data, then always think twice

when you fill out an online form that asks for your information. Remember that you should always think before you share anything personal online.
- **Imposter syndrome:** The fear for writing something “stupid”, the little voice in your head that wonders: “Who am I to speak up” [10]… it’s the imposter syndrome at work. Another related fear is when you write on the internet, your writing will grow up, have a life of its own, grow teeth, and return to bite you. How often is research misused for a sensational headline? Imagine the same happening to research results you share on your blog… So suppose that happens, wouldn’t it be better that you use the internet as a practicing ground for making a mistake than having to retract a journal paper? Blogs are for starting discussions and sharing insights to advance the entire body of knowledge. If we don’t share our thoughts out of fear for saying something stupid, then how are we supposed to solve the big questions of our days?
- **Too time-consuming**: Researchers have busy lives. If you combine research, teaching, administration, outreach, booking conference trips, and service commitments, you may wonder when you should be blogging. There are however a lot of blog posts that don’t require much effort: posting a conference abstract with your slides, copy-pasting a reply you wrote to a fellow scholar or student with advice (just edit to protect the identity of the other person, unless you have their explicit permission to use their name), or typing a short discussion of interesting work you recently read. It’s perfectly fine to write a blog post per month, or less. If you are still not sure, you can test the waters by writing a guest post for another blog.
- **Lack of ideas**: You don’t have to wait until inspiration strikes before you start writing a blog post. There’s enough low-hanging fruit that can be easily turned into a blog post, as mentioned above. As a PhD student, you can give a weekly/monthly update on your progress, which comes easy when you have the habit of writing down your goals, planning for them, and then evaluating them. Did you struggle figuring out how to do something (like getting a landscape table in a portrait page [11]), then write a quick tutorial – it can be helpful for yourself when you need to do the same thing again, as well as for others.

9.3 Twitter for Researchers

9.3.1 How to Engage with an Audience

Twitter is more than just the place where politicians go for uncensored ranting. For researchers, there is a wealth of information and possible contacts on Twitter [12]. Is Twitter beneficial for academics? A survey among 116 marine biologists seems to indicate that it is indeed beneficial [13]. The average marine biologist tweep had a 45% general public following and 55% scientific following, showing a good balance between niche and general outreach. Tweets referring to publications get retweeted 19% of the time, increasing research visibility.



Dr Eva Lantsoght

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Structural Engineer. Full Professor of Research in Ecuador. Researcher @TUDelft (concrete). Blogs. Pets cats. Plays music. Music reviews for @darkviewBE

Quito/Delft/Lier

phdtalk.blogspot.com

Joined April 2010

Born on August 10, 1985

Fig. 9.3 My Twitter bio

Admittedly, finding your gang on Twitter can take time. While most people start by following news websites and perhaps their president or prime minister, the interaction with these accounts is different from the interaction with fellow academics. Actively search for peers on Twitter: fellow PhD students across disciplines, or scientists from your field at different stages of their careers. Let's take the whole process step by step. If you get confused about which button to push where, I'll refer you to the wealth of YouTube tutorials that talk you through these steps. Here, we will focus on how to use Twitter as an academic:

1. **Write a bio:** One of the first things you need to do when you sign up for Twitter, is to add your bio (maximum 140 words!). Your bio should at least mention your current position. Twitter is a lighter platform. There's no need to cite your recent publications in your Twitter bio. My bio includes "Blogs. Pets cats. Drinks tea.", see Fig. 9.3, which prepares my audience for the random tweets that are not directly related to concrete and higher education. Make your Twitter profile public instead of private if you are open for interaction: you want fellow scientists to be able to find and follow you. You can add the warning that Retweets are not Endorsements, although most of the Twitterverse is aware of this.

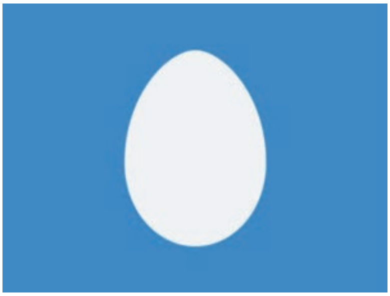

Fig. 9.4 Don't be an egg

2. **Profile picture:** Your standard profile picture is an egg, see Fig. 9.4. When I get followed by an egg, I won't take the effort to read the profile of this person, because his/her profile is not even finished with a profile picture. Since Twitter profile pictures look small, you should use a headshot. A full body picture will be reduced to the size of a stickman. Use a recent, clear, recognizable headshot, so that a fellow researcher can recognize you at a conference.
3. **Follow people:** Besides cat memes and news articles, Twitter can be a great place for reaching out to the scientific community, and I'm assuming that becoming part of this community is your first goal for joining Twitter[3]. There are different types of accounts that you can start following:
    (a) The accounts of your university and department: these accounts will also retweet tweets from fellow academics at your institute, who you can follow.
    (b) The accounts of universities and research groups worldwide you are interested in.
    (c) The accounts of academic publishers.
    (d) The accounts of news websites and blogs related to higher education, e.g. @ insidehighered and @timeshighered.
    (e) Make a search for your field and/or a keyword of your research, and go through the profiles that show up.
    (f) Professional organizations in your field.
    (g) Main companies in your field.
    (h) Browse Twitter lists to see which lists in your field are curated, or in which lists researchers from your institution are featured.

    Keep in mind that growing a list of interesting people to follow, just like growing your own following, is something that happens over time. You'll see an interesting retweet, check out the profile of the original tweep, and perhaps decide to follow him/her. If you start following a lot of people in a short amount of time, Twitter will ban you from following more tweeps.
4. **Create content:** With a profile, profile picture, and some people to follow, you can start creating content. Remember to balance tweets you write yourself,

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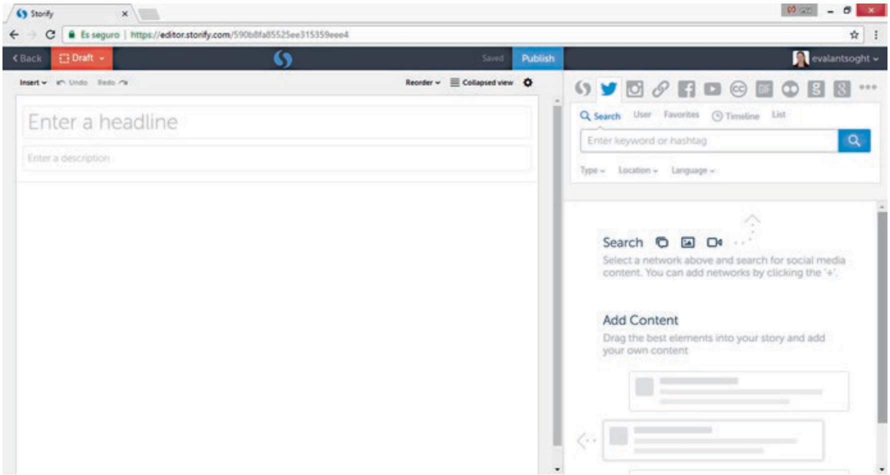
[3] I'm not judging you if the cat memes lured you in in the first place

@-replies, and retweets. You can tweet about your recent publications, retweet interesting tweets from the accounts you follow, and more. If you have more to say than 280 characters, create a tweetstorm, in which you make a thread of tweets by @-replying your first tweet. Here are some ideas for creating content:

   (a) Tweet about the topic you will discuss in class.
   (b) Tweet about the conference you will attend or are attending. Be careful not to tweet contents and pictures of presentations if you don't have the authorization of the presenter!
   (c) Share your writing progress.
   (d) Discuss a recent publication, and the ideas it gives you.
   (e) Join the discussion about higher education policies.

5. **Join the discussion:** In real life you wouldn't simply barge into a group of people who are discussing a topic of your interest. On Twitter, however, there's nothing wrong with jumping into a discussion, because nobody on Twitter knows you are interested and reading along until you drop your two cents into the conversation. Comment to tweets of fellow scholars, ask for ideas and opinions, and interact. You can tag people in a post by adding their @account when you share an article and ask for their opinion. Don't be afraid, go ahead and join the online academic discussions.
6. **Using hashtags:** Those hashtags, like #selfie #socool #nomnomnom, that you see showing up all around social media? On Twitter, discussions center on certain hashtags. In the academic world, important hashtag to check out are #phdchat, #withaphd, #ecrchat (for early career researchers), #scholarsunday (on Sundays, to get ideas on who to follow), #acwri (for academic writing), #acwrimo (in November, the month in which academics pledge to move an important writing project forward and post daily word counts), and #goscholargo (to encourage fellow scholars). Some hashtags have a weekly time slot to chat, with the option to vote on the topic for the chat. Other hashtags are continuous sources of information. Check if your research field has its own hashtags. Listen in to the discussion first to get a feeling for the style of discussions, and then start contributing.
7. **Curating content:** Retweeting posts, sharing articles, pointing people to interesting discussions, and hosting people to write on your blog – all these activities are related to curating content and broadcasting it to your audience. You can go through newsletters from your field, and share interesting articles with your followers. Figure out which information you and your followers find relevant (i.e. content that receives feedback or retweets), and start distributing relevant contents.


Storify
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Undo
Redo
Reorder
Collapsed view
Enter a headline
Enter a description
Search
User
Favorites
Timeline
List
Enter keyword or hashtag
Type
Location
Language
Search
Add Content

Select a network above and search for social media content. You can add networks by clicking the '+'.

Drag the best elements into your story and add your own content

Fig. 9.5 Storify for building stories out of social media contents

9.3.2 *Curating Content Through Storify*

Storify[4], see Fig. 9.5, is an online tool you can use to turn interesting conversations from social media channels into a story that you save separately [14]. While Storify works for Twitter, Facebook, Instagram, Flickr, YouTube, and Google, we will focus here on the combination between Storify and Twitter. Does this sound like extra work for you? Don't be afraid – consider Storify as a place to archive conversations you would want to access later, just like you archive papers you read, and bookmark interesting web pages. Storify works as a news channel, and a number of major newspapers use it to generate articles. You can collect tweets of an interesting discussion, and add your commentary and reflections between the lines. You can also add the context and background of the discussion. As such, Storify is for information on the internet like scrapbooking is for your holiday pictures.

As mentioned before, a powerful function of Storify is its ability to create stories based on Twitter chats. As Twitter is a fast medium, information goes lost under the constant publication of new tweets. The oldest tweets in a discussion can already be difficult to find back. Storify has a quick function to sort tweets from the oldest to the most recent, so that you can read a discussion in the right order. To collect the information from Twitter for Storify, you can search based on the tweeps or hashtag used in a discussion. After selecting these tweets and dropping them into the Storify editor field, you can sort them and add text between the tweets.

Storify can be used to report on the commentary and discussions from a conference. You can collect the tweets based on the hashtag used for the conference, and add

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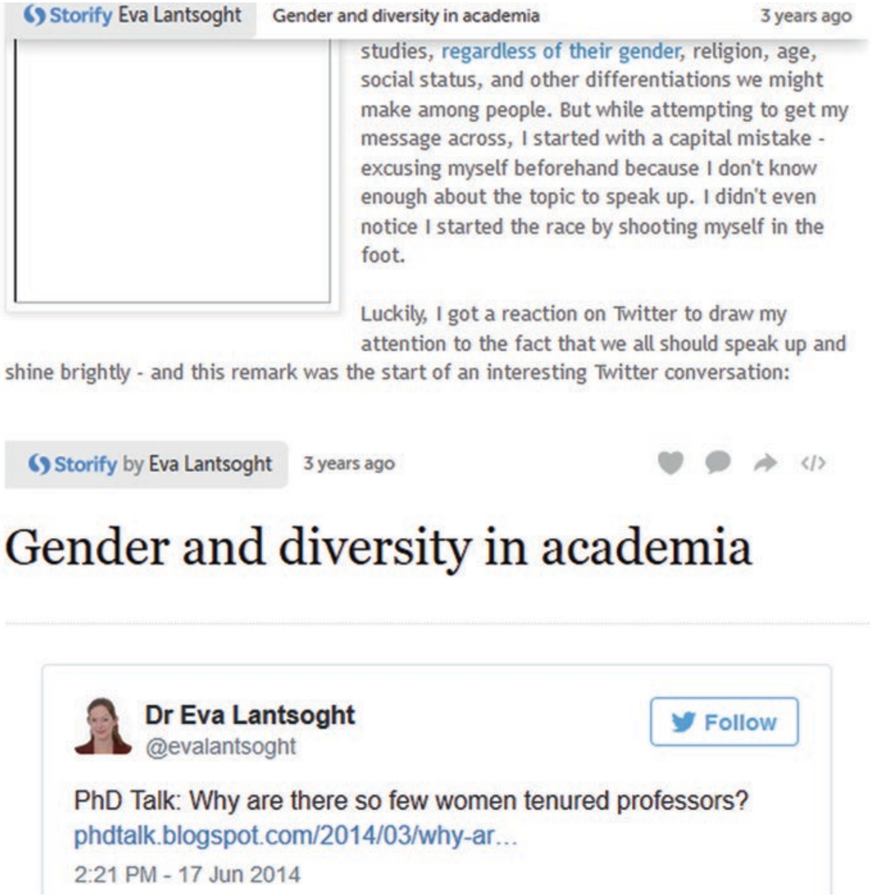
[4] Service is planned to go out of business, and other companies are busy trying to fill up this vacuum Wakelet currently seems to be the best replacement.



studies, regardless of their gender, religion, age, social status, and other differentiations we might make among people. But while attempting to get my message across, I started with a capital mistake - excusing myself beforehand because I don't know enough about the topic to speak up. I didn't even notice I started the race by shooting myself in the foot.

Luckily, I got a reaction on Twitter to draw my attention to the fact that we all should speak up and shine brightly - and this remark was the start of an interesting Twitter conversation:

Gender and diversity in academia

PhD Talk: Why are there so few women tenured professors? phdtalk.blogspot.com/2014/03/why-ar...

2:21 PM - 17 Jun 2014

Fig. 9.6 Embedding Storify into blog posts

some of your own thoughts and comments about the day. You can find an example here [15]. Another typical use of Storify is to turn a Twitter discussion into a story. In this case, you will search for the @-accounts you interacted with to compile the story. You can find an example here [16]. Once you have developed a Storify, you can embed this story into a blog post by copying the html code of the embedded story and pasting it into the html editor of your blog, see for example Fig. 9.6.

9.4 Online Branding for Scientists

Besides your blog and Twitter account, all information that is available about you online is your digital business card. Online branding is in fact having control over the information available about you online [17]. When I mention online branding, often researchers shoo away. Branding is for marketeers, they tell me, and I have no need to brand myself at all. I myself don't like the term "branding" that much (am I a "product"?). But let's be practical and call it branding, because that's the definition somebody gave it.

Let's focus on what online branding means: having an influence on what the internet shows the world about you. If you are not active online, or not conscious about your online activities, you depend on other people. If you do not manage your online profiles, perhaps only irrelevant information about you is available online, which can give people the wrong impression of you.

Let's start with an exercise. Go to your favorite search engine and type your name in the search field. What do you find? What are the ten first results that show up? My information is shown in Fig. 9.7.

If your search returns the fact that you won the lottery of your local baker, some emotional comment you once made on a news article, or random stuff you are trying to sell online, it is time to get some grip on your content. If future employers look you up online, you want the search engine to gently take them by the hand and bring them straight to your professional information.

If you have a unique name like me, you could think that it is easier. If your name is common, and you find only information about other people, redo the exercise with your name and your current institution, and see what shows up. If you have a very common name, it could be wise to use the first letters of your other first name(s), to distinguish yourself. If you decide to use the first letters of your other first names, do so consistently[5].

Let's now see what you can do to get grip on the content that is available about you online. Remember that once you start to take action, the irrelevant stuff will sink down to the bottom of the search results and your important information will be there at first glance. Here are several actions you can take to curate your online profile:

- **Twitter:** Here we go again with Twitter. Your Twitter profile will show up in a Google search[6] about your name, unless you used a nickname for your profile. Google search will only provide one entry from Twitter. However, possible employers will certainly feel like checking out your profile. So put a bit of time and effort into your profile (or, in other words: spend a bit of time working on your Twitter profile when you want to procrastinate in a productive way, and you may be surprised by the interesting professional results that follow). Follow the tips from the previous section.
- **LinkedIn:** LinkedIn is your online resume. There's no discussion on whether or not you need a profile on LinkedIn – the answer is yes. If you don't have a LinkedIn account, carve out two to four hours some day to get this thing up and running. Take the summary from your resume, and add it to your LinkedIn summary. Use a recent photograph. Transport all the categories from your resume

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[5] For all your publications, for all work occasions, and on all your online profiles.

[6] Or your favorite search engine. I currently use Ecosia.

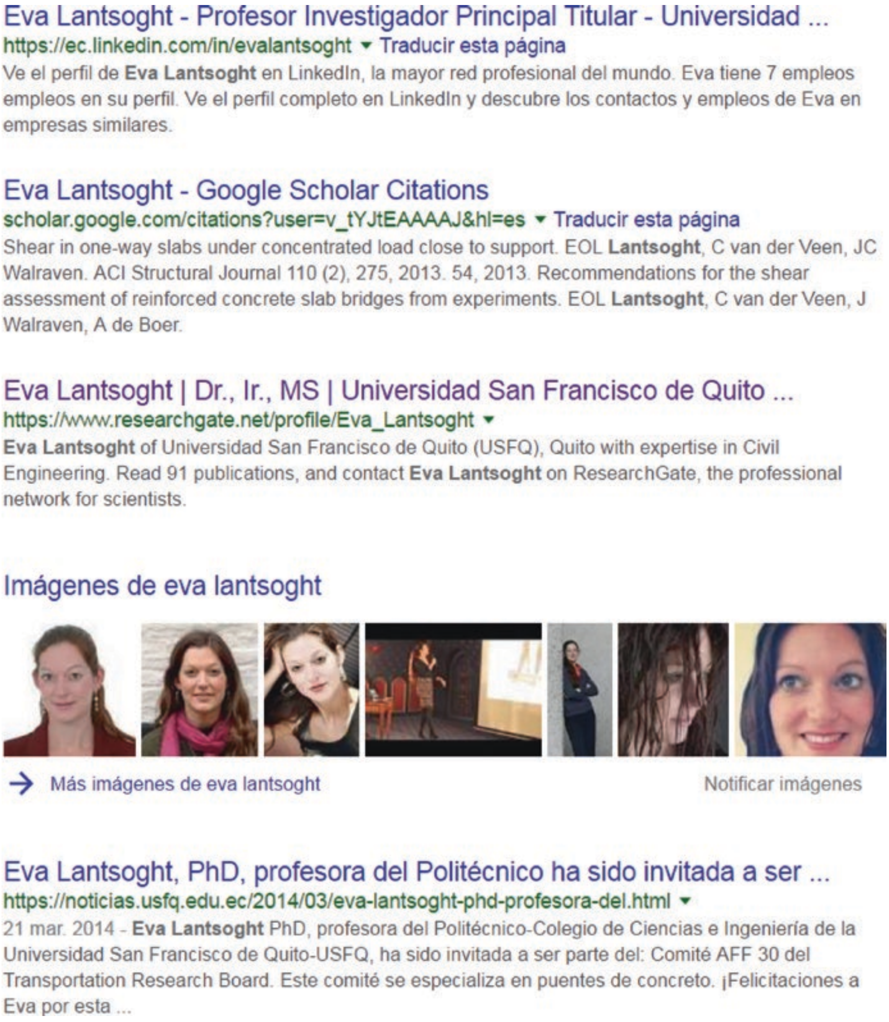

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Fig. 9.7 Google your own name

into LinkedIn, and make sure your information is up to date. Then, start connecting with people you know. Typically, LinkedIn will suggest people you know to get started. If you have a profile, give it a serious look, pretending you are an outsider (say, somebody who would be interested in working with you). Do you like what you see? Is your information up to date? If not, it's time to clean ship and give your profile a makeover.

- **Your blog:** Blogging is an excellent way to control the information available about yourself online. If you prefer to guest post, make sure your byline has your name and information correctly, so that you are searchable.

- **Developing a brand:** While the word "brand" may give you visions of ketchup and makes of cars, you should keep in mind that a brand for a person links back to this person's core values. What is the most important thing you want others to see about yourself? The internet is not there to give people the impression that your life is perfect, and more and more, voices in social media and the internet world are asking for more authenticity online. Think about the impression you want to make. Do you want to focus fully on your work, or do you think it is fine to give a sarcastic remark about the state of affairs in the world every now and then?
- **Find your tribe:** Once you start using social media platforms to broadcast who you are, you can start to form bonds online. Through the blogging and Twitter community, I've been reaching out to fellow academics, and have gained numerous insights. I learned a lot of tips and tricks from fellow researchers during my PhD, and learned how to manage my time and plan accordingly. My tribe, as such, has been generally academic. Your tribe may be more specific to your field - whatever you are comfortable with, and whatever feels like developing meaningful connections. Reach out to others by leaving comments on their blogs, replying to tweets, and interacting in different ways. Once you have found your community, you will hopefully see the benefit of putting some time into your online profiles, and an online search will show information that you yourself provided to the internet.

9.5 Summary

In this chapter, we explored the possibilities of the internet to reach out to fellow researchers and the general public. We discussed how internet tools can be used to extend the traditional tools to disseminate research (writing and giving presentations). We focused on the use of blogs to share research insights, or general musing about the PhD trajectory. We also looked at the use of Twitter for academics, and the benefits Twitter brings for interaction with fellow scientists. Finally, we looked at the information that is available about you online, and how you can get a grip on this information to show the world your most important professional information when someone searches for you online.

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Chapter 10

Preparing for Your First Conference

Abstract In this chapter, we discuss all steps necessary to prepare for your first conference. The first topic deals with selecting a conference and provides guidance on how to find a suitable venue for presenting your work for the first time. Then, we explore the possible topics for a conference paper. Based on the preliminary work you have ready, a number of topics can be suitable for a conference that later on will lead to a journal publication or dissertation chapter. The type of paper to present, as well as the topic, are closely related to the audience of the selected conference. Subsequently, we discuss the different steps to take into account when planning towards a conference, and the total time you should put in your planning when you decide to attend a conference. This scheme looks at all the steps you go through from finding a suitable conference to feeling tired and needing a bit of time after a conference to recover from the trip. Finally, we look at how you can get most out of a conference by preparing well. You might want to get in touch with someone working in your field prior to the conference, so that you can build up your network. We also discuss self-care during a conference.

Keywords Conference · Academic conference · Networking · Presentation · Travel

10.1 Introduction and Learning Goals

This chapter discusses the steps required to prepare for a conference. As conference papers are often submitted about a year prior to the event, preparing for a conference involves a fair amount of planning. The first step is to decide which conference(s) are interesting for you. Then, you need to select a topic to present at the conference so you can prepare an abstract for submission. Once the abstract is accepted, you need to make sure that you plan your preparation activities for the conference as well as the required time for these activities. Before leaving for a conference, it is important to prepare thoroughly, so that you can get the most out of your conference attendance. You need to figure out in advance which sessions, workshops, networking events, panels, etc. you want to attend. At larger conferences, sessions will overlap, so you need to think about your choices. In addition to these activities, you also need to figure out who you want to meet at the conference. Another important aspect is interaction

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during the sessions, and you will learn in this chapter how to prepare yourself to ask questions and engage with fellow scholars at conferences. We finish this chapter with a word of caution: conferences are exhausting, so you need to have a plan for self-care during the conference if you want to avoid getting worn out and returning home sick.

10.2 Selecting a Conference

At the beginning of your PhD trajectory, you should outline at which conferences you would like to present your work. Don't wait until you feel "ready" to present something – it is not uncommon for conferences to require an abstract submission 1.5 years before the actual conference. Talk to your fellow PhD students to learn where your supervisor usually takes his/her students, and talk with your supervisor about wanting to present your work at conferences as early as possible.

Ideally, you have been able to discuss travel funding prior to taking up your PhD position, but if you are unsure about what to expect, then bring the topic up as soon as possible. The funding of the project you are working on is crucial here: it could allow you to present at a number of conferences each year, or it could limit you to one single conference per year. If your funding does not include a travel budget, look for other options. Many universities and professional associations provide scholarships for students to travel to conferences. You can also consider participating in student competitions, essay contents, and other competitions which can award you with travel funding.

Now that you know that there are many ways to find funding to travel to conferences, and that you should start building your conference wishlist early in your PhD trajectory, let's focus on selecting the right conference. There are different types of conferences:

- **Meetings of international associations:** The largest conferences tend to be the meetings of international associations. These associations can meet annually, or less frequently. A good place to start looking for information would be on the websites of international associations that you are involved with or that are important in your field. If you are not a member of any international association, start looking for the important players in your field. A good starting point would be the associations that publish the journals you read, for those journals that are not owned by large publishing houses. Keep in mind as well that many international associations offer free or very cheap student memberships. Once you've identified the important international associations, look on their websites for information about their events. Many international associations will also mention events they cosponsor, so you can be informed about meetings you would not hear about otherwise.
- **National meetings:** If you want to test the waters before you take your research abroad, looking into national meetings is a good starting point. While not all national meetings require you to write a conference paper, presenting your work to a smaller audience and perhaps in your native language may be a more com-

fortable first step. These national meetings can be organized by national member groups of the international associations that you follow. Another type of event is organized by research groups of universities that study the same topic, giving PhD students an opportunity to share their work with researchers in the same field. Sometimes, young member groups or student chapters of international organizations organize events in which you may want to present your research.

- **Industry events:** There's a whole array of different industry events that can be particularly interesting towards the end of your PhD trajectory, as you explore opportunities in the industry. Some industry events are gatherings of academics and practitioners in a certain branch of the industry. These events typically have lectern sessions, in which you could present your work. Inquire if there is a possibility, but keep in mind that in some fields these lectures feature only senior professors who give a more general overview of the current state of research. Other industry events are career fairs, and trade shows, which you may want to attend to learn about your opportunities after your graduation, but which do not offer you the ability to present your work.
- **Specialized workshops:** Workshops on specialized topics can be organized by international associations, or on the initiative of a few senior professors. Whereas these events typically tend to gather a small but focused group of researchers, it is more difficult for you during your PhD to learn about these events. Sometimes, these events are announced on the website of the overbearing international association. The presentations can be by invitation only, but if you are interested in participating and presenting your work, talk to your supervisor and see if he/she can get you a spot in the workshop.

Most information about upcoming conferences can be found online, and the internet (including the websites of the most important international associations) can provide you with a great amount of information. Sign up for newsletters of international associations to stay informed about the events they organize or co-sponsor. Tell your fellow PhD students and supervisor that you are looking for information about interesting conferences; they will forward you calls for abstracts when something interesting comes up. Ask your fellow PhD students and supervisor to bring flyers announcing future conferences when they travel to conferences.

Before finishing this topic, I need to give you a word of caution. If you receive an e-mail with an invitation to submit an abstract for a conference, and it looks interesting, make sure you check if the conference is legit. Check their website, and see if the event is endorsed by any international association that you know. Check the organizing committee and scientific committee, and see if there are reputable scientists involved. If you are doubting whether the conference is legit, write one of the members of the scientific committee to ask about the scope of the conference. Some predatory conferences unfortunately just slap some names on a website without asking these scholars for permission. You wouldn't expect it, but some companies have decided to make easy money with the organization of "academic" conferences: they ask high registration fees, and use no academic rigor in the peer review process (or use no peer review whatsoever) to organize conferences with the sole objective of making some quick money. Red flags for these predatory conferences are: poor

English in the e-mail, a promise for fast publication or publication in a journal, or you being invited as plenary speaker or session chair (by someone you don't know at all). If you are doubting whether a call for abstracts is legit, Google the name of the conference with "bogus conference", "fake conference", "predatory conference" or "scam conference" added to it to see if others have been fooled by the same organization. For an overview of conferences in structural engineering, see [1].

10.3 Selecting a Topic

10.3.1 The Right Topic for the Conference

The type of paper to present, as well as its topic, are closely related to the audience of the conference you have selected to attend. First of all, you need to verify that the topic you have in mind for your presentation and conference paper fits the list of topics of the conference. If that's not the case, you need to either change your topic (if you have already quite some work done, and can select from a number of different topics to present), or consider another conference. If you are not sure if a topic you have in mind is suitable, ask a senior colleague about it, if he/she has traveled to this conference in the past. He/she will be able to give you an idea of the audience of the conference, so that you can evaluate if your topic would fit into the scope of the conference and would be of interest to the audience. If you don't know anybody who has traveled to this particular conference before, try to find the proceedings of a previous edition of the conference, or check the schedule from a previous edition. Do you think your work would fit in there? Take some notes about what you learned about this conference from talking to colleagues or from looking up information of previous editions – this information will be useful when you start to prepare your presentation. You can add these notes to your research journal.

For your presentation, you'll have to tailor your story even more to the audience of the conference. Only if you are presenting at a very specialist gathering will it be fine to spend most of your presentation on your data and results. In all other cases, you need to spend most of your time on explaining the background of your research, and how your findings may impact the daily working practice of your audience, or how it could be important for their research.

10.3.2 Ideas for a Conference Paper

Ideally, your conference paper is a first start for what later will become a journal paper and/or a dissertation chapter. But when you're earlier in your PhD trajectory, and still have several open question marks in your research, you can still present a smaller piece of your work at a conference, see Fig. 10.1. All practice of presenting at conferences is valuable, and every opportunity to discuss your ideas with peers

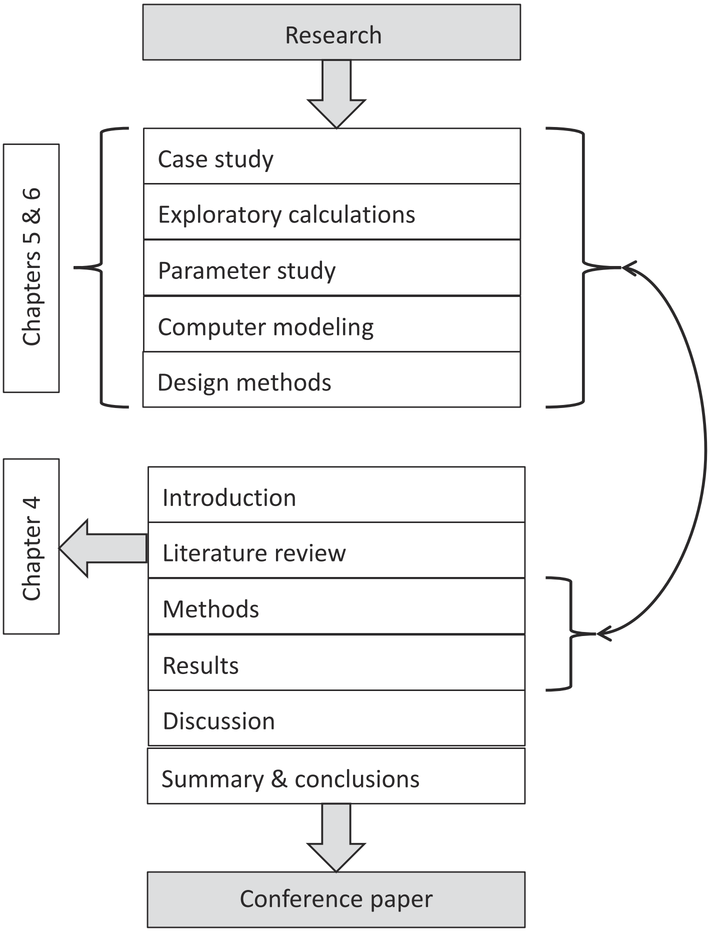
Research
Chapters 5 & 6
Case study
Exploratory calculations
Parameter study
Computer modeling
Design methods
Chapter 4
Introduction
Literature review
Methods
Results
Discussion
Summary & conclusions
Conference paper

Fig. 10.1 From research to a conference paper

and senior academics will prepare you for your defense. Don't say that you have nothing to write a conference paper about. If you are doing research, you should have some material and the skills to develop something that is worth showing to the international research community. If your experiments aren't finished yet, you still may have learned something that is worth talking and writing about [2]. If your work isn't finished yet, you are in the perfect situation to ask for feedback from fellow researchers. Here are some examples of smaller research ideas that you can write about early in your PhD trajectory and present at a conference:

- **Case study:** Take an example from practice, and use the knowledge you obtained while carrying out your literature review to delve deeper into this case. Besides standard calculation procedures, you can test the outcomes of the case study with newly published theories. While carrying out this small exercise, you may either find that the proposed theory “works”, or you can run into the boundaries and limitations for the application of the proposed theory.

- **Review paper:** The review paper is a classic, and certainly something that can be developed further into a journal paper. Often overlooked by PhD candidates, writing a good review paper is an essential skill. If your research has only focused on reviewing the literature, you can already develop your review paper for a conference. While writing a solid review paper for a journal is challenging, and perhaps a task to keep for the last years of your PhD trajectory, developing your first review paper for a conference is good practice for getting acquainted with the concept of writing a review paper. If you’ve done a thorough literature review, you should have the right information to write a solid and critical review paper that can be of value to other researchers. Focus on pointing out the lacks in the current knowledge in your field, and highlight possibilities for future research. Use your conference presentation then to bounce some of your research ideas off your audience.
- **“Mix & Match” paper:** This type of paper you can write when you have been making small calculations while preparing your literature review and/or developing your research question, as we talked about in Chaps. 4, 5 and 6. While this type of paper does not have sufficient substance to become a fully-fledged journal paper, it is a starting point for sharing your research. In such a paper, you can compare the test results from researcher X with the theory proposed by researcher Y. For a full journal paper, you would have to develop a full database of experimental results from all available literature, but for this first exploratory calculations, you can focus on a deeper analysis of a single series of experiments. The advantage for you is that you gain practical skills you need for your research: you may want to apply the theory of researcher Y to your future experiments. By practicing with an existing set of data, you will gain a deeper understanding of the theory of researcher Y, and at the same time you will gain new insights from the existing data. You develop spreadsheets or program tools to apply the method from researcher Y, which will be useful when you predict and analyze your experiments. Your understanding of the topic will deepen, and you may even find ideas for your future research.
- **Parameter study:** Parameter studies are the type of work that you can carry out in the beginning of your PhD trajectory to prepare small documents for discussion with your supervisor, as described in Chap. 5. Playing around with the effect of different parameters on different theories gives you a solid starting point for developing the required ranges of parameters that you need to test. Something as simple as using Excel to study how a certain parameter is represented in different theories, and how this variation corresponds (or not) to observations in experiments can be a valuable starting point for your research, and an interesting small study to share in a conference paper.
- **Boundaries and assumptions:** The study of the limitations and boundaries to assumptions that are at the basis of existing theories is an important step between your literature review and your own research. In your literature review, you should focus on the limitations and boundaries to the major existing theories in your field. Now you can take this work one step further, and study the assump-

tions that are at the basis of the existing theories in more detail. Ask yourself what these boundaries and assumptions exactly mean. Then, discuss in your paper what the research community should do to verify if these bounds are correct, or if the theory can be expanded to include cases that lie outside its originally defined boundaries.

- **Comparison of design methods:** This idea is deeply rooted in my structural engineering background. In my field, it is interesting to compare different codes and design methods. Take a simple case, and see how different the resulting design would be if you use different codes. Again, it is important here to discuss the boundaries and assumptions of the codes that you considered.
- **Computer modeling:** Advances in computer modeling certainly are a topic that is worth of PhD research. However, for a conference paper, you can focus on the tried and trusted methods for computer modeling. You can for example start modeling an experiment from the literature, and discuss your results as a function of the different input parameters that are required in the computer model. Practicing computer modeling is also valuable when you need to model your own experiments in the future – you will have already experimented with the software and gained some insight in the different input parameters that need to be assumed.

Exercises

1. Make an overview of conferences that can be of your interest. Start by looking at the events organized by international associations.
2. Look at your planning, and try to limit yourself to maximum four interesting conferences per year to attend (if your funding and supervisor allow). Check the due dates of the abstracts. In your first year(s), you won't be able to travel much because the abstract deadlines may have already passed, but plan ahead and see where you want to go in two years from now.
3. Make an overview table of the conferences you want to attend, the topic(s) you want to present, and the necessary budget. Discuss this table at your next meeting with your supervisor, and prepare a justification of why the selected conferences are interesting for you.

10.4 Planning Towards a Conference

10.4.1 Plan Your Time

If you've decided on attending a conference, and decided on the topic for your paper, it is time to start planning, see Fig. 10.2. Thinking about the required steps to get you to the point of success is part of success itself. Have a good look at all the

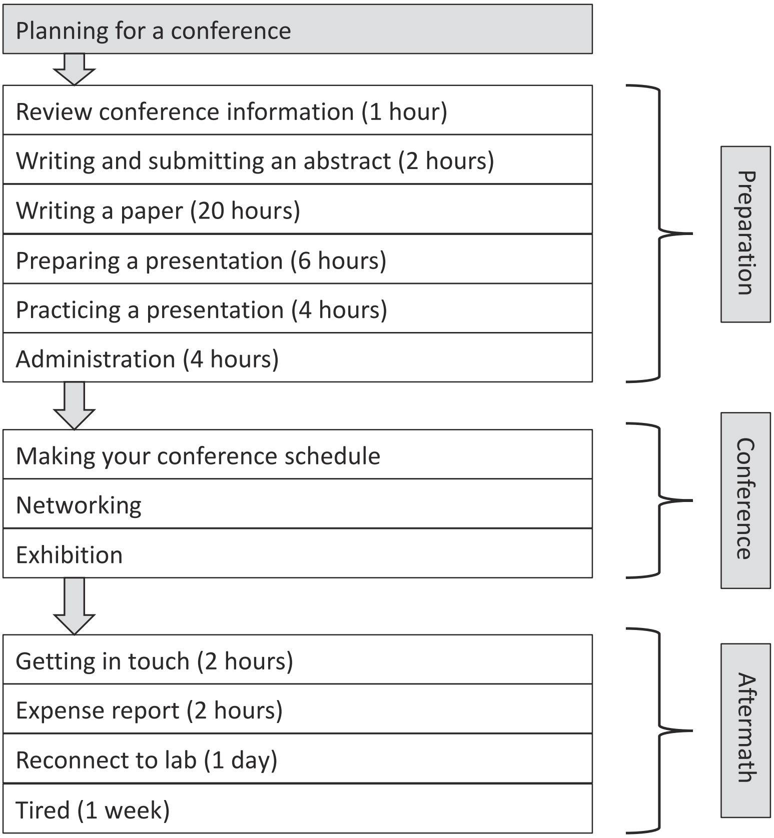
Planning for a conference
Review conference information (1 hour)
Writing and submitting an abstract (2 hours)
Writing a paper (20 hours)
Preparing a presentation (6 hours)
Practicing a presentation (4 hours)
Administration (4 hours)
Making your conference schedule
Networking
Exhibition
Getting in touch (2 hours)
Expense report (2 hours)
Reconnect to lab (1 day)
Tired (1 week)
Preparation
Conference
Aftermath

Fig. 10.2 Planning for a conference: before, during, and after

deadlines for the conference (abstract submission, full paper submission, registration, and the actual dates of the conference), and put these on your calendar. Plan in such a way that you can make it to each deadline, with still sufficient air in your planning to deal with any curveball life may throw you.

In this section, I give you an estimate of the minimum amount of time that you need for each step in your preparation for a conference based on my experience. Adjust the time estimates based on the results of your time tracking where possible to get a planning that suits your working style. Make sure you add enough air and space for interruptions in your schedule. Here's an overview of all the steps you go through in the process of preparing for a conference, so these are all the steps you should add to your planning.

1. **Step 1: Preparation – 37 hours**
    1.1. **Reviewing the conference information – 1 hour:** I'm assuming here you have already figured out which conferences are important in your field – otherwise you should set aside an afternoon to browse the websites of inter-

national organizations and look for interesting events, as we discussed before. Say that you have decided on a conference and on a topic for your paper, then you still need at least one hour to familiarize yourself with all conference information. This information includes all the important deadlines, and the formatting requirements for your abstract. Have a quick look at the location of the conference, the airfare, and other practical elements to update your budget and to know which administrative issues you need to take care of. In case of doubt, check if you need to apply for a visa. Add all these activities to your planning and list of tasks.

1.2. **Writing and submitting an abstract – 2 hours:** The first time you write an abstract, you will need more time, and you probably will want to discuss your proposed abstract with your supervisor. Make sure your abstract contains the four (six) basic elements: (background), problem statement, (scope), methods, results, and conclusions. To include all important information, my favorite method for writing an abstract consists of copying the following questions into a new document, and typing the answers to these questions, which I originally found in an article on how to write an abstract [3]. Then, I delete the questions and revise the text for consistency. The questions are the following:

- *Why are the problem and the results important and why should they be studied?*
- *What problem specifically are you trying to solve?*
- *How are you trying to solve the problem? Which methods did you use?*
- *What's the answer of applying these methods?*
- *What are the implications of this answer?*

This method is discussed in more detail in Chap. 11. Submitting your abstract itself can be a separate and time-consuming task. You'll need to enter all information of your coauthors and yourself, select keywords, and you may want to check and double-check to make sure you filled out every step correctly. Plan enough time for the actual activity of submitting your abstract.

1.3. **Writing a paper – 20 hours:** If you have all research ready, and depending on how much or how little you struggle with academic writing, the task of writing a paper will "only" involve the activities of making your outline,[1] writing the text, updating your figures, updating your references, proofreading your work, discussing it with your supervisor and/or coauthors, and making changes. If you're not sure about how much time certain activities take, then track your time. On average, I needed about 20 hours to write a conference paper, and 40 hours to write a journal paper and/or special publication during my PhD. In my post-doc years, and with more practice, these numbers have gone down. Of course, everybody is different, and you may need only 12 hours for writing a conference paper, or maybe you need

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[1] If outlining works for you.

100 hours the first time you write a conference paper. If you have no idea how much time you need, err on the safe side and assume you will need two to four hours each day for six weeks to write your first conference paper. Start developing the paper as soon as possible after you receive your abstract acceptance. Then, track your time while you are developing this conference paper to get a better estimate of how much time you need to write a conference paper. Certainly, unless you isolate yourself from the rest of the world and your teaching and research duties, you can't devote eight hours a day to writing your conference paper. Try to reserve a time slot of two to four hours in the early morning or late afternoon, when chances of disturbances are the lowest, to write your paper. If you don't have a comfortable writing space, try writing in the university library, from home, or from a quiet coffee shop.

1.4. **Preparing a presentation – 6 hours**: If you have no material available, the rule of thumb is that a minute of public speaking takes an hour of preparation. For research presentations, and especially if you already wrote your paper, you will have the contents and figures ready, and your time and effort will go into designing your slides. Be careful with figures: if the font in your figures from the paper is small, you will need to adjust the figures so that they are readable for the audience.

1.5. **Practicing a presentation – 4 hours**: To make sure that my presentation fits within the allotted time, I practice my presentation a number of times with a stopwatch to check if I am on time, or if I need to cut out material. Don't make the mistake of waiting until the day or night before your presentation to make your slides, and completely forego practicing your talk. A well-rehearsed presentation, that stays within the time limits, will leave a favorable impression on your audience.

1.6. **Administration – 4 hours:** This part is not fun, and it has nothing to do with science, but unfortunately it is necessary to make all your arrangements before a conference. Administrative tasks include: requesting a travel budget, registering and paying for the conference, or arranging with the department of finance of the university to pay for your registration, booking the flight, booking the hotel, booking train tickets, and figuring out how to get from the airport to the hotel and from the hotel to the conference venue. If you are traveling abroad, you may also need to go to the bank to get foreign currency, and perhaps you need to apply for a visa.

2. **Step 2**: **The conference – 3 to 5 days**

2.1. **Making your planning – the night before the start of the conference:** While I like to have my conference schedule and an idea of who I want to meet at a conference ready before I leave, many conferences make last-minute changes to their schedule. Check the final conference schedule the night before the conference, if you've managed to register and pick up your conference bag the day before the actual start of the conference. Always try to travel early enough, so that you can register the day before the start of the conference. If for any reason, something went wrong with your registration and/or payment, you still have enough time to take care of it. If the conference bag contains a book of abstracts, you can use both the program and book of abstracts to find the most interesting talks for you, and set up your itinerary for the next days of the conference. Sometimes, the topic of a session and the actual titles of the presentations don't fully match, so make sure you check the titles of the presentations. Allow some time as well to attend sessions you would normally not attend, to learn about new topics. Find time to network or rest, or go for a walk in the conference city, if your schedule allows.

   2.2. **Networking – 3 days**: When selecting a conference to attend, you will have had a look at the organizing and scientific committees of the conference. These people are likely to attend the conference. Moreover, have a look at the list of attendants (if available) to identify who you would like to talk to. Check for interesting presentations, and try to talk to these presenters after their presentation. Allow plenty of time to meet new people: PhD candidates who just started their research, professors with years of experience, practitioners from the industry – try to get a good sample of the population of the conference. If you travel with a number of people from your research group, resist the temptation to only hang out with people you know. Avoid the trap of only interacting with other PhD students. Sure, some senior professors can be snobbish (I've had a fair amount of belittlement at conferences because of my gender), but the vast majority of professors are actually very accessible, and happy to talk about their work – just as we all are passionate about our research.

   2.3. **The exhibition**: Conferences that have strong ties to the industry feature an exhibition hall with companies presenting their work. Most conferences with an exhibition bring their coffee breaks and lunches into the exhibition hall. Use this opportunity to get an idea of what is happening outside the walls of academia, and to get in touch with industry partners (always good for after your graduation, or if you need contacts for ordering lab equipment or software licenses). Some conferences also provide a space in the exhibition hall for presentations from the attending companies. Try to attend some of these presentations if your schedule allows, to get an idea of the applied research many companies carry out. Talk to industry representatives to learn about the main challenges your industry is currently facing, and to get some ideas for future research projects to address these challenges.

3. **Step 3: The aftermath – 1 week**

   3.1. **Getting in touch – 2 hours:** Place all the business cards you've collected at the conference on your desk, and go through these. See if you can find your new contacts on LinkedIn for an easy way of connecting and staying in touch. If someone is not on LinkedIn, send him/her a short e-mail to let them know you enjoyed getting to know them, and perhaps to follow up with a technical discussion you had by sending some of your recent material. LinkedIn makes keeping in touch easier, as it will remind you of birthdays and job changes, which are a good time to get in touch and ask how your contact is doing. Staying in touch by e-mail can be a bit more challenging, but typically the start of a new year or the start of a new academic year are good times to write to people you haven't heard from in a while.

3.2. **Expense report – 2 hours:** Depending on the system your institution uses for financing conference travel, you will have to do administrative work of some kind after the conference to justify the advance payment you received, or to receive a reimbursement. Some fun tasks here include pasting all your receipts on paper, scanning these pages, and sending the overview to the finance department of your institution for reimbursement.

3.3. **Reconnect to the lab – 1 day:** Plan one day to test the waters when you return. Catch up with all people involved in your projects to see what you missed. If some elements need your immediate attention, solve the problems as soon as you can. Talk to your fellow PhD students to see how they've been while you were gone. Share your conference trophies with your colleagues: announcements for conferences and workshops, the conference proceedings, and any interesting information you learned about at the conference.[2] Start cleaning out your mailbox.

3.4. **Tired? – 1 week:** Conferences are exhausting: you are learning and studying many hours a day, with limited time to reflect on all the new material, and then your evenings are booked full with either more sessions or with social events. Traveling to conferences, especially when having to take red-eye flights and/or traveling to different time zones can be an additional burden on your body. You'll notice that you are just a bit more tired when you return from a conference, and that your head may feel really full. Allow yourself some rest, keep some evenings to yourself, and take time to let all the new information and impressions sink in.

10.4.2 Plan Your Activities to Get Ready

Let's look at all the steps you go through when planning to go to a conference. You may think that all you need to do is book your ticket and go. But in reality, there are a few more steps to think about. Keep in mind for your planning that you will need time after the conference for the aftermath we discussed earlier [4]. As part of the preparation before a conference, and the unavoidable administration related to all this, there are a number of activities you should keep in mind – you don't just "show up" to a conference and assume it will all work out:

- **Request a travel budget:** A conference is work, and there should always be financial assistance for traveling to, and assisting conferences. While the idea persists in some institutions that conferences are just academic holidays, and that you should fork out most of the money yourself if you want to attend a conference, most universities provide their students and faculty with financial support to attend conferences. By all means, I think it's almost criminal to ask an underpaid PhD student to pay a registration fee of 1000 USD at a conference. Every university has a different system for providing financial aid to assist conferences. Some universities have an online system in which you request permission if you can show that your project has travel funding, other universities require you to write a letter to an Important Person in the institution to get funding, and then you need to hope that this person likes you and/or is having a good day.

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[2] And if you want to make everybody happy, share some of the free pens you scored and typical candies from the country you travelled to.

- **Book in advance:** Most conferences have reduced early-bird registration fees. If you have all your permissions on time, try to book as early as possible. Flight tickets and hotel registrations are also cheaper if you book in advance, and you will avoid the unpleasant surprise that all flights and hotels close to the conference are booked full. Booking early is part of being well-prepared; but sometimes it takes months for your travel budget permission to come through and you have to improvise last minute. Such is the reality of the bureaucracy of academic institutions.
- **Plan your downtime:** As mentioned before, conferences are exhausting. Traveling can wear you out physically, and all the new information tires you mentally. When you set up your conference schedule, make sure you plan some downtime.[3] See where you can fit in a run or walk, or when you can try out the swimming pool of the hotel. Outline a few fun activities for the place you will be visiting: look up restaurants to try out, select a museum to visit, or plan to spend an evening catching up with friends who went to study elsewhere and who happen to attend the same conference. If your conference is organized in a beautiful historical city, don't pack your schedule so tightly that all you'll be able to say afterwards is: "It looked like a nice place – I'll have to go back there in the future with more time." Trust me on this one, you'll never have "more time". Some conferences do their best in taking you out to dine at a beautiful location, so you get a taste of the city. Even if your schedule is tight, try to find a few hours to see something of the city you are visiting. A good strategy is to arrive early: having a bit of air in your travel schedule can be a lifesaver in case you miss a connecting flight, and if all goes well you'll have some time to recover from the long flight, register for the conference, and walk around the city. Especially when you need to travel long distances or during winter months, make sure you have a day of buffer. I once almost missed the first day of a three-day conference because a flight delay made me miss my connection. I was then placed on a waiting list, and was lucky enough to get the last spot on the last flight of the day. As a result, I had to pick up my badge on the first day of the conference, where I discovered something went wrong with my payment and I was actually not registered. The whole mess of figuring out with my university what happened, and then paying the on-site registration fee myself made me lose the entire first morning of the

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[3] We are all different and our needs for downtime differ.

conference. Let my bad experience be a lesson for you: always plan a buffer day when you have to travel a long distance. Think cost-benefit: paying one night extra in a hotel is still cheaper than missing a day of conference.

- **Have your presentation ready:** If possible, upload your presentation to the conference website before you leave. Then, check your presentation on the day of registration in the speaker ready room to verify if everything is functioning properly, especially video material. If you made your presentation in an older software version, or in a different package, your slides suddenly may look as if everything has been moved around – always check your presentation in the speaker ready room before you face unpleasant surprises on stage. You don't want to spend valuable conference time in your hotel room while you are making your presentation. Go to the conference with your presentation ready and practiced. After all these years of conferencing, I still make my presentations at least three weeks in advance, so my coauthors can check it, and so that I have time to talk through my presentation a few times before traveling. Check and double-check the amount of time you have for presenting – nothing is as annoying as a speaker who seriously runs over time, for the audience, the next speakers, and the session moderators. It gets even more annoying when everybody is looking forward to the coffee or lunch break to relax a bit. If you have four presentations in an hour, don't make the rookie mistake of thinking you have 15 minutes for your presentation – go for 10 to 12 minutes. You need to factor in the time required between speakers for announcements and introductions, and enough time for questions after your presentation.
- **Back-up all your material:** On your last day before traveling, reserve some time to print out all your confirmations: boarding pass, travel insurance information, hotel reservations, and conference registration confirmation. Figure out how to get from the airport to the hotel with public transportation if possible, to avoid the cost of a cab. Print out your slides and a copy of your paper to revise your material. Copy all information you have (e-mails about the conference, your paper, presentation, and all relevant documents) to a flash-drive for emergencies. Make a cloud backup additionally if you can. Decide which device you will take with you (laptop and/or tablet), and see if it can fulfil all the tasks you need it to perform during the conference. These tasks usually are limited to taking notes, replying e-mails, opening PDF files, and looking up directions and places to eat.

10.4.3 Prepare Your Outfits

The opinions on how important your outfits are during a conference range from "nobody cares" to "first impressions are everything". Especially for graduate students it can be difficult to balance professional attire and wanting to be taken seriously at the game of academia with personal taste and youthfulness. And honestly, if you are a young woman in STEM, people will judge you. I'm writing this paragraph not to tell you exactly what to wear, but to help you navigate personality and professionalism in a way that makes you feel comfortable and confident at a conference.

When you pack your bags for a conference, travel as light as possible: your conference clothes, a spare shirt in case you spill your coffee, workout clothes (an extra motivation to really squeeze in a bit of movement while you travel), and comfortable clothes for your flight. If you need to sleep on a flight, think comfort above everything else. Avoid anything with buttons that can push into your skin, and avoid short shirts – they'll hike up during the flight, you'll get cold, and the cold can wake you up.

If you are traveling abroad, check the weather forecast to know if you should pack an extra coat or an umbrella. Keep in mind that conference venues can have a very different climate than the outside world. If you are traveling to a snowy city in January, the heating may be switched on, and you get grilled alive. On the other hand, traveling to the desert in summer does not mean the conference venue will be hot inside; the AC might be set on arctic. When in doubt, take layers of clothing [5].

The clothes you need for a conference depend on your field. I've read that it is common in a number of research fields to show up in shorts and flipflops at a conference. In my field, on the other hand, it is mostly suits (not always ties). If you're not sure how formal the dress code of your conference will be, ask a fellow PhD candidate who went to the conference before. If nobody knows, look at the website for photographs of previous editions to get an idea of the atmosphere. By all means, when you are a young graduate student, don't dress like someone in their forties, but also don't give the impression of being the lost student. Advice on what to wear in academia and at conferences is scarce, but many younger PhD students have taken me aside to whisper in my ear "What should I wear to this conference?", so it's a topic we should address. The few articles online with advice on what to wear in academia and at conferences focus on being neutral, and on almost disappearing into the background. While black, navy, and grey are safe choices, I'm not convinced that they are the best choices or the only choices you have.[4]

Your conference clothes should be comfortable. You shouldn't be wearing something because you think you have to fulfil a certain ideal. You should wear something because you like it. Use the colors you gravitate towards naturally. If you think you should stick to a suit in a neutral color, you can still wear something more colorful underneath if you usually prefer colorful clothing. If you are in full doubt about what works for you, borrow some clothes from a friend, parent, or sibling (if you wear the same size, of course) to try out some more professional clothes. If you live on a limited budget, go to a thrift store and sift through the items to find some great conference picks.

Let's now look in detail at a few basic pieces that you will need as a male graduate student when you travel to a conference:

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[4] An excellent source is the website "Stylish Academic".

- **Dress shoes**: Unless your conference is full of people on flipflops, you will want to wear a comfortable, clean[5] pair of dress shoes at a conference. Dress shoes look better under slacks than sneakers.
- **Belt**: Avoid the sagging pants problem and wear a simple belt. Bonus points if your belt matches your shoes.
- **Socks**: You'll need them; especially if your walk from the hotel to the conference venue is about a mile long and you haven't been wearing your dress shoes much before.
- **Pants**: Either suit pants or slacks work. A nicely fitted and tailored pair of jeans (not the jeans you wear to the lab, of course) can work as well. Have your pants hemmed if they are too long.
- **Shirt**: Be authentic in your choice of shirt, and select a color that feels good for you. As long as your shirt is the right size and properly ironed, it will look fine.
- **Tie**: Only if you like wearing a tie should you wear a tie. If you're not into ties, you still have over 40 years of career in front of you in which you, at some point, may want to wear a tie.
- **Jacket**: Go for something you like, whether that be a suit jacket, a suit separate, a corduroy jacket, or tweed with elbow patches. The most important part here is the fit. If the fit is right, it will look and feel right. If you are not sure about your fit, go shopping with a friend to ask how something looks on you, or, if you can afford it, go to a boutique store and get something that fits and is altered to your body. If you don't want to wear a jacket because it is warm enough, then just a shirt is fine. If you are not so sure about wearing a jacket, a classic sweater can go a long way as well.
- **Bag**: Invest in a good bag for your laptop if you want to use your laptop at the conference. Your old and torn backpack is fine for the flight, but may not be the right item to wear with a suit at a conference.

Let's look at some basic pieces for female PhD candidates. First off – you have a lot of options. Start from what you like wearing. Are you usually in jeans, then go for pants. Do you prefer skirts and dresses, then stick with skirts and dresses. Look for items in colors that you like, so that you can feel comfortable and at ease. Here are some basic pieces to look for when shopping for conference clothing:

- **Comfortable shoes:** If you always wear lab shoes or sneakers, don't assume you will be able to run around for days at a conference on high heels. Look for something comfortable and stylish: either a fine pair of flats (as long as you've been wearing them before to avoid blisters), or a pair of moderate-height heels.
- **White blouse:** If you like wearing colorful skirts, you can combine this with a classic white blouse. Make sure the blouse looks crisp and has no signs of wear and tear, fits properly at the shoulders and waist, and does not bulge at the buttons. Getting the right fit can be quite a challenge.
- **Suit:** If suits are the staple in your field, invest in a good suit. Choose if you prefer pants or skirts, and get the right alterations. If you're in doubt about what

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[5] Shine your shoes.

to wear for a conference, take a suit. You can always style it in different ways: more conservative with a standard white blouse, and more personal with a colorful top and chunky jewelry, or a colorful scarf.
- **Jackets:** Jackets are the workhorses of my wardrobe at conferences. Add a jacket to an outfit, and it's immediately more dressed up. As always, pay attention to get the right fit at your shoulders and waist, and avoid bulging at the buttons.
- **Cardigan:** In warmer weather, or when you don't feel like putting a jacket, a cardigan can be the necessary layer for going from outside temperatures to AC-cooled inside temperatures. Alternatively, a large scarf can have the same function.
- **Tops:** As a graduate student or young professional, a more casual or colorful top can look great under a suit or with slacks and a cardigan. If you usually like clothes with print, look for printed tops to add a pop of your personality to your outfit.
- **Conference dinner dress:** Fancy conference dinners with a dress code have often driven me to despair. Am I supposed to dress like the men who attend to conference and stay in my suit for the evening, or am I supposed to dress like the wives who show up in their long gala dresses? Sometimes, I don't have time to change and simply go in the suit I was wearing the entire day. Sometimes, I pack a separate dress for the conference dinner. If you want to pack a conference dinner dress, follow your personal taste. I like knee-length printed dresses, as this style compares best to my regular clothes.
- **Opaque tights:** If you wear a skirt or dress, you'll need tights. Depending on your field and the weather, bare legs typically are uncommon. Opaque tights have the benefit that they are a bit warmer and less transparent.
- **Big purse:** Unless you want to carry your purse, and the conference bag, and a laptop bag, all at the same time, look for a big purse or tote bag. Make sure your purse fits your laptop, the book of abstracts, the program, and all the other items you want to jam into your purse.

10.5 Getting Most Out of a Conference

10.5.1 Navigating the Conference Schedule

Learning how to make sense of the conference schedule can be an important part of preparing for your conference. The largest conference I attend annually draws about 11,000 attendants, and has a conference schedule the size of a book. As you can imagine, at such a conference you don't just show up and wander into a random room to see what's up. Read the conference website carefully – many conferences offer smartphone applications or applications on their website to help you create your conference schedule. If that's the case, then by all means take advantage of these tools. If you haven't traveled to a certain conference before, and there are a multitude of parallel activities, then you will need to sit down for an afternoon and look through everything that is happening at the conference. When you return to this conference, you will know which technical committees organize the events you are interested in.

When you are looking at lectern and poster sessions, don't only read the description of the session. Often, the conference organizers identify the session topics first, and then fill these with papers as they see it fit. As mentioned before, sometimes the paper topics divert from the main topic of the session. Always check the paper titles and abstracts to select which session you want to attend.

If a conference combines sessions and workshops with their technical committee meetings, and if these meetings are open to the public, take advantage and attend such meetings. As you learn about the work of the committee, you may feel like you have interesting material to share. Don't interrupt during the meeting, but talk to a committee member after their meeting if you want to share some of your material with them. These interactions often can be the beginning of your future involvement with these committees.

When you are traveling to a conference for the first time, try to leave some air in your conference schedule to rest or explore the city. While your main goal of attending a conference is of course being at the conference, days from eight am to ten pm of technical content can be brutal. Enjoy a bit of air when you are still a PhD student – as you start to return to conferences and advance your career in science, your schedule will only be more and more packed, as you will need to squeeze in more scheduled meetings, catching up with colleagues of other universities, and perhaps even using the opportunity to work on something with a collaborator who lives on the other side of the world.

10.5.2 Navigating the Attendants

If a conference publishes the list of attendants, go through this list to identify who you want to meet. If you want to meet a senior scientist from the scientific committee to discuss your work with him/her, see if you can ask for a short meeting by sending an e-mail. If you never get a reply, don't feel offended – you wouldn't want to take a look into a professor's overflowing mailbox where everybody is demanding actions and reactions from him/her. If you do get a reply, try to schedule just a short meeting, for example during a coffee break, so that you don't demand a too large time investment. If you want his/her feedback on your work, prepare some short information to show during the meeting. A few slides, or a short overview document could be useful here.

Avoid only hanging out with your friends and peers at a conference. Try to sit at a table where you don't know anybody for lunch or for the dinner to meet new people. Sometimes, you'll find that you ended up in the middle of a group of colleagues who only interact among each other in their native language, but most of the times, you'll get the opportunity to make new contacts. During the coffee break, look for somebody who is standing alone at a table to have a chat. If you enjoy a conversation with someone, then tell him/her that it was a pleasure to talk to them and give your card to stay in touch.

If the conference has an exhibition, don't forget to stop by and get in touch with people from the industry. Striking up a conversation with exhibitors is always easy, as you immediately see what they work on, so you have a topic to ask questions about. If you are reaching the end of your PhD, you can mention this. You'd be surprised to hear how often to exhibitors will tell you that they have job openings, and that you should have a look at their website or send them a follow-up e-mail.

10.5.3 Interacting During Sessions

If the imposter syndrome has you in its claws, you may feel insecure about asking questions during sessions at a conference [6]. You may worry that you are perhaps asking a stupid question, that you may sound aggressive or belittling, or that you will leave a bad impression on the senior scientists in the room. If you are an introvert, you may prefer written interaction over talking. I prefer to grind away in the shadows and remain unseen, but I've learned that this approach can get in my own way. Therefore, I developed a strategic plan on how to get better at speaking up and asking questions during sessions. If you feel an interior barrier to asking questions, here are three things you can try:

- **Practice small:** if speaking up and asking questions comes to you as a challenge, then start small. Don't try to force yourself to raise your hand during a large annual symposium in your field. Start by getting comfortable asking questions during presentations at your own university, and at meetings of groups in which you feel at ease. By starting small, you will learn that you won't get decapitated when asking a question. Based on this experience, you can slowly start to build up the confidence to move forward and raise your hand at larger gatherings.
- **Interact after the session:** If raising your hand during a Q&A session is not for you, you can approach the presenter after the session to ask your question. You can interact with just the presenter, away from the piercing eyes of the audience. It can happen that the speaker brushes you off, which mostly means he/she is rushing to another meeting. But most of the time, you will be met with enthusiasm, and end up chatting with the speaker for a fair amount of time. I personally prefer this type of interaction with a speaker over asking a question for a full room, but I know that both ways of interacting with speakers are necessary, and I myself equally enjoy receiving questions during the Q&A session as well as after the session.
- **Join panel discussions:** Sheryl Sandberg [7] invites women to "sit at the table", and likewise, I'd like to invite you to break out of your comfort zone and join panel discussions at conferences. Speak up based on what you have learned over the past year(s). If you've been putting in the time and work to do your research, then you know enough to participate. Don't belittle yourself: it's not because you

are just a student that your point may not be valid – in the end, you are studying a certain topic for the vast majority of your time. Participate instead of sitting and soaking up all the information. If you feel intimidated, practice by trying to speak up more at any meeting you attend.

10.5.4 Essential Self-Care

Some conferences run from eight am in the morning until midnight, including the social events, or to ten pm, with just technical content. As we've discussed a number of times already, conferences are exhausting. I typically notice after a conference that I suddenly need an alarm clock to wake up, just because I am more tired than normal [8]. With that said, if you've prepared months in advance for a conference, you don't want to miss out on the action because you're suddenly too tired and too overwhelmed. Try to support yourself as much as you can to get through these extra-busy days, so that you can get out of the experience what you need. Avoid placing extra stress on your body, and make a few conscious choices that enable you to go those few extra miles before your gas tank runs empty. As always, the key here is a good preparation:

- **Go prepared**: Don't arrive to a foreign airport all stressed out, trying to remember your hotel name, and needing to figure out how to get to the hotel. Have all these practical issues sorted out, and, if needed, come with printed maps to navigate your way from the airport to the hotel, and to the registration desk. Make sure you have your presentation ready – you don't want to spend the nights in your hotel room finishing up your presentation. Prepare everything you can in advance, so you can focus your concentration and energy on learning, delivering your talk, and networking.
- **Prioritize**: Prepare your schedule before the conference, and make sure you have a realistic schedule. Nobody can attend lectern sessions from eight am to ten pm, meet all the people, and visit the exhibition to network with the industry. Before traveling to the conference, take a few moments to list your priorities. Who do you need to talk to? Which company should you visit at their booth in the exhibition hall? Which sessions do you want to attend? When should you schedule to go for a drink with acquaintances? You can also add different levels of priority to your schedule. For example, you can give top priority to the session that you really want to attend, and a lower priority to sessions where you would like to go, but that you can skip if you feel a bit tired and need to recharge.
- **Make conscious food choices**: If the conference offers a buffet, try to compose a nutritious meal for yourself. I've once been to a conference that offered a dessert buffet for breakfast, lunch, and dinner – and I simply prioritized cakes over nutrition. Needless to say, I stormed through that conference on a sugar and caffeine high, and crashed like no other afterwards. Don't overdo it with coffee at a conference. I'm not saying you should only sip herbal tea and green juices, but replacing a coffee once in a while with a healthier choice will go a long way. You

don't have to steer away from the dessert buffet, but make sure you get in your nutrients from the appetizers and main courses first. By all means, a conference is not a place to put yourself on a strict diet and live like an ascetic (unless you have to do so for health reasons). Just make sure you get your required (micro) nutrients before you dive into the coffee, alcohol, and sugar.
- **Exercise**: Pack your sports clothes, and exercise! Look at your conference schedule, and try to identify when you have time to squeeze in some exercise. You don't need to wake up super early, or forego the conference dinner to work out – any time of the day when you can free up some time will do. A conference involves a lot of sitting, so the best treat you can give yourself is exercise. Remember that you are not limited to the treadmill in the hotel gym – you can go for a run outside to see more of the city you are visiting, do an interval training on the treadmill in the hotel gym, compose a varied strength-training workout with the limited equipment in the hotel gym, do a bodyweight workout or a yoga sequence in your room, or go for a swim in the hotel pool. Make sure you find time for movement for at least 15 minutes every day.
- **Find some quiet time**: If you feel that fatigue and overwhelm are starting to get a hold of you (and remember, each of us is different in that regard), try to withdraw from the noise and hustling for about half an hour to read, sit in the sun, take a nap, or do whatever feels right for you at that moment. Half an hour is a short amount of time, but taking this time for yourself may be exactly what you need to keep going again, and may work better than another double espresso and forcing yourself to push through.

10.6 Summary

In this chapter, we looked at all the aspects related to preparing for, traveling to, and attending conferences. We first looked at which conference you should attend, and which topic you should present there. If you think you have nothing to show at a conference, we've looked at a number of topics that are suitable for a conference paper, and that you could develop for presentation at a conference. Once your abstract is accepted, it is time to start preparing for the conference. We've discussed all the elements that are part of preparing for a conference that you should add to your schedule. Additionally, we've looked at all additional (administrative) tasks that you need to consider so that you can plan all the activities involved with preparing for a conference. We also discussed what to wear for a conference. In a next topic, we looked at how you can get the most out of your conference attendance. Again, good preparation goes a long way. Prior to the conference, you should make your planning, and identify the people that you need to talk to. For those who feel intimidated by raising their hand and speaking up during sessions, we've discussed some strategies to tackle this fear. Finally, we discussed how you can use self-care strategies to get the best out of your conference experience.

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Chapter 11
Writing Your First Journal Article

Abstract This chapter deals with writing your first journal article. First, we discuss how to select the right journal for the publication. The audience, the impact factor and journal rankings are discussed, as well as the current possibilities and pitfalls with open access publishing. Then, we look at planning the writing of a journal paper, and finding time for writing. The elements of writing a good abstract are discussed, and the popular method from PhD Talk on "Writing an abstract in 30 minutes" is explained. Then, we discuss the review process, including the timeline of reviews, and how to deal with reviewers' comments. You learn how to write a comprehensive reply to the comments of the reviewers to increase your chances for publication. Then, we look into dealing with rejection. Most journals only accept about a third of all submitted manuscripts. Therefore, rejection is quite normal. We discuss how to rework a rejected paper for submission to another journal. Finally, we look to the future, and how to juggle a number of papers in different stages of the writing and publication process.

Keywords Journal article · Journal publication · Academic writing · Publishing · Planning · Rejection

11.1 Introduction and Learning Goals

The goal of this chapter is to discuss the steps that are required to turn your research into your first journal paper. We discuss all the steps that lie between finishing the actual research, and having a paper about the research published. First, we need to discuss where you can publish your research, and you will learn how to select the right journals for possible publication of your work. As always, we discuss the importance of planning your work in order to get your work done: in a first instance, to write your first draft version, and in a second instance to discuss this draft with your coauthors, and finalize the draft version for submission. As an abstract is an important part of a paper, we discuss what makes a good abstract, and how you can quickly write a good abstract. Then, we discuss the review process, and how to deal with the comments of reviewers. Again, we start from the concept of planning your work, and then discuss the steps required until submission of a revised manuscript. We also discuss the reality of rejection of academic work, and how to move forward after getting a rejection.

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Finally, we will look towards the future, discussing your next papers and how you can work in your academic career towards a constant output of journal papers.

11.2 Selecting a Journal

11.2.1 Audience of a Journal

A first factor to consider when selecting a journal is the audience of the journal. There are two ways of determining if the audience of the journal is the audience you have in mind for reading your work.

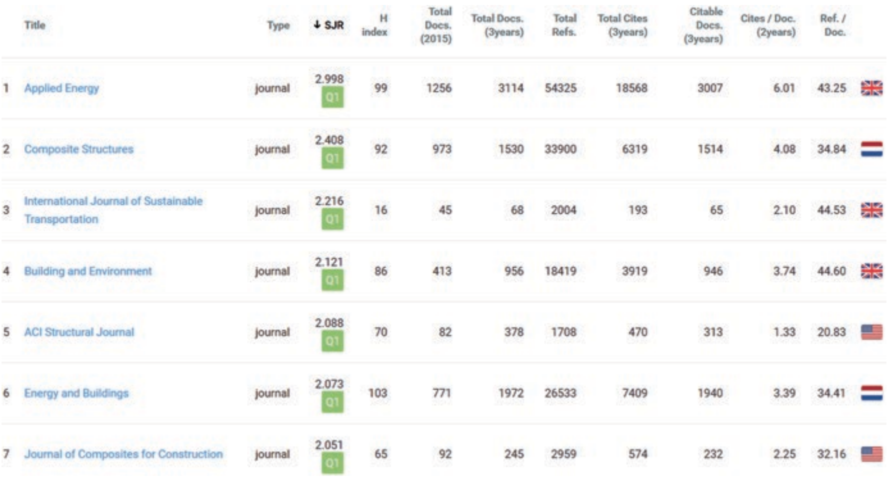
The first method is by identifying who publishes the journal. The publisher can be a large publishing house such as Elsevier, Springer, Wiley, or Taylor and Francis, to name a few of the big guys, and in that case the publisher won't tell you much about the audience of the journal. However, if the publisher of the journal is a professional association, you know more about the readership of the journal. For example, the two journals that are published by the American Concrete Institute are read by the members of this institute, and a subscription to one of the journals is included in the membership of the institute. Some professional associations pair up with a large publishing house to streamline their digital workflow. In these cases, you can find the journal and submission page for the journal on the website of the publishing house, but the description of the journal will clearly say that this is the journal of a certain professional association.

A second method is by reading the journal description on the journal's website. This description will mention the aim and scope of the journal. While this description often does not directly mention the audience, the aim and scope will list the areas of research that are covered by the journal. And from the areas of research, it is easy to find out the audience. For example, if the area of research is infrastructure engineering, the audience will be infrastructure engineers. The audience of journals that are not published by professional associations is typically more academic, unless the publications are open access. While you as a PhD student may take your library access for granted, many practitioners in the industry or scholars at less privileged institutions don't have the same library access. They may only receive the journals that come with the membership of professional associations, for which they often have to pay themselves.

11.2.2 Impact Factor and Rankings

A second factor to consider when selecting a journal, is the relative importance of this journal. This relative importance is usually expressed by the impact factor of the journal, and by the journal ranking.

The impact factor is calculated based on the ratio of citations to publications in a given year. The higher this value, the more important the journal. You should only compare impact factors within your field – it does not make sense to compare to other fields: if you are doing research in architecture, you won't publish in Nature,



	Title	Type	↓ SJR	H index	Total Docs. (2015)	Total Docs. (3years)	Total Refs.	Total Cites (3years)	Citable Docs. (3years)	Cites / Doc. (2years)	Ref. / Doc.	
1	Applied Energy	journal	2.998 Q1	99	1256	3114	54325	18568	3007	6.01	43.25	🇬🇧
2	Composite Structures	journal	2.408 Q1	92	973	1530	33900	6319	1514	4.08	34.84	🇳🇱
3	International Journal of Sustainable Transportation	journal	2.216 Q1	16	45	68	2004	193	65	2.10	44.53	🇬🇧
4	Building and Environment	journal	2.121 Q1	86	413	956	18419	3919	946	3.74	44.60	🇬🇧
5	ACI Structural Journal	journal	2.088 Q1	70	82	378	1708	470	313	1.33	20.83	🇺🇸
6	Energy and Buildings	journal	2.073 Q1	103	771	1972	26533	7409	1940	3.39	34.41	🇳🇱
7	Journal of Composites for Construction	journal	2.051 Q1	65	92	245	2959	574	232	2.25	32.16	🇺🇸

Fig. 11.1 Overview of Scimago journal rankings for civil and structural engineering

and the impact factor of Nature is not relevant to you. Moreover, some journals try to use certain tactics to amp up their impact factor.

A good reality check is to see if you have been reading articles from the journal you are considering. If you have, submitting your work to this journal is a good move. If you have not, check out a few of the most recent issues of the journal, and carry out a search on the keywords of your research on the journal website. If nothing really interesting comes up, then probably your work is not the right fit for the journal – leaving the impact factor aside here.

Another way to find the relative importance of a journal is by looking at its standing in the Scimago Journal & Country Rank [1]. You can see an example of the rankings of 2015 for civil and structural engineering in Fig. 11.1. This ranking is based on a slightly different metric, the SJR, which is based on the weighted average of citations in a certain year by the documents published in the three previous years. Based on this metric, a journal is also categorized in a certain quartile. If the journal belongs to the top 25% of journals in its field, it will be classified as a Q1 journal. Similarly, a Q2 journal sits in the top 25–50%, whereas a Q3 journal ranks between 50% and 75% and a Q4 journal lower than 75%.

When you are determining possible journals for submitting your work to, don't focus on one single journal. Instead, make an overview of the journals that are relevant for your research. Look at the journals that you are reading, look at the journals of professional associations of which you are a member, or that are relevant for your field, and look at their impact factors and rankings. You can make an overview table of interesting journals. An example of such a table, for journals relevant for my research and related topics, is shown in Table 11.1 [2]. You can immediately see from this table that the journals related to structures (for example, the ACI Structural Journal) tend to have a lower impact factor than the journals related to concrete materials (for example, Cement and Concrete Composites). Even though both research fields are closely related, you can see that, depending on your research

Table 11.1 Example of list of journals relevant to research on reinforced concrete bridges, values of 2015

Journal	IF	SJR	Quartile
ACI Structural Journal	1.03	2.088	Q1
Transportation Research Record	0.556	0.474	Q2
Journal of Structural Engineering (ASCE)	1.63	1.431	Q1
Journal of Bridge Engineering (ASCE)	1.39	1.038	Q1
Magazine of Concrete Research	1.50	0.955	Q1
Structural Concrete	1.023	0.874	Q1
Advances in Structural Engineering	0.83	0.475	Q2
Beton- und Stahlbetonbau	0.16	0.493	Q2
Cement and Concrete Composites	4.37	3.017	Q1
Construction & Building Materials	3.27	1.606	Q1
Engineering Structures	2.54	1.813	Q1
Materials and Structures	1.76	1.136	Q1
Journal of Performance of Constructed Facilities (ASCE)	0.70	0.582	Q2
Heron	0.00	0.282	Q3
Structural Engineering International	0.299	0.339	Q2
ICE – Bridge Engineering	0.19	0.212	Q3
Structures & Infrastructure Engineering	1.11	0.699	Q1
Structural Control and Health Monitoring	2.51	1.549	Q1
Structural Safety	2.72	1.609	Q1
Computers and Structures	3.24	1.71	Q1

topic, it may not make sense to compare the journals you are (trying to) publish in to the journals in closely related fields. You may also see in Table 11.1 that, since the impact factor and SJR are calculated differently, the rankings based on both metrics become different. There's not a single way of quantifying which journal is the "best" one. Use the impact factor and similar parameters wisely, as one of the many tools to select the right journal, but not as the only element for selection.[1]

With this discussion about relative importance of journals and impact factors, you may be wondering if you, as a little PhD student, can publish in high-impact journals [3]. You may be wondering if you should focus on publishing as much as possible, but only in low-impact journals? In general, a lot of the acceptance of a paper in a certain journal depends on the reviewers. It has happened to me that I have submitted a paper to one journal, and got rejected. Then, I decided to resubmit it, to a journal with a higher impact factor, and got an acceptance after only one round of reviews. The system is not always equally logical. Most of the time, I submit first to the journal in which I'd love to see my paper published (and that is not always the journal with the highest impact factor!). If the work gets rejected, I will rework the manuscript and submit it to a similar journal, that has slightly less of my preference. Don't shy away from submitting your work to certain journals – in the worst case you'll get a rejection with some stingy comments, in a slightly less worse case, you'll get a rejection with useful comments, and in the best case it will get accepted. Aim high when you submit. Don't settle for the low-hanging fruit (although, arguably, a journal paper never is a low-hanging fruit, and especially not your first journal paper). Encourage yourself to go the extra mile and try to get your work up to the standards of your favorite journal.

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[1] Unless your institution or supervisor explicitly asks you to do so.

A final aspect to consider when you decide where to submit your work, is the estimated time it takes between submission and review, and between acceptance and publication. If you need your publications to start to apply for grants, scholarships, and post-doc positions, you may want to find journals that have a faster publication track. For some journals in my field, it is not uncommon to take two to three years between first submission and publication, which can be a serious disadvantage when you need the build up your publication record. Moreover, if you receive reviewers' comments after a year, you will be scratching your head to remember what the paper was originally about. Other journals, especially those managed by large publishing houses, have shorter review and publication cycles. The speed record in my field is a journal where after acceptance of the paper, the publishing house immediately takes matters into hands to develop the proofs, and the paper is published online ahead of print shortly afterwards.

11.2.3 Open Access Publishing

Most scientific journals are only accessible if you have a library subscription. If you are lucky enough to be working at a large, first-world institution, access to scientific papers is typically not an issue for you. If, on the other hand, you are not working at a privileged institution, you may feel desperate if you run into a paywall again. The basic idea of open access publishing is taking away the paywall and making sure the paper can be downloaded without restrictions or required library subscriptions.

When you chose to publish your paper in an open access journal, there are possible types of open access you can encounter. The first type of open access journals is fully organized by volunteers, possibly with some funding of a professional organization or higher education institution to pay for the website hosting and small costs. This type of journal does not make profit, and publishes all papers on a website where no library access is necessary to download the papers. The second type of open access journals is the most common type, where the journal charges the cost of publication to the author. Upon publication, the article will be freely available for downloading by all visitors to the website. Library subscriptions are not necessary. As such, the income the publisher usually has from the library subscriptions is now replaced by the publication fee paid by the author. For many authors, however, the publication fee can be hefty: between 500 USD to 5000 USD, depending on the journal.[2] This money goes to the employees that work fulltime for the publishing house, for example the employees that make the proofs of your paper, and also goes into the profits of the publishing house. The authors, reviewers, and editors of scientific journals are volunteers, and never get paid for their work. In some cases, the publishing house will offer a discount on the open access fees to reviewers and editors of the journal.

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[2] Some institutions or countries have agreements with publishers so that these fees for the authors are waived. Do look into what is available at your institution and country. Ask your library for the institutional policies and targets for open access publishing.

With the increasing popularity of the open access publishing model, a number of so-called predatory journals have entered the market. Just as with fake conferences, the only goal of a predatory journal is to cash in the publication fee of authors for profit, without the normal rigor of the peer-review process. If you just published a conference paper, and a journal you never heard of approaches you to ask you if you want to resubmit your conference paper as a journal paper, it is most likely a predatory journal that sniffed out you published a conference paper without a copyright transfer form. In some cases, however, it can be the journal of the professional organization of the conference that is inviting you for their journal. In case of doubt, check the website of the journal, see which professional organization they are affiliated with (if any), check their editorial board, and see from which country the journal is operating. If the website has poor grammar, that's a red flag for a predatory journal. Another typical case of a predatory journal is a journal that welcomes submissions from pretty much any topic, or a journal that describes itself as the "best" journal. If you have doubts about the quality of a journal, just Google "name of journal" with "predatory journal" and see what shows up, and to learn if other authors have been duped by the journal in the past.

Exercise

1. Go through your literature managing software, and write down the names of the journals from which you have read papers. Write down the names of journals issued by professional organizations in your field. Once you have a list of potentially interesting journals, make a table like Table 11.1, in which you write down the impact factor, SJR, and quartile of the journal. Keep this table as a guide to help you decide in which journals you should aim to publish your work throughout your PhD and in the years after your PhD.

11.3 Planning Towards Your First Draft

11.3.1 Finding Time for Writing – Slow and Steady

When it comes to writing journal papers, planning is key. During your PhD years you perhaps can still pull it off to set aside a few days or weeks, perhaps in the summer when nobody is in the lab, to get your manuscript out. However, you won't be

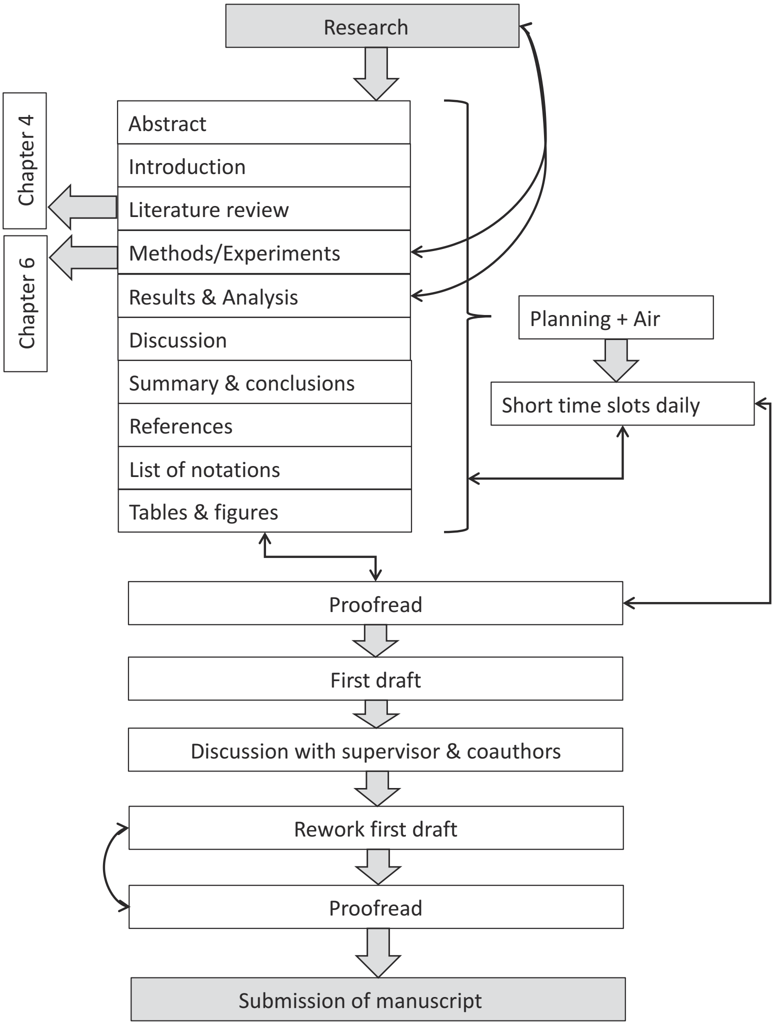
Research
Chapter 4
Chapter 6
Abstract
Introduction
Literature review
Methods/Experiments
Results & Analysis
Discussion
Summary & conclusions
References
List of notations
Tables & figures
Planning + Air
Short time slots daily
Proofread
First draft
Discussion with supervisor & coauthors
Rework first draft
Proofread
Submission of manuscript

Fig. 11.2 From research to the submission of a journal paper

able to use this trick later in your career. Once you start teaching, supervising students, and juggling a number of research projects, with service appointments and other duties, you need a different strategy for writing. The tried and tested method is slow and steady: reserve a few hours a day to work on your paper, and plan accordingly. You can find an overview of the process from research to the submission of your manuscript in Fig. 11.2.

You may want to postpone writing your first paper until you have finished the experiments you are currently working on, but if you keep postponing your writing, you'll never get to the point of having a finished draft [4]. Make writing a priority.

For finishing your PhD, writing your dissertation and/or your journal papers is what will determine your graduation. For your future academic career, your publications are the most important parameter. Even if you decide to go to the industry, I would still encourage you to keep involved with research and publish on a regular basis.

The key point is that you'll only find time for writing if you make time for writing. Set aside an uninterrupted time for writing each day, and make it a priority. When making your planning, reserve that time for writing. For most people, writing first thing in the morning works. Some scholars prefer to get in a few hours of writing from their home office before going to campus. I, too, write from my home office or the office of the company where I work as a consultant before showing up to campus when I am in Ecuador.[3] When I am in the Netherlands, some mornings I need to start in the lab right away, or I sit with my colleagues to catch up first. Nonetheless, I make sure that at some point during the day, I fit in my writing.

The amount of time you can reserve for writing each day varies widely. If you are a PhD student, and you don't have any experiments going on, you may be able to write for as many hours a day as you want. Don't try to write for eight hours – you'll just end up procrastinating. Two slots of two hours, on the other hand, may be feasible. Keep in mind that many tasks count as writing: typing words, making figures, sorting out the references you need for the paper, and proofreading/editing. Don't try to force yourself to type words for many hours on end in a given day – you'll end up dreaming about words appearing on a white screen. If you are working in industry, 30 minutes a day after dinner may be the only time you have available. If you are a starting professor, with a heavy course load, protecting your time for writing can be hard. But typically, you will need to publish your papers to get tenure, and to be considered for course load reduction based on your research. You may start out with ambitious plans, but if you need to develop a lot of new courses, your teaching duties will take up most of your time. When I started teaching, I had a 3-3 course load without the help of a TA. On average, I managed to write three to five days a week, for one to two hours at a time, and tried to submit six manuscripts per year. It worked, and after two years in which I had to set up five new classes, I managed to get course load reduction to two courses per semester. After another year, I got tenure, the position of full research professor, and a course load of only one course per semester. This achievement would not have been possible without the publications, and these would not have been possible without reserving time for them, each day, and working slowly and steadily towards submission.

With these warnings, you should by now have pulled your planner a little closer to see when you can free up time to work on your publications. That brings us to the next question: "How much time does it take to write a draft journal paper?" Of course, it all depends – not all papers are born equally. Sometimes putting together a paper comes very easily, because you've already done all the research, experiments, literature review, and general thinking. For some papers, you need to revisit some concepts, and find yourself in an uphill battle to write a stand-alone paper on a topic you have been working on previously. Based on my experience, writing your first journal papers will take about 40 hours, spaced out over two to four weeks. If you struggle with writing, you can space out the development of your article over 12 weeks, following the course in reference [5]. As you get more practice in writing, you will see that sometimes writing a journal paper takes only 12 hours, spaced out over one to two weeks – not on a single day; the key is to write in short blocks of time so that you can be fully focused. In case of need, it is possible to write a paper (typically a conference paper) in two days [6], but you shouldn't be doing this too often. These numbers are only valid when you have all the experimental and calculation results, an idea of the audience, contents, an outline of the paper, and some material in research reports that you can pull from. Remember that you are recommended to develop reports and small documents for discussion with your promotor while you are working on your experiments and their analysis. If you have a dissertation chapter ready and want to turn it into a journal manuscript, you will be faced with the challenge of needing to cut a lot of words, and at the same time, making sure the paper stands on its own.

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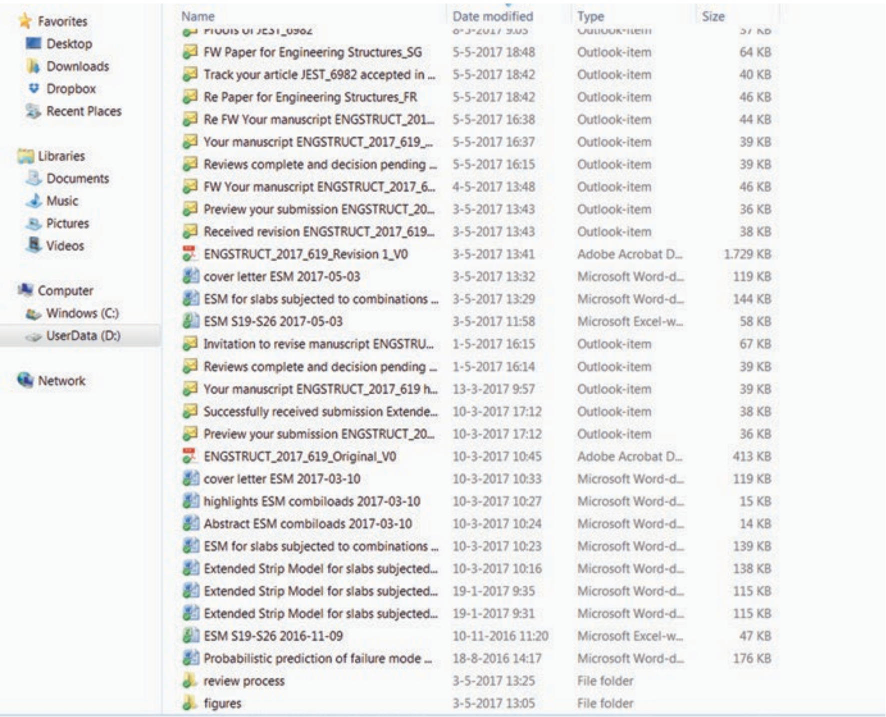
[3] Or at least, that's what I did pre-baby. Now I write from my campus office because I can't concentrate at home with the baby and I can't pump in the company office.

As mentioned previously, 40 hours for writing a first draft refers to the case where you have all experimental results and calculations ready, as well as some good text in research reports. Your main task then is to make one story out of the material, to provide the drawings, and to summarize information into tables. The second part that I mentioned is that these 40 hours tend to be spaced out over two to four weeks. You could think that 40 hours make for one fine work week, but typically you have a number of additional tasks that you need to take care of: supervising students, replying e-mails, making a small calculation for your supervisor, and meetings.

The way you divide these 40 hours depends on you and your skills. Some people are fast at putting together text, but drawing figures takes them a lot of time. I remember that for the second chapter of my dissertation (the literature review), I needed more time for drawing the figures than for writing the text. For me, drawing is an uphill battle: I'm not good at it, I don't like it, and I easily loose concentration when I need to draw. For other people, drawing comes naturally, but producing text is where they struggle. Know which element of writing is your nemesis, and make sure you reserve enough time for this.

Once you have identified the number of hours you need to add to your planning to work on your paper, how many hours a day you can reserve for writing, and have an idea of the tasks you need to carry out (i.e. write a certain number of words, make a certain number of drawings and tables, edit, write the summary, proofread, and format the references), you will be able to put these tasks on your planner. As always, leave some air in your planning: if you have a chunk of two hours for writing, plan tasks that you can realistically achieve in 1.5 hours of undisturbed time, so



Name	Date modified	Type	Size
FW Paper for Engineering Structures_SG	5-5-2017 18:48	Outlook-item	64 KB
Track your article JEST_6982 accepted in ...	5-5-2017 18:42	Outlook-item	40 KB
Re Paper for Engineering Structures_FR	5-5-2017 18:42	Outlook-item	46 KB
Re FW Your manuscript ENGSTRUCT_201...	5-5-2017 16:38	Outlook-item	44 KB
Your manuscript ENGSTRUCT_2017_619_...	5-5-2017 16:37	Outlook-item	39 KB
Reviews complete and decision pending ...	5-5-2017 16:15	Outlook-item	39 KB
FW Your manuscript ENGSTRUCT_2017_6...	4-5-2017 13:48	Outlook-item	46 KB
Preview your submission ENGSTRUCT_20...	3-5-2017 13:43	Outlook-item	36 KB
Received revision ENGSTRUCT_2017_619...	3-5-2017 13:43	Outlook-item	38 KB
ENGSTRUCT_2017_619_Revision 1_V0	3-5-2017 13:41	Adobe Acrobat D...	1.729 KB
cover letter ESM 2017-05-03	3-5-2017 13:32	Microsoft Word-d...	119 KB
ESM for slabs subjected to combinations ...	3-5-2017 13:29	Microsoft Word-d...	144 KB
ESM S19-S26 2017-05-03	3-5-2017 11:58	Microsoft Excel-w...	58 KB
Invitation to revise manuscript ENGSTRU...	1-5-2017 16:15	Outlook-item	67 KB
Reviews complete and decision pending ...	1-5-2017 16:14	Outlook-item	39 KB
Your manuscript ENGSTRUCT_2017_619 h...	13-3-2017 9:57	Outlook-item	39 KB
Successfully received submission Extende...	10-3-2017 17:12	Outlook-item	38 KB
Preview your submission ENGSTRUCT_20...	10-3-2017 17:12	Outlook-item	36 KB
ENGSTRUCT_2017_619_Original_V0	10-3-2017 10:45	Adobe Acrobat D...	413 KB
cover letter ESM 2017-03-10	10-3-2017 10:33	Microsoft Word-d...	119 KB
highlights ESM combiloads 2017-03-10	10-3-2017 10:27	Microsoft Word-d...	15 KB
Abstract ESM combiloads 2017-03-10	10-3-2017 10:24	Microsoft Word-d...	14 KB
ESM for slabs subjected to combinations ...	10-3-2017 10:23	Microsoft Word-d...	139 KB
Extended Strip Model for slabs subjected...	10-3-2017 10:16	Microsoft Word-d...	138 KB
Extended Strip Model for slabs subjected...	19-1-2017 9:35	Microsoft Word-d...	115 KB
Extended Strip Model for slabs subjected...	19-1-2017 9:31	Microsoft Word-d...	115 KB
ESM S19-S26 2016-11-09	10-11-2016 11:20	Microsoft Excel-w...	47 KB
Probabilistic prediction of failure mode ...	18-8-2016 14:17	Microsoft Word-d...	176 KB
review process	3-5-2017 13:25	File folder	
figures	3-5-2017 13:05	File folder	

Fig. 11.3 Organize all files of a paper in the folder of the paper

that you have time to drink some water, take a stretch, or go to the bathroom in your breaks. If you use the Pomodoro technique for writing, use those five minute breaks to stretch, walk around, and get some fresh air. All you need to do now, is to get comfortable, put in the work, and move your manuscript from outline to first draft. When you write that first draft, make sure you save all high-resolution versions of the figures in the same folder as your draft manuscript, as well as additional calculations you may have made. When you need to revisit this information during the review stage, you'll be happy you don't have to start rummaging through all your folders on your computer to figure out where you save the information you need. You can see an overview of how I organize all files (manuscript, calculations, figures, highlights, cover letter, review process, abstract, and e-mails) of a paper in a folder in Fig. 11.3.

Exercise

1. This exercise is for students who have all material for writing a first draft of a paper. If you haven't been able to get started on writing the paper, or if you have stalled because lab work got in your way, this exercise is for you. Estimate the number of hours you need for writing your first draft (I recommend 40 hours), and how many hours a day you can spend on writing (I recommend two hours per day). Then, identify the tasks you need to carry out. These tasks can include, and are not limited to: write the abstract, make the outline[4], put the paper in the right format, write the text (limited to a certain number of words), make a certain number of drawings and tables, edit your text, write your summary and conclusions, proofread your draft, and format the references. Once you know all the tasks you need to do for a paper, start adding these to your planning – keeping in mind that you can only plan work for about 75% of the time you have reserved. Write in your planner for each day and each timeslot what you exactly need to do. Make sure you have clear instructions. Don't say you will write for two hours. Instead, put in your planning that you will write 500 words and make one drawing. Check by which date you are expected to have your first draft ready. Hold yourself accountable by telling your coauthors they can expect your first draft by that date.

11.4 Planning Towards Submission

Once you have finished your first draft, it is time to discuss this draft with your supervisor, who will function as your coauthor. Sometimes, you will truly coauthor a document, and another author will write entire paragraphs and sections of the paper. If you are a PhD student, typically you will publish with your supervisor and perhaps one or more other members of your thesis committee, if they helped you significantly with the research presented in the paper.

In the ideal world, your supervisor is the person who teaches you to write, and thoroughly goes through your work to improve the overall structure, the structure of paragraphs and sentences, your grammar, your figures, your tables, and virtually every element of your writing you can think of. In reality, supervisors are very pressed for time, and perhaps won't have the time and energy to go through all details of your work. If you start writing your journal paper, it is best to ask your supervisor which way of working he/she prefers, and what type of feedback you can expect. You can also ask senior PhD students how their experience is in terms of feedback from your supervisor. In how much depth can you expect your work to be read, and within how much time can you expect feedback?

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[4] If outlining works for you.

Once you have an idea of what to expect as a reasonable time schedule, plan to have a meeting with your coauthors after the time they need to evaluate your draft. If they haven't had time to look at your work or forgot about the meeting, then reschedule for shortly afterwards – it helps to at least have the topic on their mind. If meetings get postponed for months on end, and your coauthor does not seem to be interested in finishing and submitting the paper, you may consider dropping your coauthor, unless he/she is your supervisor. In that case, you will just need to keep on bugging him/her with meetings and asking for feedback.

If you have collected all the feedback of your coauthors, you need to read through everything, and assess how much time it will take you to implement the suggested changes. Set asides time in your allotted timeslot for writing to make these improvements, and commit to having the revised version by the day on which you book the last timeslot for working through the comments. Then, let the paper rest for some time, say a week, and block a timeslot of two to four hours to proofread your paper. If you think everything is ready, you can move on and submit the manuscript. Make sure you reserve time after proofreading for the actual process of submitting. Uploading the manuscript and figures, adding all author information, and writing a cover letter are all elements that can take up a significant amount of time – reserve two hours to work on this.

As you will be working on more journal papers based on your research, the involvement of your coauthors can become less. Always make sure you discuss your planning for writing the paper with your coauthors, and give them sufficient time to provide you with feedback (at least two to three weeks). If you have built up a good working relation with them throughout the publication of previous papers, you can move on with submission even if you didn't receive any feedback. Don't ever submit your first journal paper without the input and feedback from your supervisors. Don't ever submit a journal paper with a coauthor you haven't worked with before without his/her approval and feedback. You can only move forward with publishing work assuming the coauthors approve of the work if you have been working constantly and intensely with them for about five years and you worked directly with them for the research.

Upon submission, you can lean back, take some time off, and celebrate the fact that you just submitted your first journal paper. The amount of time it takes to receive the comments of the reviewers varies widely among different journals. In some cases, you will receive feedback after only a few weeks. Some journals take about a year. Some journals will give you an estimate of the required time in the e-mail confirming your submission, or provide this information on their website. If you start to worry about the status of your manuscript, check the online system first. If your manuscript still shows up as "in review", then you'll have to wait patiently. If something seems odd in the system, and only if you really have a cause for worrying about your manuscript, then you can contact the editor of the journal.

11.5 Writing a Good Abstract

11.5.1 How to Write an Abstract in 30 Minutes

One of my most popular posts on PhD Talk is titled "How to write an abstract in 30 minutes" [7]. Surprisingly, it is a post that I typed out in less than ten minutes, simply documenting the technique I use for writing abstracts. The method is based on Koopman's "How to write an abstract" [8] and elements from the course in Engineering Communications [9] I took with Dr. Rosenstein at Georgia Tech.

Starting to write an abstract is scary. The abstract is the very beginning of a new paper and a new writing project. Your acceptance for going to a conference will depend on it. For a journal paper, your abstract is an important element that will be duly studied by the reviewers and that will determine if a reviewer accepts or declines the invitation to review your paper. There can be a tremendous amount of pressure on you when you need to write an abstract. And all the while, a white page in your text processing software is staring you in the eye. You may start writing a few words, delete them again, decide you need some coffee, bring coffee, check Facebook, try a few words again, and keep fidgeting away for an entire afternoon.

To avoid the fear of the blank screen, I am using a method in which I use questions that I answer for myself. Instead of subdividing my abstract in the classical elements of background, problem statement, methods, results, and conclusions, and coming up with sentences that fall in each of these categories, I copy and paste a set of questions into the white page, and start typing out the answers to these questions. Sometimes I answer these questions by talking out loud, and then write down what I just said. Once I have answered all the questions, I remove the questions, and see how I need to modify the sentences for them to be joined together. Then, I proofread, check for style and grammar, and voila, the abstract is ready.

The questions that I use are based on Koopman's description of the elements of an abstract [8]:

- **Background:** Why are the problem and the results important and why should they be studied?
- **Problem statement:** What problem specifically are you trying to solve?
- **Methods:** How are you trying to solve the problem? Which methods did you use: simulation, analytic models, prototype construction, or analysis of field data?
- **Results:** What's the answer of applying these methods?
- **Conclusions:** What are the implications of this answer? Is it going to change the world, be a significant "win", a nice hack, or serve as a road sign indicating that this path is a waste of time?

Exercise

1. Consider the topic you are currently working on. Set a timer for 30 minutes. Use the recommended questions for writing an abstract, and develop a first draft of an abstract before the timer goes off. Use this exercise to practice the technique of writing an abstract.

11.6 Writing a Cover Letter

Many journals require that you write a cover letter to accompany your paper upon submission. Your cover letter should contain the following elements:

- It should be addressed to the editor of the journal.
- It should mention that you prepared the manuscript according to the guidelines. If the formatting guidelines include a limiting word count, mention the word count of your manuscript.
- It should contain a short description of why you consider your work interesting for the readers of the journal.
- It should mention that the manuscript is original and has not been published previously. If you've shown a preliminary analysis of these results in a conference paper, you should mention this fact.
- Print your cover letter on official university paper and include your signature.

You can find a template for writing a cover letter in Fig. 11.4 and an example of the application of this template in Fig. 11.5.

11.7 The Review Process

11.7.1 Timeline of Reviews

Suppose you finally received an e-mail with a reply from the journal where you submitted your first paper. There are different replies, see Table 11.2, you can expect:

- **Rejected:** Check out the advice in the next section.
- **Rejected with an encouragement to resubmit as a new manuscript for the same journal:** Deal with the comments in the same way as you would deal with any reviewers' comments, and give the paper a large round of editing before you resubmit it. Read it carefully, and see if you are emphasizing your original contributions sufficiently. If not, add sections to stress these elements, and eliminate superfluous paragraphs. Make sure you thoroughly rearrange the structure and contents before you resubmit.

Place and Date

Dear *Professor Editor*,

I hope you will consider the attached manuscript, "*Title of Manuscript*" for publication in *Journal*.

The manuscript is prepared according to the guidelines for authors. The topic of study is *explain the topic of study in this paragraph.*

The readers of *Journal* might be interested *my work – explain here how your work and results could be interesting for the readership of the journal.*

This original manuscript has not been previously published. The manuscript is currently not submitted to any other journal for consideration. A preliminary study on the topic was submitted as a conference paper *for Conference, if that was the case*.

Your comments and feedback on this study are valuable and of great interest to our research.

I look forward to hearing from you.

Yours sincerely,

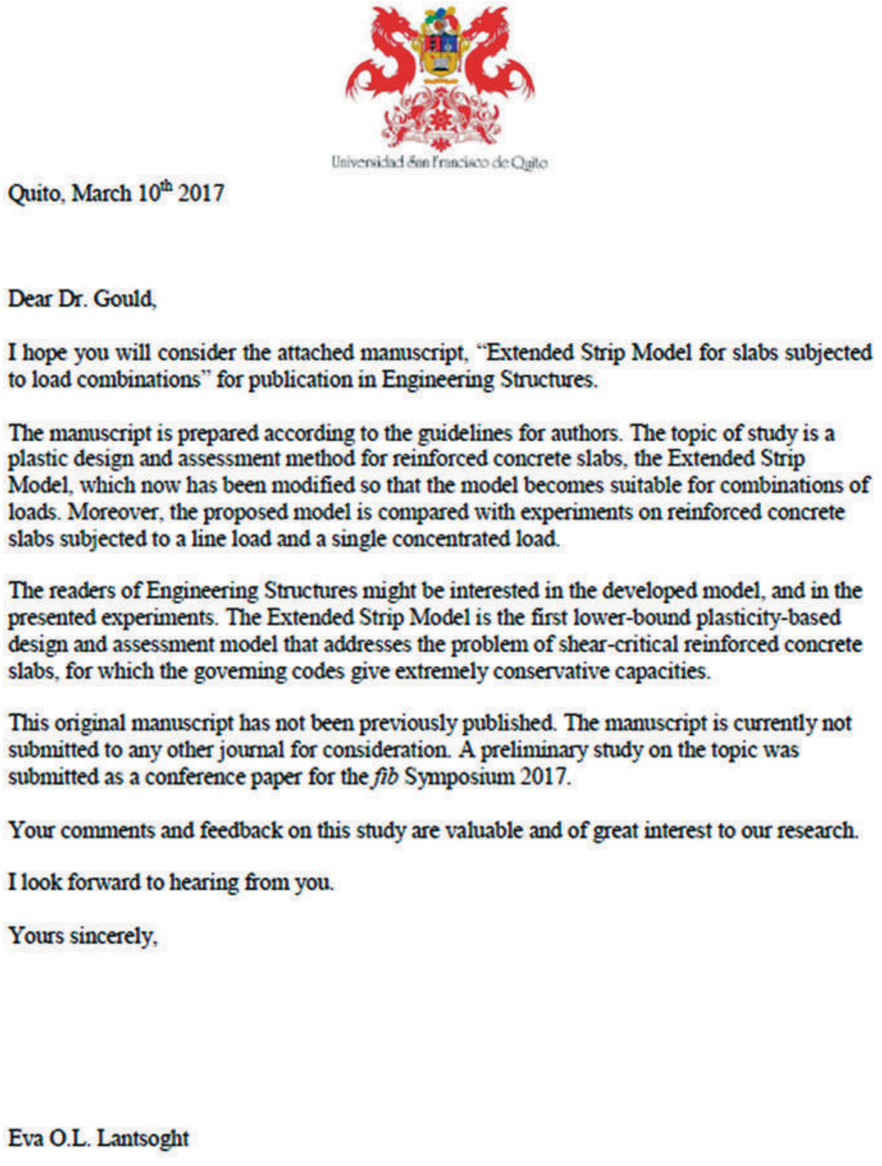
Signature

Your name

Fig. 11.4 Template of a cover letter

- **Positive decline / Revise and resubmit / Manuscript needs to undergo major revisions:** The advice in this section will mostly deal with this type of reply: you need to make some major changes to the manuscript based on the recommendations of the reviewers. The manuscript will undergo further peer-review when you resubmit it.
- **Accepted pending minor revisions:** You still need to make some changes to the manuscript, but typically the manuscript will either be re-reviewed quickly, checked only by the editor, or will not be re-reviewed at all.
- **Accepted without requested changes:** Put the champagne cold, this case is very rare and means your paper is just going through.

Depending on the decision, the journal will give you a certain amount of time to react. In case of a rejection or rejection with encouragement to resubmit, you will need to resubmit your manuscript either elsewhere or as a new manuscript to the same journal, and you will not have a deadline for resubmission. Take some time off from the paper to rework it with fresh energy, but make sure you don't let the work



Universidad San Francisco de Quito

Quito, March 10th 2017

Dear Dr. Gould,

I hope you will consider the attached manuscript, "Extended Strip Model for slabs subjected to load combinations" for publication in Engineering Structures.

The manuscript is prepared according to the guidelines for authors. The topic of study is a plastic design and assessment method for reinforced concrete slabs, the Extended Strip Model, which now has been modified so that the model becomes suitable for combinations of loads. Moreover, the proposed model is compared with experiments on reinforced concrete slabs subjected to a line load and a single concentrated load.

The readers of Engineering Structures might be interested in the developed model, and in the presented experiments. The Extended Strip Model is the first lower-bound plasticity-based design and assessment model that addresses the problem of shear-critical reinforced concrete slabs, for which the governing codes give extremely conservative capacities.

This original manuscript has not been previously published. The manuscript is currently not submitted to any other journal for consideration. A preliminary study on the topic was submitted as a conference paper for the *fib* Symposium 2017.

Your comments and feedback on this study are valuable and of great interest to our research.

I look forward to hearing from you.

Yours sincerely,

Eva O.L. Lantsoght

Fig. 11.5 Example of a cover letter (One small difference with respect to the letter I used: I took out my signature, just in case)

go stale. If the decision involves major revisions, you get a few months to rework your manuscript. Depending on the journal, you will receive between three months and a year to resubmit your work. If you fail to revise it within this deadline, you will need to resubmit it as a new manuscript, and start from the beginning of the process again. For minor revisions, you will typically receive less time to react,

Table 11.2 Overview of possible outcomes of a decision for a journal paper

Decision	Action	Timeline to resubmission
Rejected	Comments will be technical, general, and editorial Analyze the comments Rework your paper thoroughly Proofread and improve your writing Ensure at least 33% is new contents before you resubmit	No deadline, submit to another journal
Rejected with encouragement to resubmit	Comments will be technical, general, and editorial Analyze the comments Rework your paper thoroughly Rearrange the sections and restructure your work Proofread and improve your writing Ensure at least 33% is new contents before you resubmit	No deadline
Major revisions	Comments will be technical, general, and editorial Analyze the comments Address each comment respectfully and completely Proofread carefully Ensure at least 25% is new contents before your resubmit	Three months – one year
Minor revisions	Comments will be mostly editorial Analyze the comments Address each comment respectfully and carefully Proofread carefully Maximum 10% new contents	Two weeks to six weeks
Accepted	Comments will be only editorial Implement comments and provide overview of how you implemented them Verify if you need to submit additional documents such as a copyright transfer form Celebrate!	A few days

more in the order of a few weeks (two to six weeks in my field). If your work is accepted without changes, read the e-mail properly before you start celebrating. You may still need to submit a copyright transfer form, or reply in one way or another before the publisher starts to develop the print proofs and moves into the publication stage of your work.

Once you know the amount of time you have to resubmit your work, plan accordingly. Quickly read through the comments to see how much work it will be, and start reserving timeslots in your calendar to develop your revised version. If you need to discuss certain elements with your supervisors, ask for a meeting. Don't plan too closely to the resubmission deadline – the risk of having to resubmit as a new manuscript is just too large. Don't underestimate the amount of time it takes to make

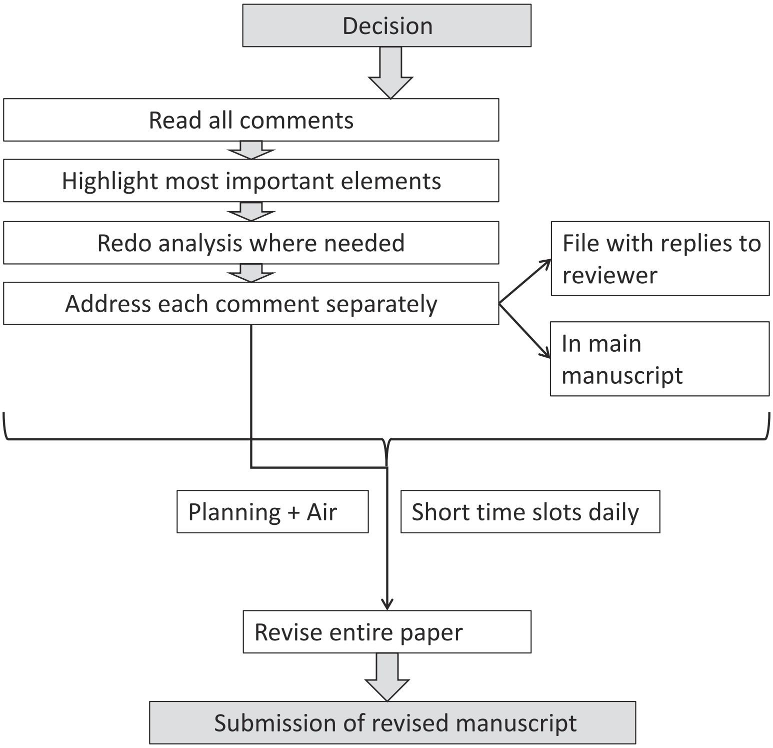

Decision
Read all comments
Highlight most important elements
Redo analysis where needed
Address each comment separately
File with replies to reviewer
In main manuscript
Planning + Air
Short time slots daily
Revise entire paper
Submission of revised manuscript

Fig. 11.6 From manuscript decision to revised manuscript

major changes to your work. As a rule of thumb, making major changes takes about as much time as writing your first draft. In fact, the whole process after writing the first draft takes about the double amount of active time on your part as the time it takes to write the first draft. This time involves going from first draft to submission, implementing reviewers' comments, subsequent rounds of reviews, and checking the print proofs. Make sure you plan enough time for dealing with the reviewers' comments. Take every comment seriously, because the acceptance of your work will depend on the impression the reviewers have of your work. As such, you should make sure the reviewers have the impression that you carefully dealt with each of their comments. When you are faced with pages and pages of comments, of up to seven reviewers, you may get tired of replying to each and every comment in detail after a while. For this reason, I recommend you work on implementing reviewers' comments in timeslots of no more than two hours, so that you can take a break after working on the comments for a certain amount of time each day. You can find an overview of how to work from the decision to the revised manuscript in Fig. 11.6.

11.7.2 How to Implement Reviewers' Comments

There is no magic hack related to dealing with the comments of reviewers. If you receive comments from seven reviewers, you will have to address each and every comment of each and every reviewer, and document how you dealt with each comment. If you receive five pages with comments, you will have to address each and every comment of each and every reviewer. If you don't document how you implemented the comments of the reviewers, it will be difficult for them during re-review to assess if you took all their suggestions into account, and they may simply decide you haven't done enough effort and reject your work.

Receiving a lot of comments can be intimidating and exciting at the same time. You can feel intimidated because the reviewers have a lot of criticism, and you may feel like implementing all their comments will be a lot of work, and you may doubt if you can do so before the deadline, or if you can do so at all. You can feel excited because a careful peer-review can be really useful for your research. If the reviewer analyzed your paper in depth and provided valuable input, you can learn and make significant improvements to your paper and your research.

The first step to take when you receive the comments of the reviewers, is to print out[5] the comments, and read through each of them. Highlight the comments that you need to discuss with your supervisor. Check if some comments from different reviewers are contradictory, and get a first idea of how to deal with these contradictory comments. Verify if some comments deal with the same topic, and how you can address this topic. You can use colored pens to make notes about recurring themes in the comments.

If there are no contradictory comments, you can simply address all comments sequentially. If there are contradictory comments, you will have to refer to the comment of reviewer 1 where reviewer 2 thinks you should have been doing the opposite, and vice versa. You will have to write a solid reply to both reviewers with your point of view, showing how you implemented the comment you agree with most into your paper, or arguing respectfully why both are mistaken.

For sequential replying of comments, you can simply copy and paste the comments of each reviewer in a separate document, and start implementing each comment. Write a reply to each and every comment, to show the reviewer that you took the comment in consideration. How to write replies to each comments is the topic of the next section.

11.7.3 How to Reply to Reviewers' Comments

As I mentioned before, it is important to reply each and every comment of the reviewers. Start to type your reply to the reviewers' comments by copying and pasting all comments of a reviewer into a new text file, so that you won't miss any

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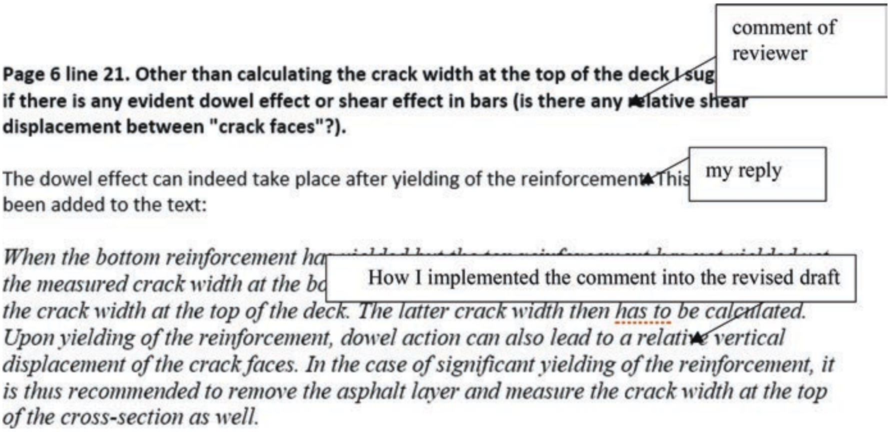
[5] Or use a digital equivalent.



comment of reviewer

Page 6 line 21. Other than calculating the crack width at the top of the deck I sug
if there is any evident dowel effect or shear effect in bars (is there any relative shear
displacement between "crack faces"?).

my reply

The dowel effect can indeed take place after yielding of the reinforcement. This
been added to the text:

How I implemented the comment into the revised draft

When the bottom reinforcement ha
the measured crack width at the bo
the crack width at the top of the deck. The latter crack width then has to be calculated. Upon yielding of the reinforcement, dowel action can also lead to a relative vertical displacement of the crack faces. In the case of significant yielding of the reinforcement, it is thus recommended to remove the asphalt layer and measure the crack width at the top of the cross-section as well.

Fig. 11.7 How to write a reply to the comments of a reviewer

Table 11.3 Using a table to reply to the comments of a reviewer

Comment	Reply	Implementation
Copy and paste each comment of the reviewer in a separate cell	*Explain what you did to implement the comment of the reviewer, or why you do not agree with the reviewer based on the literature or your research*	*Copy and paste the revised part of your manuscript to show how you implemented the comment*

comment. Make a new file for each reviewer. If you happen to receive your comments in a PDF, then simply take an image capture of each comment and paste each comment into a new file. Even when the reviewer points out a typo, just write a "Thank you" as a reply before you implement the correction. For technical comments, you can break down your reply into two parts: your reply directly to the comment, and then you can show how you implemented this information into your revised manuscript. To keep everything clear, I suggest you use simple formatting to show the different parts in your reply to the reviewer: I use **bold** when I copy the comment of the reviewer, I use a normal font when I type my reply, and I use *italic* for the quotes from the revised manuscript, as shown in Fig. 11.7. Another possibility is to make a table of comments, replies, and implementations, see Table 11.3. Where necessary, add references to your reply and/or revised manuscript, and make sure these references show up correctly in your reply file. When you are asked to revise a large section of text, a figure, or a table, I suggest you first paste the old version, explaining that this is the old version, and then the new version, explaining the changes you made. Showing the old and new versions side-by-side helps the reviewer to notice that you really did your best to fully revise a large section of text, figure, or table.

If you did your planning correctly before starting to tackle the comments, you will have sufficient time. Even when you think making changes does not take that much time, you should think again. Not only does making changes take about as much time as writing a first draft, it is also tiring. You need to concentrate very well on what the reviewer wants you to change, and how you can make this change in a way that does not violate the core of your story, or how you can argument that the comment of the reviewer should not be implemented.

If you are faced with a comment you don't agree with, then don't simply reply to the reviewer that you don't agree, and move on. If you don't agree, you have to do double the effort to convince the reviewer that you are right. Refer to other research in detail, including references, and screen captures were needed. Explain every element in detail. Make sure the reviewer sees that you've taken his/her comment seriously, thought deeply about it, and came to a conclusion that is supported by your research and the literature. Consider this exercise in argumentation as a preparation for your thesis defense.

In the case of conflicting comments between reviewers, say reviewers 1 and 2, discuss the comments in the separate files developed for each reviewer, but refer the comments of the other reviewer. In your file "reviewer 1.doc" (for example, depending on the software you use), you'll have in bold the comment of reviewer 1. Then, in your discussion, mention that you have an opposing point of view from reviewer 2, and copy the comment of reviewer 2 integrally into your reply file. Then discuss both views in depth, referring to the literature where needed, and finally state your opinion, and show how you implemented the comment into your revised manuscript. Similarly, in "reviewer 2.doc", you will have in bold the comment of reviewer 2, and the citation of reviewer 1 in your reply.

When writing your replies, make sure you give reviewer 7 as much attention and detail as reviewer 1. Don't let your attention go stale after endless hours of typing replies to reviewers. Work in short chunks of time if needed to stay sharp. Make sure every comment of every reviewer is replied in a detailed, polite, and thoughtful way. The impression the reviewers will get from your replies will also determine if your revised manuscript will get accepted, rejected, or will need to undergo further peer-review.

After you have discussed your replies, and some parts that perhaps you were not too sure about with your coauthors, you are ready to prepare your revised manuscript for resubmission. Check your layout, bibliography, and references to tables and figures again to make sure everything is still working properly. Check if your revised version still fulfills the requirements with regard to word count, and edit certain parts[6] if you need to chop words. Once you've verified the revised version of the paper fulfills all requirements for submission, send in your work again, and wait for a reply.

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[6] Not the newly added parts, obviously.

11.8 Dealing with Rejection

11.8.1 The Reality of Rejection

If your first paper comes back with a rejection, don't lose all hope. Rejection is as much part of life in the academic world as is conference travel. Most journals only accept about one third of all submitted abstracts. Your manuscript can also be rejected after a first, second, or even third round of reviews. Rejection is quite normal. Of course, it never feels good to receive a rejection, but it is nothing to worry about deeply. It does not mean that your work has no value, but it may mean that you have to present your work in a different way, or that you have to present your work to a different audience.

Sometimes, reading the comments of reviewers that have rejected your work may be horribly frustrating. There can be the ad hominem attacks (if you are PhD student, it probably means the reviewer has some beef with your promotor, because chances are small that the reviewer knows you personally), there can be the complete misinterpretations of what you were trying to convey, there can be the denigrating comments that there is not enough novelty in your work, or that your writing is bad… There is a whole slew of type of comments that can be not so helpful. The ad hominem attacks just mean you need to cross your fingers and hope your work won't be reviewed by this reviewer again. The complete misinterpretations can mean that you need to present your work and its goals in a clearer manner, but it can also mean that the reviewer is too focused on his/her own world. Comments about a lack of novelty mean that you need to write more clearly what has been done in the past, what was lacking, and how you have moved the state-of-the art forward. Finally, the comments about writing mean that you need to carefully revise your draft for logical order, grammar, and all elements of style. Sometimes, however, reviewers seem to immediately write this comment when they see the contribution comes from an institution outside of an English-speaking country.

On the other hand, sometimes reviewers will be able to point out a major flaw in your work. It may feel overwhelming to read that somebody identified an important piece of work you missed, or a flaw in your logic. You may feel upset that your supervisor did not catch this mistake. If you receive such comments, you should be grateful because it means the reviewer looked at your work in detail. Finding the flaw and sending you back to redo your analysis is something that will move your research forward. In the end, it is better that a reviewer catches a flaw before your work gets published than that you receive a comment from a reader later suggesting that maybe you were wrong in your analysis. Additionally, if a reviewer catches a mistake in your work, this input helps you for writing and preparing your dissertation.

So what does rejection really mean? It means you need to roll up your sleeves, give your manuscript a good brushing up, and submit it elsewhere. Don't throw your manuscript to the bottom of a drawer, never to be visited again, but put it in your planning to continue working on it after you've digested the disappointment.

11.8.2 How to Face Rejection

The first rejection is the worst. You may be able to shrug it off quickly, or you may feel heart-broken, wanting to know who the hell that reviewer was who completely misunderstood your work, and dreaming about pursuing the reviewer and shouting how wrong he/she is. If you feel down, take a deep breath, and see what you need. If you need to go home, soak in your bathtub, and have some wine, then go for it. If you need to go for a run to release your frustration, do so. Tune in to yourself and do what would feel good for you right now. Take the weekend off to be mad at the entire research world, if you need, and spend it reading fiction, partying with friends, gaming, cooking, and hating research. If you come back on Monday, feeling refreshed and with a new view of the situation, then you are ready to move on. If you still feel mopey, talk to a fellow PhD student about it. If the feeling lasts for a longer amount of time, talk with your supervisor about how disappointed you feel in your research.

Being able to bounce back after a setback is an important skill for every PhD student, because setbacks and disappointment are part of the life of a researcher. If you feel invincible and think you are always right, academia is probably not the right place for you. As a researcher, you are always exploring, doubting, changing ideas, and trying to find your way around in the dark. Humility, admitting that you can be wrong, that you may need to work a bit more on your writing, or simply that you don't know it all, are an essential part of your mindset as a researcher.

11.8.3 How to Move Forward and Resubmit Elsewhere

When you are ready to come out of your hole of self-pity and hate for the entire research world, it is time to gather your troops for the next battle. Read again through the comments of the reviewers that rejected your paper. Why was it precisely rejected?

If there was a flaw in your research, you should go back, and redo your analysis before your resubmit your work elsewhere (obviously!). Make sure you discuss your changes and new insights with your supervisor and possible other coauthors before you submit. Check and double check to verify if similar errors did not creep up in other parts of your analysis. If possible, make a hand calculation to check if computational results correspond with your expectations. Rewrite your analysis, results, and discussion sections in the light of your new findings, and update your research reports where appropriate. Ask a fellow PhD student to read your work and ask him/her to check if there are any possible leaks and flaws in your reasoning. If you are convinced your work is water-tight this time around, then do the scary thing – submit it again, to another journal. In this case, you can submit to a journal of the same type as where you have submitted your work before (same audience, and/or same relative importance).

If the main issue with your work was the actual writing and the English, ask your supervisors if you can get help from a professional proofreading service. Many universities have communications specialists in their departments, or an external office they exclusively work with for translations and proofreading services. Check your university's website, and ask senior colleagues for information about the options. Don't be afraid to ask for help. Know that you can learn a lot from the comments of a professional proofreader: he/she can give you an overview of grammar and style mistakes you commonly make, which will improve your writing in the long run. Don't get lazy either: if you know you have a professional to assist you, don't see this opportunity as a waiver for continuous work on your writing. You still need to put in the work on your side. Once you have the input from a professional, you can submit your manuscript to a journal of the same type as where you submitted your work before (same audience, and/or same relative importance).

If the reviewers think the contribution of your work is limited, analyze first why they came to this conclusion. Did you not stress the novelty of your work sufficiently? Are your results very similar to previous work? Are you reporting negative results? If it is a matter of wording, then rewrite in such a way that your new contributions are highlighted a number of times. Make it clear in your literature review section what the limitations of the existing work were, and how you have moved the state-of-the-art forward with your work. When you have reworked your manuscript, submit it to a journal of the same type as where you submitted your work before. If your results are very similar to previous work, or to work that has been published recently while you were working on something similar, you may need to either carefully compare your work to the existing body of knowledge to see if you maybe did manage to shine a new light on a single parameter, or other condition. If everything is pretty much the same as the other work, you will need to add something new to the contents of the paper, for example a novel analysis method of your work, or show the novelty of something smaller such as the measurement techniques you used. In this case, after reworking your manuscript, you'll have to resubmit to another type of journal. If you added new information, you can look for a journal that is more related to the contents of your newly added work. If you focused on one single parameter, you can submit to a similar journal as where you submitted before, but for example of lower relative importance. Finally, negative results are a difficult topic. Officially, all positive and negative results should be reported in the same way. However, journals prefer to publish "wins" rather than "losses". The result is the so-called publication bias. If a journal does not accept your negative results, rework your manuscript, discuss how other researchers can learn from your failed experiments for future research, and submit to a journal of lower relative importance.

If your manuscript was rejected because it does not fit the journal, make sure you do your homework better before you submit your work elsewhere. Select another journal from your table, but check recent issues of the journal to verify if the topic of your work fits this journal. You'll be more convincing for the journal editor if you check for papers about your research topic in the archives of the journal, and refer to the relevant work in your manuscript.

Use the guidelines from the previous paragraphs to select the journal where you will submit the second version of your manuscript to. Use the table of journals you developed to guide you in your choice for a second journal. Make sure your manuscript has been improved and/or changed significantly based on the comments of the reviewers from the first journal – you never know when the second journal happens to call upon the same reviewers as the first journal. Unless your work has been changed significantly, the reviewer won't change his/her opinion about your work and send a straight rejection again.

11.9 Writing Your Next Paper(s)

11.9.1 Identify Topics

Depending on the guidelines of your institution, you will either need to have a certain number of papers accepted in order to be able to defend your thesis, or write a "big book"-style thesis [10].

If you are graduating based on a number of papers, your next paper can either be another research project, or it can be the next part of your research. Generally, if you have delivered a research report to your supervisor, and have moved your research forward, there should be sufficient material in the report for writing a journal paper.

For those of us whose main task during the PhD is to develop a dissertation, you may be faced with the task afterwards to develop your journal papers based on your dissertation. Having your dissertation published is not sufficient; only very few researchers in your field will ever read your entire dissertation. Therefore, you need to turn your dissertation into journal papers after finalizing your dissertation. For those who land a research-oriented post-doc position, you will have sufficient time and space to work on your papers. For those, however, who join the industry, working on your papers will be something you have to do in your evenings and on the weekends.

It sounds easy: just take a chapter at a time and turn it into a journal paper. Unfortunately, where your dissertation has a single introduction and literature survey for the entire document, you will need to write a new introduction and literature survey for each paper you publish. In your dissertation, the description of your experiments and your analysis can be in different chapters. In a paper, you cannot publish your experiments without an analysis and without drawing any conclusions, nor can you publish an analysis without introducing your experiments. Each journal paper has to stand on its own.

The first thing you need to do is to identify the separate papers you can develop from your dissertation. Try to develop a paper from each chapter. If you have more than one original contribution in each chapter, then devote a single paper to each original contribution. The following general topics you find in a STEM dissertation can be an isolated paper:

- literature review, which then becomes a review or state-of-the-art paper,
- development of a database of results from the literature
- experiments and analysis: if you have a large amount of results, you may need to publish different series of experiments separately to discuss each of them sufficiently
- development of an analytical model
- comparison between experiments and numerical models
- comparison between experiments and existing analytical models
- comparison between experiments and existing codes and guidelines
- advanced statistical analysis of your data
- case studies
- recommendations for practice based on your work
- side studies you did during your PhD that did not end up in your dissertation

Once you've outlined the different papers you want to write, identify the right journal for each of these papers. For each paper, identify who will be your coauthors. Your PhD supervisor will probably standard be a coauthor, but perhaps some member of your committee has been particularly helpful in one part of your analysis. If that's the case, then ask this committee member if he/she would be interested in being involved in the development of a paper on this topic. If you are aiming for an academic career, try to publish with other people to show that you can work across research groups and internationally.

In a next step, decide when you will work on each paper. Take your planner to reserve time periods for the first few papers that you need to work on, but don't fall for the trap of starting to place all the papers in your calendar. Instead, identify how many papers you realistically can develop in a semester, which depends on the amount of time you have available each day for writing. Don't book all your writing time for writing your journal papers – you will need to work on conference papers as well, and as you start to receive the comments of reviewers on the papers you submitted, you will need time for working on the revisions. The number of papers you can work on per year depends on your job. If you've switched to industry, two or three papers per year will already be quite some work. If you are a post-doc, you can aim for at least six papers a year. If you are a newly appointed assistant professor with a large teaching load, four to six papers should be possible. It took me to about two years after my PhD graduation to submit the last manuscript that was based on my dissertation.

Once you have an idea of the number of papers you can develop per year, you also know which interval you should aim for to submit manuscripts. For example, if you aim at submitting three papers in a year, then you should submit a paper every four months. Based on these intervals, you can set your target deadlines for each paper you have in mind in your overview of papers and target journals. As you finish the first draft of one paper and send it to your coauthors, don't drop writing from your schedule until this paper is published. Instead, start developing your next draft. Develop a constant stream of writing, revising, implementing comments from coauthors, and submitting.

Keep in mind that not all papers are born equally. Some papers will fall out your dissertation in just a few writing sessions. Other papers will be a complete drag, as you force yourself to take a piece of your dissertation and turn it into a stand-alone narrative. Accept this fact, and don't get mad at yourself. Just put in the work each and every workday to move your writing forward, just as you practiced (hopefully) during your PhD days.

Don't get disappointed if you start to fall behind on your original planning – if anybody fell behind big time on her original ideas, it is me. I started assuming I could develop a draft every four to six weeks. The idea was to give two weeks to my coauthors for input, implement their input, and submit. And keep submitting. I forgot to factor in that I would need two to three weeks to implement the reviewers' comments each time a paper came back. I didn't factor in that my time for writing would often be limited to maximum an hour per workday, as I would need to start working on new research, put a lot of time into my teaching duties, and navigate the Willy Wonka's Chocolate Factory that is administration in Ecuador. If you fall behind, just roll with the punches, as long as you keep rolling forward.

As time passes by since the publication of your dissertation, and new research results come out, you will need to implement the latest publications in your literature review for your new manuscripts, and perhaps redo some of the calculations and analysis you did during your PhD. You may simply have forgotten in which spreadsheet or with which procedure you determined certain values in your dissertation. If that's the case, take the safe route, and redo the calculations. You may also have forgotten what you did precisely. I kept a side research project aside to develop into a journal paper. I did the research at the end of 2011. I wrote the paper in 2015, and I had to redo some sketching and thinking to remember the logic behind my calculations.

11.9.2 Become a Productive Writer

The best advice to become a productive writer is to put in the work. You can't expect to develop your journal papers if you don't plan time to work on these. Reserve time for writing each workday, and move your draft forward steadily.

If you have all material ready to turn part of your dissertation or a research report into a journal paper, you may be able to do this quickly. Your first journal paper will be a journey on a learning curve, but as you get more trained in writing journal papers, you may find that some papers roll out quickly. My fastest for a journal paper so far was eight hours, spaced out over one week (so not a single work day, but based on my one to two hour timeslots for writing daily) [11]. How is it possible that this paper came out five times faster than what it usually takes me to develop a paper? One of the main reasons is that I had a lot of the writing ready in my dissertation. You can enjoy the same benefit if you have a lot of writing ready in a research report. Often, you have more material ready than you think. Don't make the mistake of keeping the actual writing of the draft paper for "when you have time" – cast the iron while it is still hot; this approach takes the least amount of time to turn the work into a manuscript. Have that time for writing available, each workday.

Just as what you did for writing your first paper, always start by making a planning for writing your paper when you have the outline ready. If you can estimate how much time each section and subsection will take, you can assign pomodoros for the writing tasks. If you only have 30 minutes for writing in a given day, consider that one undisturbed Pomodoro for churning out a subsection of your manuscript. Even if it is just 30 minutes, reserve this time to fit writing in between other duties. Thirty minutes can be an incredibly productive bit of time; and eight days of 30 minutes will get your farther than a single time slot of four hours, in which your attention inevitably will start to trail.

If you have all material ready to develop a paper, the very minimum amount of time you can spend on each separate section can, for example, be:

- **Abstract**: 30 minutes, see above.
- **Outline and planning**: 30 minutes[7]
- **Introduction**: 30 minutes. Don't spend too much time going back and forth with your introduction. Sure, writing an introduction is stressful, because it is how you invite the reader into your research. Be ruthless, and simply focus on the following question: "What does the reader need to know before we can delve deeper into this topic?" to identify the topics you need to introduce. For the background information, answer the question: "Why should the reader care about this research?".
- **Section 1:** maximum two hours
- **Section 2:** maximum two hours
- **Section 3:** maximum two hours – provided that you have all material ready in a research report or dissertation chapter. If you have all the ingredients for cooking up the sections, simply dump your existing text from your research report or dissertation into the sections, and start rewriting the text. Make sure your tables and figures fulfill the guidelines of your target journal, and make alterations where needed.
- **Proofread:** one hour. Read your paper after a few days, so you revisit your work with a fresh mind.
- **List of notations, conclusions, references:** one hour. Either develop the list of notations while writing a paper, or wait until the end, then use a colored pencil to highlight each symbol as you come across the notations while proofreading, and develop the list of notations at once. Write your section of conclusions after proofreading the manuscript and making notes about the most important points discussed in the paper. After writing these conclusions, crosscheck with the

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[7] If you use outlines to structure your writing.

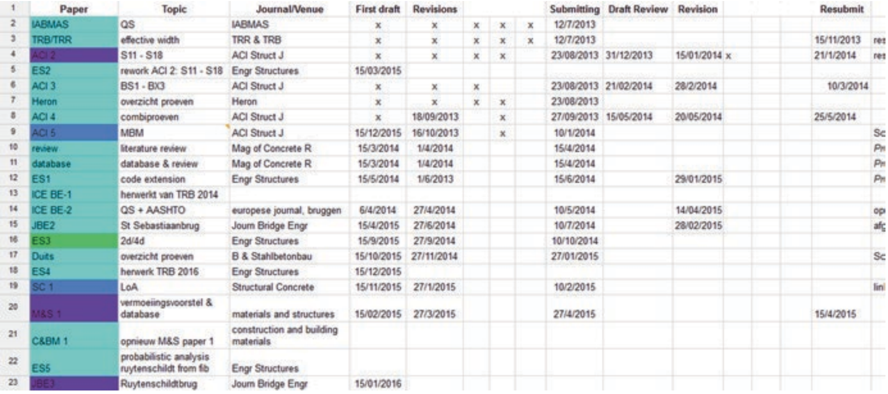
abstract to see if all topics you promised in the abstract are effectively discussed in the paper. Finally, if you use automatic referencing software, read through your list of references to check for the occasional typing error, or possible minor issue with formatting.

11.9.3 Juggling Different Papers

Once you have different papers submitted to an array of journals, each in different stages of the review process, keep a close look at your files and time. Once you start to submit papers, you will need to combine some planning, some list-making, and some document-tracking.

For starters, it helps to have an overview with all papers you are working on, and want to work on in the future. I use one Google Drive spreadsheet with an overview of all papers, target journals, target deadlines for submission, and a color code to identify where in the review process this paper sits. You can take a look into my paper cooking kitchen in Fig. 11.8. At any given point in time, I have a number of papers that I am working on, that are with my coauthors, that are in review, that need further action after review, that are in press, or that are published. Believe me when I tell you it is good to have a handy overview of what is going on with each paper [12].

You will need a handy overview to see when it is time to ask the editor when you will hear back from the reviewers, or when your paper in press will be published, or to keep track of which of your coauthors have already given feedback on a given paper. Additionally, you will need to learn how to juggle your self-imposed deadlines for developing your first drafts with the deadlines of the journals to resubmit your revised versions, as well as all other deadlines that you need to meet.



1	Paper	Topic	Journal/Venue	First draft	Revisions				Submitting	Draft Review	Revision				Resubmit	
2	IABMAS	QS	IABMAS	x	x	x	x	x	12/7/2013							
3	TRB/TRR	effective width	TRR & TRB	x	x	x	x	x	12/7/2013						15/11/2013	res
4	ACI 2	S11 - S18	ACI Struct J	x	x	x	x		23/08/2013	31/12/2013	15/01/2014	x			21/1/2014	res
5	ES2	rework ACI 2: S11 - S18	Engr Structures	15/03/2015												
6	ACI 3	BS1 - BX3	ACI Struct J	x	x	x			23/08/2013	21/02/2014	28/2/2014				10/3/2014	
7	Heron	overzicht proeven	Heron	x	x	x	x		23/08/2013							
8	ACI 4	combiproeven	ACI Struct J	x	18/09/2013		x		27/09/2013	15/05/2014	20/05/2014				25/5/2014	
9	ACI 5	MBM	ACI Struct J	15/12/2015	16/10/2013		x		10/1/2014							Sc
10	review	literature review	Mag of Concrete R	15/3/2014	1/4/2014				15/4/2014							Pr
11	database	database & review	Mag of Concrete R	15/3/2014	1/4/2014				15/4/2014							Pr
12	ES1	code extension	Engr Structures	15/5/2014	1/6/2013				15/6/2014		29/01/2015					Pr
13	ICE BE-1	herwerkt van TRB 2014														
14	ICE BE-2	QS + AASHTO	europese journal, bruggen	6/4/2014	27/4/2014				10/5/2014		14/04/2015					op
15	JBE2	St Sebastiaanbrug	Journ Bridge Engr	15/4/2015	27/6/2014				10/7/2014		28/02/2015					afg
16	ES3	2d/4d	Engr Structures	15/9/2015	27/9/2014				10/10/2014							
17	Duits	overzicht proeven	B & Stahlbetonbau	15/10/2015	27/11/2014				27/01/2015							Sc
18	ES4	herwerk TRB 2016	Engr Structures	15/12/2015												
19	SC 1	LoA	Structural Concrete	15/11/2015	27/1/2015				10/2/2015							lin
20	M&S 1	vermoeiingsvoorstel & database	materials and structures	15/02/2015	27/3/2015				27/4/2015						15/4/2015	
21	C&BM 1	opnieuw M&S paper 1	construction and building materials													
22	ES5	probabilistic analysis ruytenschildt from fib	Engr Structures													
23	JBE3	Ruytenschildtbrug	Journ Bridge Engr	15/01/2016												

Fig. 11.8 Color-coded overview of papers, target journals, and self-imposed deadlines. Color code: light blue for accepted and published, dark blue for accepted and in press, purple for rejected but submitted elsewhere, green for in review (Minor edit: I removed the names of my coauthors from their respective columns)

My Google Doc may look surprisingly low tech, but it has a number of advantages. It is a shareable document, so my coauthors have access to it to check on the progress whenever they want to. At any point in time, they can access the most recent version. If I need to make a snapshot in time, for example for my annual evaluation, then I simply print out a PDF of the most recent state of the document. Since the document is rather low-tech and accessible online, I can always add ideas wherever I am, without needing to download a heavy file. By now, I have all files I need for working in the cloud through Dropbox, but I keep this particular file on my Google Drive.

The added benefit with the color-coding is that I can quickly see which papers may need some following up. If a paper has been in press forever, it may be a good idea to ask the editor about a time schedule with regard to publication. If you haven't heard anything for more than six months or a year (depending on the journal), it may be wise to get in touch with the editor. Check online about the time it takes for papers to be published in the journal, to have an idea if your waiting time is normal. Similarly, if you have submitted a paper for review, but haven't heard anything from the reviewers after a year, it may be a good moment to inform with the editor about the process.

Besides using the overview in the Google Doc, you can integrate this system with a to-do list. For me, that means to have a reminder in my to-do list when I start writing a paper, reminders to follow-up with coauthors, and my self-imposed deadlines for submission of the manuscript. Besides an online to-do list, which generates a daily list of tasks, I also like to map out my work per semester by writing in a notebook. Typically, I outline in my semester plan somewhere between four and six papers that I want to work on. If I have deadlines coming up in a semester (for example, for conference papers, or revised versions of journal papers), then those papers certainly need to make their way to the list.

When reviewing tasks for the upcoming week, I add these tasks in their respective categories into the weekly template (for me, in Google Calendar). Timeslots for writing papers get filled in with the paper I need to work on. If planning the paper shows me that I will need two weeks' worth of timeslots for this particular paper, then I fill in the timeslots for two weeks.

A final difficulty when juggling papers is that you may lose track of the files you use. To avoid confusion, create a folder for each paper you are working on, and make sure you have all necessary information in this folder. Keep all figures you used for the paper in a subfolder. Save your cover letter, the calculation sheets that you have used, word equivalent calculation table, and other relevant information in the folder of the paper. Create a subfolder for the review process, in which you store the comments of the reviewers and your replies. Store all e-mails regarding the paper in this folder (if you do Inbox Zero, you should already be filing all e-mails in the right folder instead of having them pile up in your Inbox). Save different versions of the paper in an organized manner (I use "Paper Title YYYY-MM-DD"), see Fig. 11.3. For the figures, it may be a good idea to number the figures in the file name (for example “fig 1.eps” and “fig 2.tif”). Doing so will facilitate uploading and organizing the figures into the online submission system.

11.10 Summary

Writing your first journal paper may feel like a major step to take. If you graduate based on a number of papers accepted for publication, it is a step towards your graduation. If it is not a graduation requirement, it is an important step in growing as a researcher. When you start writing a journal paper, you need to know where you want to submit this paper. We learned in this chapter the different elements to consider when you select a journal, and you developed an overview of interesting journals for your work.

As mentioned numerous times in this book, to get anything done, it helps to plan ahead. Before writing your first draft, plan your time and your actions. You practiced developing a planning towards a first draft. Then, you need to ask for feedback on this draft from your coauthors and/or supervisor(s), and rework your draft for submission. These steps too need planning.

A separate topic in this chapter deals with writing good abstracts. We discussed the different elements that make up an abstract, and you learned a method to quickly write an abstract when writer’s block tries to get a hold of you.

After submission of a manuscript, you wait. After some time (shorter or longer, depending on the journal and/or the reviewers), you will either receive the bad news that your paper has been rejected, or you will need to rework your manuscript for resubmission. Only in very few cases your work is accepted without any requested changes. If you need to rework your paper for resubmission, your first step should be to make a plan of how you will deal with the comments. Then, you will need to implement the requested changes, and –equally important- you will need to write a good reply to the comments of the reviewers, explaining them how you implemented the comment, or arguing based on the literature why this comment should not be implemented, and then showing where in the paper you implemented the comment or provided more information. If your paper is rejected, which happens to about 66% of all papers, you will need to decide where else you could submit the paper. You learned in this chapter how to analyze the comments of the reviewers that rejected your paper to identify which steps you need to take to have a larger chance of acceptance upon submission to another journal.

Finally, we looked towards the future in this chapter. After writing your first journal paper comes a second, third, fourth – and before you realize it, you are juggling a number of papers that you are drafting, that are with your coauthors, that may be in different rounds of review, or in press. We discussed how to juggle working on different papers, especially after completion of the PhD trajectory, when other responsibilities start to vie for your attention.

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Chapter 12
Compiling Your Work into a Dissertation

Abstract In this chapter, we discuss writing the dissertation. The first topic deals with planning the writing of a dissertation. We discuss how to estimate the amount of time that you need for your writing, and how you can spread out the writing so that you can move forward slowly but surely, without needing to pull all-nighters or other forms of writing sprints. A second topic deals with structuring a dissertation: you have all your material ready, or you are at a point where you have a good grasp of your work and what remains to be done – how do you now bring everything together into a coherent dissertation? A third topic deals with self-care during the writing of a dissertation. Writing a document of 100,000 words takes time, and often PhD students burn out before finishing their writing. To avoid this pitfall, we stress the importance of a good planning that allows sufficient time for writing, and the importance of routines and other activities that keep your mind balanced. A fourth topic deals with the practicalities of writing the introduction and conclusions chapters of your dissertation. We also touch upon the topic of future work, and how to identify additional elements for future research. The fifth topic deals with the defense committee. We talk about how to compile a balanced committee, for those who have a voice in the selection of their committee members. Then, we look at how to implement the comments of the committee members. The final part of this chapter talks about the thesis defense. To prepare for a defense we outline some standard questions.

Keywords Dissertation · Thesis · Writing · Academic writing · Introduction · Conclusions · Thesis defense · Viva

12.1 Introduction and Learning Goals

This chapter describes all steps required for submission, completion, and defense of your doctoral dissertation, or PhD thesis. If your requirement for graduation is the development of a "big book"-style thesis, then you will find all relevant information in this chapter. If your requirement for graduation is a number of journal articles, revise the information in Chap. 11. To compile your journal articles into a dissertation, you will still need to write the introduction and conclusions chapters. You can find recommendations for these elements in this chapter.

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E. O. L. Lantsoght, *The A-Z of the PhD Trajectory*, Springer Texts in Education,
https://doi.org/10.1007/978-3-319-77425-1_12

As always, planning is essential in finishing your dissertation before your funding or scholarship runs out. We discuss when is a good moment to start writing your dissertation. If writing propositions is part of the graduation requirement, check out the section about writing propositions, and finding ideas for propositions. Then we continue with looking at the actual writing of a dissertation. A typical PhD thesis is about 100,000 words long. The main technical challenge for many students that need to write such a large amount text, is to keep the “red thread” through the entire text. This red thread should be your answer to your research question and subquestions. Moreover, when you need to produce a large document, you may feel overwhelmed, or you may lack motivation, For those of you in this situation, we will discuss how you can stay motivated and stay on track with your planning while you write your entire dissertation. Writing a dissertation is a marathon, not a sprint. In a next topic, we go into the technical details of bringing everything together in the first and last chapters of your thesis: the introduction, and the conclusions. For these chapters, it is important to crystalize the most important elements of the dissertation, without becoming repetitive.

Depending on the procedures in your country and institution, you publish your thesis before your defense, or need to submit revisions after your defense. This chapter is written assuming you will finish your dissertation first, and then defend your thesis. The recommendations, however, are still generally valid in case the procedures are different at your institution. Since the publication of the dissertation prior to the defense will involve quite some interaction with the committee members before the defense, you will find all tips related to implementing the comments of committee members in a subchapter.

The last topic is the actual defense[1] of the dissertation. We will discuss how to move from finished thesis to the day of the defense, how to prepare for the defense, and how to sail smoothly through the big day.

12.2 Planning Towards Your Dissertation

12.2.1 How to Plan Your Dissertation

By now, you may wonder if I’m even able to start a chapter without talking about planning in the first place. If you made your general plan for your PhD trajectory as outlined in Chap. 3, then you should already be planning towards the finalization of your dissertation, and your defense. So why should you plan your dissertation then? Let’s say that your multiple-year-plan from Chap. 3 has all the major milestones. You won’t know in the very beginning when you are exactly ready to start

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[1] Also called: viva.

Table 12.1 Overview of writing of dissertation

Time period	Activity
19/02/2012–03/03/2012	Writing chapter 1 & 2
04/03/2012–02/04/2012	Writing chapter 4
03/04/2012–21/04/2012	Writing chapter 3
22/04/2012–09/05/2012	Writing chapter 2
23/05/2012–21/06/2012	Writing chapter 7
04/07/2012–31/07/2012	Research for chapter 6
01/08/2012–16/08/2012	Write chapter 6
05/09/2012–20/10/2012	Research for chapter 5
21/10/2012–30/10/2012	Write chapter 5
01/11/2012–11/11/2012	Calculations with theory of chapter 5 for chapter 6 + add this information to chapter 6
05/11/2012	Update chapter 2 with model used in chapter 5
05/11/2012	Update chapter 7 with discussion about skewed bridges
06/11/2012–11/11/2012	Write chapter 8
12/11/2012–13/11/2012	Compile dissertation
14/11/2012	First draft to supervisor

writing – you may have it as a goal to start writing somewhere half-way your PhD trajectory, but you will not have defined your chapters and contents yet.

When we talk about planning your dissertation, we deal with identifying in which months you will write which chapter. You will need to already have a main idea of the chapters that you will write, even if you haven't finished all the research yet or have all results available for each chapter. You need to be able to estimate the time it will take you to come to the first draft of each chapter, including the remaining time to finish your research. In doing so, you will also need to move some topics to the side that may look interesting, but that don't have a direct place in your dissertation. When you make a planning for writing your dissertation, also add an estimated word count for each chapter.[2] Generally, your introduction and conclusions chapters will be shorter, and all chapters in between can be of comparable length. You can see how and when I wrote the chapters of my dissertation in Table 12.1. As you can see, I didn't write all chapters in order, and I still had to do all the research for Chap. 5, which then also influenced what I introduced in the literature review chapter (Chap. 2) and what I compared to my test results in Chap. 6.

So, once you have identified in which month you will write which chapter, you need to translate this into estimating the amount of time you will need for writing each chapter, and the amount of time you need to reserve in your calendar on a daily basis to move your writing forward. Plan ahead, and leave yourself plenty of time, so that you can work steadily towards graduation without needing to pull all-nighters and other forms of writing sprints. Keep in mind that you still need to fit in other activities, such as teaching and writing conference papers.

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[2] Provided that you find working with goal word counts motivating.

As with all writing, you need to know that writing the first draft is not what takes most time. When I finished writing the first draft of my dissertation, I was convinced that I had done the majority of the work on my thesis. The data [1], however, proved that I was wrong. During my PhD, I meticulously tracked my time in ManicTime on my office computer, and I calculated that it had taken me about 205 hours to write my first draft version, between March 2012 and November 2012 (nine months, see Table 12.1, not counting the long summer holidays I took that year, because that's the summer I will always remember as the summer I got married, not the summer I spent holed up inside, writing my dissertation). Little did I know that I would need much more time to finish the final version of my dissertation. Including the comments of my promotor and copromotor took me 123 hours, between November 2012 and January 2013. Then, my draft thesis was sent to the committee. Implementing the comments of my committee is what took me most time: 255 hours in total between February 2013 and April 2013. In adding the comments of the committee, my thesis grew from 200 pages to 300 pages. The last preparations included layout and getting the document ready for printing and publishing, which took 30 hours in May 2013. In total, writing the entire dissertation took me over 600 hours. For most chapters, I had research reports ready by the time I got to writing the chapter. I progressed rather slowly in the first months, as I combined finishing reports with writing up the respective chapters. For one chapter, I still had to do all the research. As a result, the actual time spent writing over those first nine months was only 205 hours, but I needed the time of those nine months to finish the required research. I did most of my writing in the evenings and on weekends, as my work days were still filled with finishing up research and teaching duties.

Before you start planning, and think that you can simply fit 600 hours in ten weeks of 60 hours, read carefully what I wrote above. The number of months it takes and the number of hours you can spend on writing depends on how far you are in your research. You need to look at your time logs of the previous months to have a good estimate of the amount of time it takes you to write a certain number of words, how much time it will take you to do the remaining research work, and how much time it will take you to finish the remaining research reports. Keep in mind as well that you can't just storm forward to the completion of your dissertation. Sooner rather than later your supervisor will need to read your work, and provide input. If you try to finish everything in a short amount of time, you can't expect from your promotor that he/she will be able to read it all and provide feedback in a matter of a few days.

When you plan writing your dissertation, keep in mind that dissertation-writing can bring out doubts and fears about your writing voice and expertise. As such, the process can be a "messy, unanticipated experience of conducting research and writing a dissertation" [2]. Kamler and Thomson argue that the development of your dissertation is text work/identity work, i.e. that your identity as a scholar is "formed together, in, and through the process of dissertation writing". "The practices of doctoral writing simultaneously produce not only a dissertation but also a doctoral scholar," they caution. Allow yourself time and space for this growth process.

12.2.2 How to Kick-Start Your Writing

If the idea of starting to write a chapter feels terrifying, you can start to generate documents with loose ideas for each chapter. Typically, a dissertation will contain (some of) the following chapters:

- Introduction
- Literature review
- Methods
- Analysis of results
- Development of theory
- Verification of theory with results
- Computational modeling
- Comparison between computational analysis and experimental results
- Recommendations for practice
- Case studies
- Summary and conclusions.

Depending on the type of research you are doing, you can identify which of these elements will go into your dissertation, and number your prospective chapters. Then, start a file for each chapter. Every time you come across some interesting information, you can copy the reference, a relevant figure, and/or an interesting quote into the document of the relevant chapter, see for example Fig. 12.1, in which I added information about a certain topic from a report to a section and commented how I needed to implement this information into the chapter. As you start to shape your research, you will be able to spend an afternoon developing an outline[3] for the respective chapter as well. Just add this outline to the document of the relevant chapter, reshuffle the snippets of information that you have in there, refer perhaps to parts of your research report, or even copy-paste parts of your research report in there for future modification, see Fig. 12.1, and then let it be again. Once you feel ready to start writing a chapter, you can take this document, and you will already have some information to start working with. You don't need to start writing your first chapter first. You don't need to start writing each chapter from the beginning to the end – you can start from the part of the outline where you have the most

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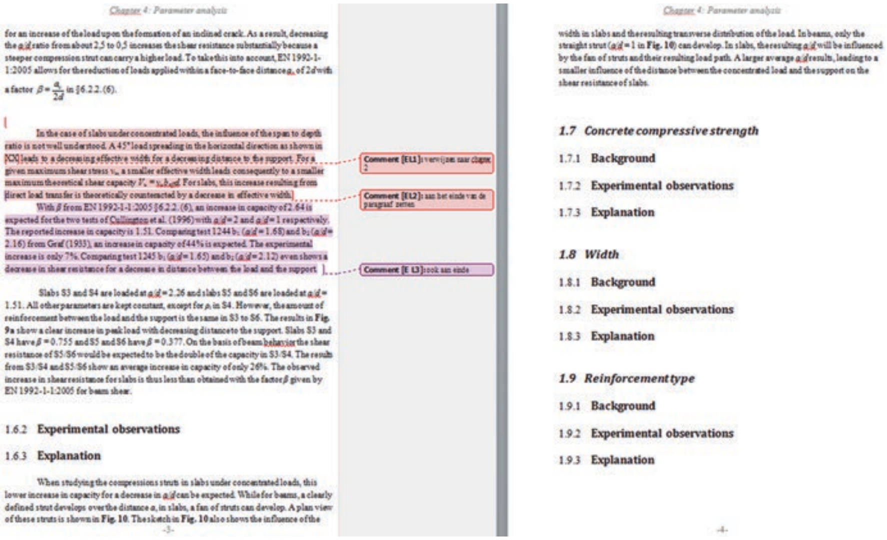
[3] You can simply list the topics you want to discuss and organize later if outlines don't work for you.



Chapter 4: Parameter analysis

for an increase of the load upon the formation of an inclined crack. As a result, decreasing the a/d ratio from about 2,5 to 0,5 increases the shear resistance substantially because a steeper compression strut can carry a higher load. To take this into account, EN 1992-1-1:2005 allows for the reduction of loads applied within a face-to-face distance a_v of $2d$ with a factor $\beta = \frac{a_v}{2d}$ in §6.2.2.(6).

In the case of slabs under concentrated loads, the influence of the span to depth ratio is not well understood. A 45° load spreading in the horizontal direction as shown in [XX] leads to a decreasing effective width for a decreasing distance to the support. For a given maximum shear stress v_u, a smaller effective width leads consequently to a smaller maximum theoretical shear capacity $V_u = v_u b_{eff} d$. For slabs, this increase resulting from direct load transfer is theoretically counteracted by a decrease in effective width.

With β from EN 1992-1-1:2005 §6.2.2.(6), an increase in capacity of 2.64 is expected for the two tests of Cullington et al. (1996) with $a/d = 2$ and $a/d = 1$ respectively. The reported increase in capacity is 1.51. Comparing test 1244 b_1 ($a/d = 1.68$) and b_2 ($a/d = 2.16$) from Graf (1933), an increase in capacity of 44% is expected. The experimental increase is only 7%. Comparing test 1245 b_1 ($a/d = 1.65$) and b_2 ($a/d = 2.12$) even shows a decrease in shear resistance for a decrease in distance between the load and the support.

Comment [EL1]: verwijzen naar chapter 2

Comment [EL2]: aan het einde van de paragraaf zetten

Comment [E L3]: ook aan einde

Slabs S3 and S4 are loaded at $a/d = 2.26$ and slabs S5 and S6 are loaded at $a/d = 1.51$. All other parameters are kept constant, except for ρ_l in S4. However, the amount of reinforcement between the load and the support is the same in S3 to S6. The results in **Fig. 9a** show a clear increase in peak load with decreasing distance to the support. Slabs S3 and S4 have $\beta = 0.755$ and S5 and S6 have $\beta = 0.377$. On the basis of beam behavior the shear resistance of S5/S6 would be expected to be the double of the capacity in S3/S4. The results from S3/S4 and S5/S6 show an average increase in capacity of only 26%. The observed increase in shear resistance for slabs is thus less than obtained with the factor β given by EN 1992-1-1:2005 for beam shear.

1.6.2 Experimental observations

1.6.3 Explanation

When studying the compressions struts in slabs under concentrated loads, this lower increase in capacity for a decrease in a/d can be expected. While for beams, a clearly defined strut develops over the distance a, in slabs, a fan of struts can develop. A plan view of these struts is shown in **Fig. 10**. The sketch in **Fig. 10** also shows the influence of the

-3-

Chapter 4: Parameter analysis

width in slabs and the resulting transverse distribution of the load. In beams, only the straight strut ($a/d = 1$ in **Fig. 10**) can develop. In slabs, the resulting a/d will be influenced by the fan of struts and their resulting load path. A larger average a/d results, leading to a smaller influence of the distance between the concentrated load and the support on the shear resistance of slabs.

1.7 Concrete compressive strength

1.7.1 Background

1.7.2 Experimental observations

1.7.3 Explanation

1.8 Width

1.8.1 Background

1.8.2 Experimental observations

1.8.3 Explanation

1.9 Reinforcement type

1.9.1 Background

1.9.2 Experimental observations

1.9.3 Explanation

-4-

Fig. 12.1 Getting started with writing a chapter by copying and pasting available information from reports and adding comments

information ready to get your writing momentum going. With this simple method, you won't have to stare at a blank screen to start writing a chapter – you can just plunge in and start working on the information you have available. As you start working on these documents, make sure to turn them into the right format for your final dissertation – you don't want to spend countless hours moving tables and figures around because the page size for your final dissertation is smaller than the regular A4 or Letter size that you are using for most documents.

12.2.3 When to Start Writing

Often, students ask me when is the right time to start writing. Should you start writing your dissertation at the beginning of your PhD trajectory, and revise and edit your documents as you move your research along? Should you wait until the very end, when you have everything ready and all you need to do is sit down and write? The truth lies somewhere in between.

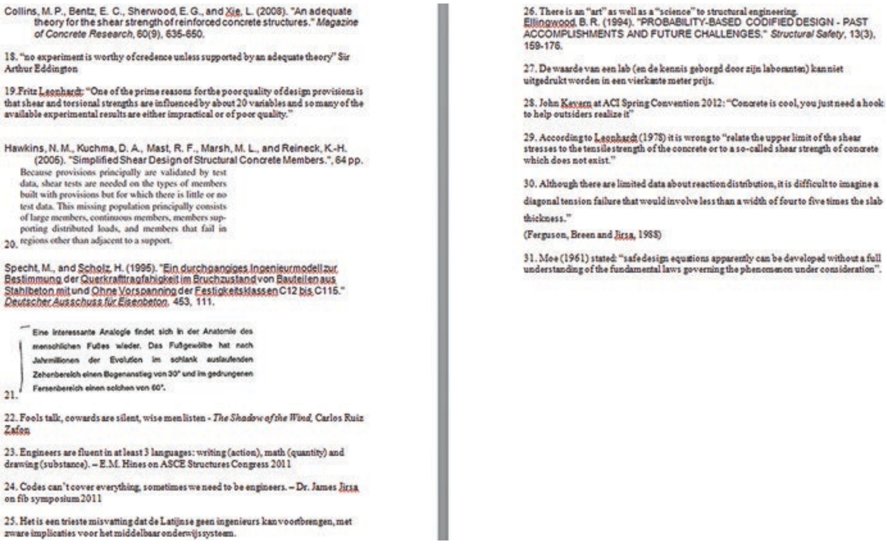
As discussed in Chap. 2, you should start writing in the very beginning. But, here's the caveat: you won't start writing your dissertation at the very beginning of your PhD trajectory. To start writing your actual dissertation chapters, you will need to be sufficiently far in the PhD trajectory (half-way is a good starting point) to know the red thread that needs to be woven through your work. That red thread will be your main answer to your research question. If you start writing and rewriting material from the very beginning, you risk to develop a very fragmented dissertation. Instead, I recommend you start writing short documents and material for discussion with your supervisors early on. After these initial exercises, you can move to research reports, such as the report with your literature review, or giving the description or analysis of your experiments. You won't reproduce large amounts of text from these research reports into your dissertation. Instead, you will summarize the important information (often in overview tables or figures) and refer to your reports for further reference. What you summarize, and the way you present the information in your dissertation, will again be related to how you are answering your research question and subquestions.

Don't postpone writing to the very end of your PhD trajectory. You may have heard wild stories from other students that claim that you can easily write a dissertation in six weeks or three months. Perhaps it is possible. Perhaps that first draft will need many rounds of revisions because it was written so hastily. But by all means, if you need to sit down and write from the morning to the evening, you won't be having a good time. I haven't met anyone who claims he/she wrote his/her thesis in six weeks and didn't feel miserable or ended up living on junk food and coffee. Do yourself a favor, and plan. You'll perhaps end up spending the same amount of time on your writing, but stretched out over a larger period of time, than when you need to speed up the process at the end. But, you'll be writing when your planning tells you it is time for your daily timeslot of writing, and at the end of the day you can go home and relax. So, which option sounds more pleasant to you?

12.2.4 Writing Propositions

In some countries like the Netherlands, your requirement for graduation is the development of the dissertation and propositions that you need to be able to defend. Traditionally, the propositions were the only graduation requirement in the Netherlands. Nowadays, the propositions are still an integral part of the defense. In the Netherlands, these propositions should include some defendable statements that result from your thesis, some defendable statements related to your field in general, and some statements related to other fields that are not related to your research, such as politics. One proposition is also supposed to be "funny".

You can imagine that if you need to come up with these propositions, you don't sit down one afternoon and write a list of propositions. You will need sufficient time during your PhD trajectory to think and develop possible propositions. Don't wait until the very end to write your list of propositions. I was lucky to hear this golden nugget of advice from a senior PhD student, and it made developing the propositions a walk in the park. If against all better advice, you do end up with a draft dissertation but still no propositions, then get out of your office. You'll get more inspiration for your general propositions by going to a coffee place or pub with friends, and discuss life, the universe, and everything. Just remember to write down your ideas before you forget them.



Collins, M. P., Bentz, E. C., Sherwood, E. G., and Xie, L. (2008). "An adequate theory for the shear strength of reinforced concrete structures." *Magazine of Concrete Research*, 60(9), 635-650.

18. "no experiment is worthy of credence unless supported by an adequate theory" Sir Arthur Eddington

19. Fritz Leonhardt: "One of the prime reasons for the poor quality of design provisions is that shear and torsional strengths are influenced by about 20 variables and so many of the available experimental results are either impractical or of poor quality."

Hawkins, N. M., Kuchma, D. A., Mast, R. F., Marsh, M. L., and Reineck, K.-H. (2005). "Simplified Shear Design of Structural Concrete Members.", 64 pp.

20. Because provisions principally are validated by test data, shear tests are needed on the types of members built with provisions but for which there is little or no test data. This missing population principally consists of large members, continuous members, members supporting distributed loads, and members that fail in regions other than adjacent to a support.

Specht, M., and Scholz, H. (1995). "Ein durchgangiges Ingenieurmodell zur Bestimmung der Querkrafttragfahigkeit im Bruchzustand von Bauteilen aus Stahlbeton mit und Ohne Vorspanning der Festigkeitsklassen C12 bis C115." *Deutscher Ausschuss für Eisenbeton*, 453, 111.

21. Eine interessante Analogie findet sich in der Anatomie des menschlichen Fußes wieder. Das Fußgewölbe hat nach Jahrmillionen der Evolution im schlank auslaufenden Zehenbereich einen Bogenanstieg von 30° und im gedrungenen Fersenbereich einen solchen von 60°.

22. Fools talk, cowards are silent, wise men listen - *The Shadow of the Wind*, Carlos Ruiz Zafon

23. Engineers are fluent in at least 3 languages: writing (action), math (quantity) and drawing (substance). – E.M. Hines on ASCE Structures Congress 2011

24. Codes can't cover everything, sometimes we need to be engineers. – Dr. James Jirsa on fib symposium 2011

25. Het is een trieste misvatting dat de Latijnse geen ingenieurs kan voortbrengen, met zware implicaties voor het middelbaar onderwijssysteem.

26. There is an "art" as well as a "science" to structural engineering.
Ellingwood, B. R. (1994). "PROBABILITY-BASED CODIFIED DESIGN - PAST ACCOMPLISHMENTS AND FUTURE CHALLENGES." *Structural Safety*, 13(3), 159-176.

27. De waarde van een lab (en de kennis geborgd door zijn laboranten) kan niet uitgedrukt worden in een vierkante meter prijs.

28. John Kevern at ACI Spring Convention 2012: "Concrete is cool, you just need a hook to help outsiders realize it"

29. According to Leonhardt (1978) it is wrong to "relate the upper limit of the shear stresses to the tensile strength of the concrete or to a so-called shear strength of concrete which does not exist."

30. Although there are limited data about reaction distribution, it is difficult to imagine a diagonal tension failure that would involve less than a width of four to five times the slab thickness."
(Ferguson, Breen and Jirsa, 1988)

31. Moe (1961) stated: "safe design equations apparently can be developed without a full understanding of the fundamental laws governing the phenomenon under consideration".

Fig. 12.2 Collecting ideas for the propositions

Just as with the kick-start method for writing dissertation chapters, you can keep a file on your computer, and jot down an idea or quote that could be a proposition whenever you stumble across it. You can see the file that I developed in Fig. 12.2. Once you need to compile your final list of propositions, you will have a fair amount of information to pull from. You will need to revise your wording, and make sure every word is crystal clear (unless you are using a quote). You will need to be honest with yourself, and see if you can defend each and every proposition, even the proposition that is supposed to be funny. Do you have enough data and background for each proposition?

12.3 Structuring a Dissertation

12.3.1 How to Outline Your Dissertation

Once you know the general topics that need to go into your dissertation, you need to decide how you will tie all these elements together. Remember that the main idea, the red thread through your work should be your answer to your research question. If you have all material ready, or are at a point where you have a good grasp of your work and what remains to be done, you need to tie everything together into a coherent dissertation. You need to bring structure into your mass of ideas [3].

Once you feel ready to start writing your dissertation, the first thing you will need is an overview of how you will structure your dissertation. Traditionally, the first thing your supervisor will ask you, is a table of contents for your dissertation.

However, you may need another approach to get started. You may need to think very well about the cohesion of your dissertation, and how you will answer your research question and subquestions, and how you will keep your main idea strong and solid throughout your entire dissertation. If you start by developing a table of contents, without keeping the bigger picture in mind, you risk ending up with a very fragmented document, which will need many rounds of revisions before it all comes together.

Think of your general overview as the map you can refer to. Think of your thesis as Mordor. One does not simply walk into Mordor. One does not simply walk into thesis writing. You need a plan and some magic powers (or better: a good grip of how you will answer your research question in your dissertation). You need to gather your weapons and have your map to guide you before you start plodding through thesis writing land.

The best way to have a map of what you will write, is to mind-map. Develop a scheme or diagram of the contents of your dissertation, so that you get to understand how the different chapters are interrelated. You can make a rather elaborate mind-map, or stick to a general overview that looks like a flowchart. If you are not sure about what you want to discuss in your dissertation, start from your research question. The answer to your research question should be the red thread through your dissertation. The answer to the subquestions can each be discussed in a chapter, for example. Or, if you are more of a visual person, draw a mind-map of your research question, how you branched out to subquestions, and the results you have so far and/or are expecting in terms of answering each subquestion. In the next step, you need to draw, sketch, or describe how these elements tie together. Refer to Chap. 5 for a discussion on how to combine the subquestions of your research question into your main chapters.

Besides functioning as a map, you can also use this scheme in your introduction chapter to explain the contents of your dissertation to your readers. A typical introduction contains a short summary of what the reader can expect in every single chapter of your dissertation. If you add the diagram of how the contents of these chapters are interrelated, or which data you have used where, it will be clearer for your how to read your dissertation.

Exercise

1. On a sheet of paper, write a bullet list with the major research tasks you have done so far (eg. literature review, case study X, recommendations for funding institution, experiments, theoretical work, …) . Then, write your research question in the middle of a large sheet of paper (a new sheet), and branch out with your subquestions. Identify how you need to answer each subquestion. Then, look at your page with the research tasks you have done so far. Where do they fit in? Add these to your sketch with the solutions to the subquestions. Some research tasks may fit in multiple categories – if that's the case, identify the relation between these subquestions. Now, look at your overview. How can you tie this information into a structured dissertation? Make an overview drawing that is as simple as possible, to function as your map for writing the dissertation. Which research tasks do you still need to do to answer your research question and subquestions? Identify the remaining tasks, and plan for them. Use the overview you developed to draft a table of contents for your dissertation,[4] and send this to your promotor for discussion.

12.4 Staying Motivated When Writing Your Dissertation

12.4.1 A Little Goes a Long Way

A key element to staying motivated when you need to write an entire dissertation is that you need to start early on. Slow and steady wins the race. Don't try to cram too much writing into a short amount of time – you will crash and burn before reaching the finishing line. Again, planning is a key tool here – to know when to start writing, and to put in the daily work of writing. Work in time slots of one to two hours daily, and try to achieve a certain word count during those hours if you need to produce text, draw a certain figure, edit a certain number of pages… Make sure you know exactly what you will be doing with your short time slot for the day, and do something that moves your dissertation forward – slowly but surely. You don't need to spend endless hours behind your computer screen every single day. Of course, you will have plenty of other tasks to fill your workday – but don't feel tempted to stay late every day to get your writing done faster. Take enough time for rest and relaxation, so that you will feel refreshed, energized, and inspired the next day when you tackle your next, well-defined writing task.

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[4] If your promotor likes seeing a table of contents as a starting point.

Schedule frequent meetings with your supervisor to discuss your progress, and to discuss the chapters you have written so far. Don't wait until you have a complete first draft to show it to your supervisor, but start to get his/her input early on. If you have doubts about requirements with regard to contents, depth, level of detail, or writing style, make sure that you discuss these elements early on, so that you can make course corrections as you write your first draft. For an excellent book, filled with weekly exercises to become an academic writer, see [4].

12.4.2 How to Stay Motivated and Balanced

When you have written two chapters, but still need to write six more chapters, you may have the impression that you have been writing forever, but that at the same time you are nowhere. Just remember that every day, every time you show up to write and move your dissertation forward, you are placing one foot in front of the other. And some day, somehow, your dissertation will be finished.

If you feel disheartened by the realization that you've already done so much, yet achieved so little, you may start to lose your motivation. You may feel stressed and worried, or simply dread the idea of waking up in the morning and going to university, where another day of writing, doing research, and teaching waits for you. One way to tackle this dark mood, is by having routines in your schedule. If you commit yourself to writing simply one or two hours each day, and to do one specific task (as discussed above) during that time, you may feel as if you have more grip on the situation. Your task is clear, and you know that at the end of your writing time slot for the day, you will have done something small but significant towards completion of your dissertation.

Another important element while writing your dissertation is to take good care of yourself. Routines in your working schedule and other activities that are not related to work are important to get you out of your stuffy office and into the world [5]. At the very beginning, in Chap. 2, we talked about the importance of including self-care and fun activities into our schedule. This advice is more important than ever when you are writing your dissertation. If you feel that your life currently is all work and no play, turn it around by signing up for a dance class, joining a book club, or simply calling your friends for drinks.

Whereas most of us begin with outlining our work (for example, in the form of a table of contents or by developing a diagram), and most of us finish our dissertation with compiling the list of notations, checking the format of references, compiling the final table of contents, and writing our acknowledgements for those who supported us during all this time, what happens in between these moments can be a bit messier. Somehow, at some point, we all run into gaps in our work, and need to spend a few more weeks to figure things out. Dissertation writing is almost never a process of smooth sailing,[5] so here are some ideas for what you can do to pick up your motivation again:

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[5] It's a journey of finding your identity as a scholar.

- **Reread an important paper**: Remember what got you inspired and motivated to do your research in the first place. Look for that inspiration again by revising a paper that was crucial for your research. If you are stuck in trying to fill a gap in your work, reread a paper that was essential to your work. If you need some fresh ideas, read a recent publication in your field. Remember that reading sparks creativity [6].
- **Edit a previous chapter**: If you want to leave the heavy number-crunching behind for a few days because you got stuck in trying to fill a gap in your work, then procrastinate by doing something useful. Pick a task that doesn't require much of your deep work capacities, but that still needs to be done before completion of your dissertation. You can edit a chapter that you wrote earlier, format a table, put some symbols in the list of notations, or make a drawing. Do something that you can easily tick off your checklist, and perhaps the action will make you forget about your foul mood.
- **Work on your propositions**: If a list of propositions is part of your graduation requirements, as it is in the Netherlands, then you may divert your thoughts when you get stuck by working on your propositions. If you've started to compile a list of possible citations and ideas, you can start to filter out some good ideas for your list of propositions. If you don't have any idea yet, you may want to browse your literature for good citations for your propositions.
- **Take some time off**: Sometimes, all you need is a weekend of time away from your research to feel refreshed and inspired again on Monday morning. Commit to having an evening or weekend to doing things you love. Don't spend it scrolling through your Twitter feed on your phone. Instead, think about what would feel really good for you now. Is it a dinner with friends, a cup of wine, a hot bath, three hours of escape with a book, a long bike ride…? Ask yourself consciously what would feel good for you right now, and honor that feeling.
- **Talk to your supervisor**: Are you having a difficult time, then let your supervisor know. If you are stuck and can't find a way out, outline possible solutions, list down what you've done so far to try and tackle the problem to no avail, and discuss this with your supervisor. He/she may just have the right idea to get you started again. If there are other difficulties in your life that keep you feeling down, let your colleagues and your supervisor know.
- **Accept friction**: Friction and creative blocks are inherent parts of the research process. There will always be this point when you feel really stuck and you need to sweat all the little details before suddenly you start to move forward again. Be prepared to face some creative and mental blocks while writing your dissertation. Everybody goes through these difficulties at some point during their PhD trajectory, and for many these difficulties arise during the writing stage. Accept friction as part of the process – it is not a sign that something is wrong with you as a scientist. In fact, you are growing as a scholar and finding your identity.
- **Set boundaries:** Don't work all your waking hours. Sure, there will be times during your PhD when you need to do a little sprint, or need to temporarily put in some extra effort. The number of scholars who've worked a nine-to-five schedule from the days of their PhD until getting tenure and beyond is very lim-

ited. You should set office hours (or work hours, if you don't always work in an actual office) for yourself for most days, and at the same time allow yourself to roll with the punches when needed. Everybody is different in what works best for them. For me, starting around 8 am together with my colleagues and leaving no later than 6 pm (when I am hungry and want to have dinner) worked well during my PhD days. If needed, I'd put in a bit more work after dinner, and I often worked on Sunday. Just identify for yourself what is a comfortable working schedule. Know what are non-negotiable self-care elements for yourself, and commit to never giving these up. Identify your comfortable working schedule, even if you are a part time PhD candidate, and plan your tasks and time slots accordingly.

12.5 Writing the Introduction and Conclusions Chapters

12.5.1 How and When to Write Your Introduction

There is a lot of discussion on when you should write your introduction chapter. Should you start writing your introduction chapter at the beginning, because it is your first chapter? Should you wait until the very end, because the introduction chapter needs to contain a brief introduction to what you will cover in all other chapters? As with all difficult questions: it depends…

If you start writing your dissertation, I recommend that you start by developing your overview diagram, and an extended table of contents or mindmap outlining how your subquestions will be answered in the separate subsections of each chapter. Then, if you feel ready for it, I recommend that you write a first draft of your introduction chapter. Your introduction chapter will discuss what the reader can expect in your dissertation. As such, writing the introduction chapter is an excellent exercise in framing your mind to what you need to discuss in your dissertation. Similarly, having your introduction chapter ready, with an overview of what you will cover in your dissertation, is a good starting point to discuss with your supervisor. Does he/she agree with your writing style? Did you define and limit the topic in an appropriate way? Your introduction will typically give a short background to the problem you studied, define the scope of your research, outline the aim of your research and/or state your research question, discuss the outline of your thesis, and perhaps give an idea of the impact of your work on society (or how your little piece of research fits into something that has a broader impact on society). By sitting down, and writing out all of this information, you will have a better grasp of what needs to be the red thread through your writing.

However, your introduction chapter may change significantly as you start to develop your dissertation. After you will have written your entire dissertation, you may need to seriously revise your introduction. It may be that you still needed to complete important chunks of research, and that the red thread you originally had in mind was altered significantly during the writing process. Once you have written all

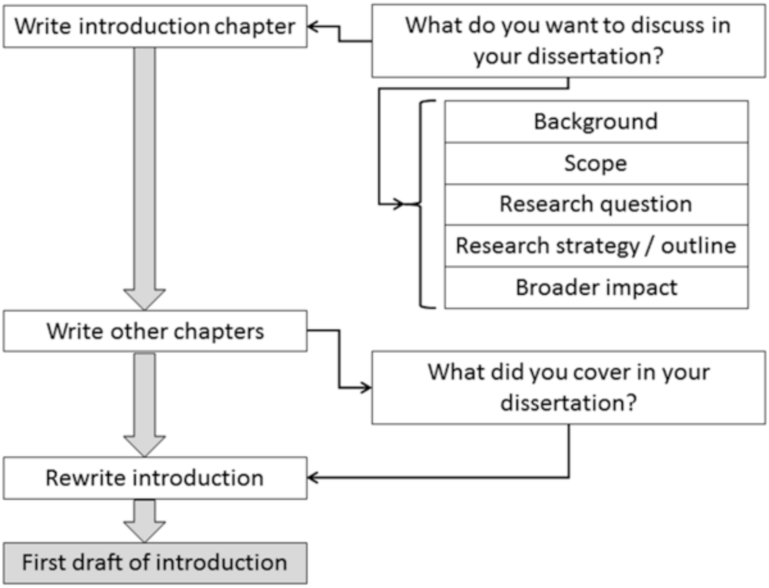

Write introduction chapter
What do you want to discuss in your dissertation?
Background
Scope
Research question
Research strategy / outline
Broader impact
Write other chapters
What did you cover in your dissertation?
Rewrite introduction
First draft of introduction

Fig. 12.3 Writing your introduction chapter at the beginning and revising it at the end of writing your dissertation

your draft chapters (including the chapter of conclusions), revise your introduction in depth. Ask yourself for every element that you mention in the introduction if your dissertation covers this element. Revise your research question and scope to make sure these sections are still reflected in the final version of your dissertation. You can find a flowchart of this recommended procedure in Fig. 12.3.

12.5.2 How to Write Conclusions

We mentioned in Chap. 11 that for writing the "Summary and Conclusions" section for a paper you can take notes while proofreading your paper and then draft this section based on your notes. Remember that you learned that you should not introduce new information in this section. The same holds true in general for writing the final chapter of your dissertation [7]. In terms of planning, you want to write your conclusions chapter after you've written all dissertation chapters, and before you thoroughly revise your introductions chapter.

Before discussing how you should write the final chapter of your dissertation, let's have a look at the goals for this chapter. Your final chapter contains specific messages that you want your readers to remember. Consider covering the following elements in this chapter:

- **Overview of main original contributions:** Give an overview of your original research contributions. This list helps your committee identify what you have contributed, and if it is worth graduation. It will also help your readers to see where within the research field your contributions are situated, which helps readers to identify if they should read your dissertation.
- **Executive summary:** Your conclusions chapter should include an executive summary of your entire dissertation. This summary may help a reader decide if he/she should read your entire dissertation. Use this summary to give a helicopter view of your work, so that a reader pressed for time can quickly identify what you worked on. You can provide the summary as a series of summaries of each chapter, but I recommend that you release the structure of the chapters and organize your summary in a thematic manner. Identify a number of main topics and summarize your work around these ideas.
- **Reach out to the industry:** Think about the practical implications of your work, and include a section in which you discuss how your results can impact the industry in your field and/or society. If you worked on a more practice-oriented research topic, you may have developed recommendations for practice, and be able to develop a paragraph that is detailed and ready to implement. If that's not the case, you still can write a general paragraph that points towards a few ideas for further development by the industry.
- **Future work:** Every Conclusions chapter contains an overview of future work. There will always be smaller open questions that remain, and the "future work" section is the right place to discuss these open questions. Having open questions does not mean that your work is not finished. If you've provided a supported answer to your research question, your work is finished sufficiently for graduation. But as you do research, you will always find other topics that seem interesting to study, or you may have identified the next necessary steps in experimental work to continue where you left. Smaller side questions are a good topic for assigning to a master's student.

Now that we have identified all the elements that we want to include in the Conclusions chapter, we can have a look at how to do this. As always, the key here is a lot of reflection on your work (which comes best when you have sufficient time to think everything through without needing to rush). Ask yourself the following: If a reader only has time to read your Conclusions chapter, what do you want him/her to remember from your work? What is the big take-home message (i.e. the answer to your research question) for your audience? Keep these questions in mind while you write your final chapter. If you want to decide if a topic needs to be discussed in your Conclusions chapter, revise these questions. If the topic is of minor importance, leave it out. If it's something you want every reader to remember, include it.

A method that you can use for writing the final chapter of your dissertation, see Fig. 12.4, is based on reading each chapter, and developing summaries of each chapter first. This method is similar to my recommended approach for writing the "Summary and Conclusions" section of a paper:

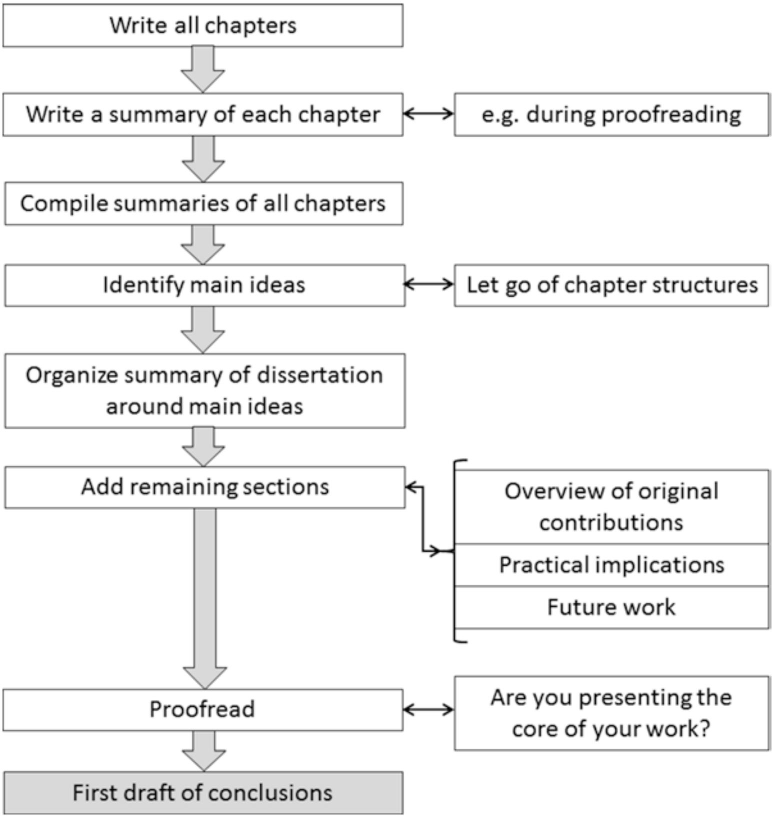

Write all chapters
Write a summary of each chapter
e.g. during proofreading
Compile summaries of all chapters
Identify main ideas
Let go of chapter structures
Organize summary of dissertation around main ideas
Add remaining sections
Overview of original contributions
Practical implications
Future work
Proofread
Are you presenting the core of your work?
First draft of conclusions

Fig. 12.4 Writing your conclusions chapter around the main ideas of your work

1. Develop a summary of each chapter. You can takes notes of each chapter while you proofread it, and then type out these notes into a summary of the chapter.
2. Compile the summaries of all chapters. The result will not be a cohesive piece of writing – yet.
3. Identify the main ideas from this compilation of summaries. Rearrange and rewrite all material of the compilation of summaries so that it is centered around the main ideas of your work.
4. Add the sections about your original contributions, practical implications of your work, and future research.
5. Reread the entire draft chapter after a few days. Ask yourself if the material that you are presenting is the very core of your work or not. If a main idea is missing, add a paragraph about this topic. Identify superfluous material and leave out all that is unnecessary.

In terms of planning, you should be able to develop a draft version of the final chapter of your dissertation in a week (it took me about two or three days). Remind yourself to stay on course, to stay close to the main idea of your work (i.e. the answer to your research question), and avoid writing excess text. Write your conclusions chapter with the pressed-for-time reader in mind!

12.5.3 How to Identify Future Work

We've briefly looked at future work in the previous section. If you can't think of any topics to add to this part, take a step back. Have a look again at the material that you used to outline your dissertation, and how you subdivided your research question in subquestions. Which of these subquestions led you away from your research question into lands full of unknowns? Identify these remaining unknowns as possible topics for future work. You can subdivide your recommendations for future work in the following elements:

1. **Future experimental work:** At some point you may have needed to make space in the laboratory, or you may have gathered sufficient data to answer your research question adequately. However, there will always be parameters that you may have wanted to vary as well, or other measurement techniques that at some point sounded interesting to try out. These topics certainly fit the "future work" section. If your work was mostly analytical, you may want to add experimental validation of your work as future work.
2. **Future numerical work:** If you've mostly focused on experimental work, there may be interesting work remaining in modeling your experiments numerically, extending your experiments numerically, or using other simulation techniques. Similarly, if your research mostly involved numerical work, you may identify other modeling techniques, other material models, or other parameters that still would be interesting to analyze.
3. **Future theoretical work:** Every doctoral dissertation contains a certain advance at a theoretical level. You may have had ideas for other theories to explore, which you can mention here. You can have found the basic assumptions of your theoretical work and the boundary conditions to exclude some cases. An extension of your theoretical work to include these cases then makes an excellent topic for the "future work" section.
4. **Improvements for practice:** If your research is practice-oriented, you may have developed recommendations for the industry, but you may have also identified for which cases you cannot extrapolate the results of your work. Such extensions fit in the "future work" section. If your work was more theoretical, you may have written a paragraph with some ideas for implementation in practice. In the "future work" section you can outline how you would go about developing these implementations, and which additional research may be required to come to conclusive recommendations.

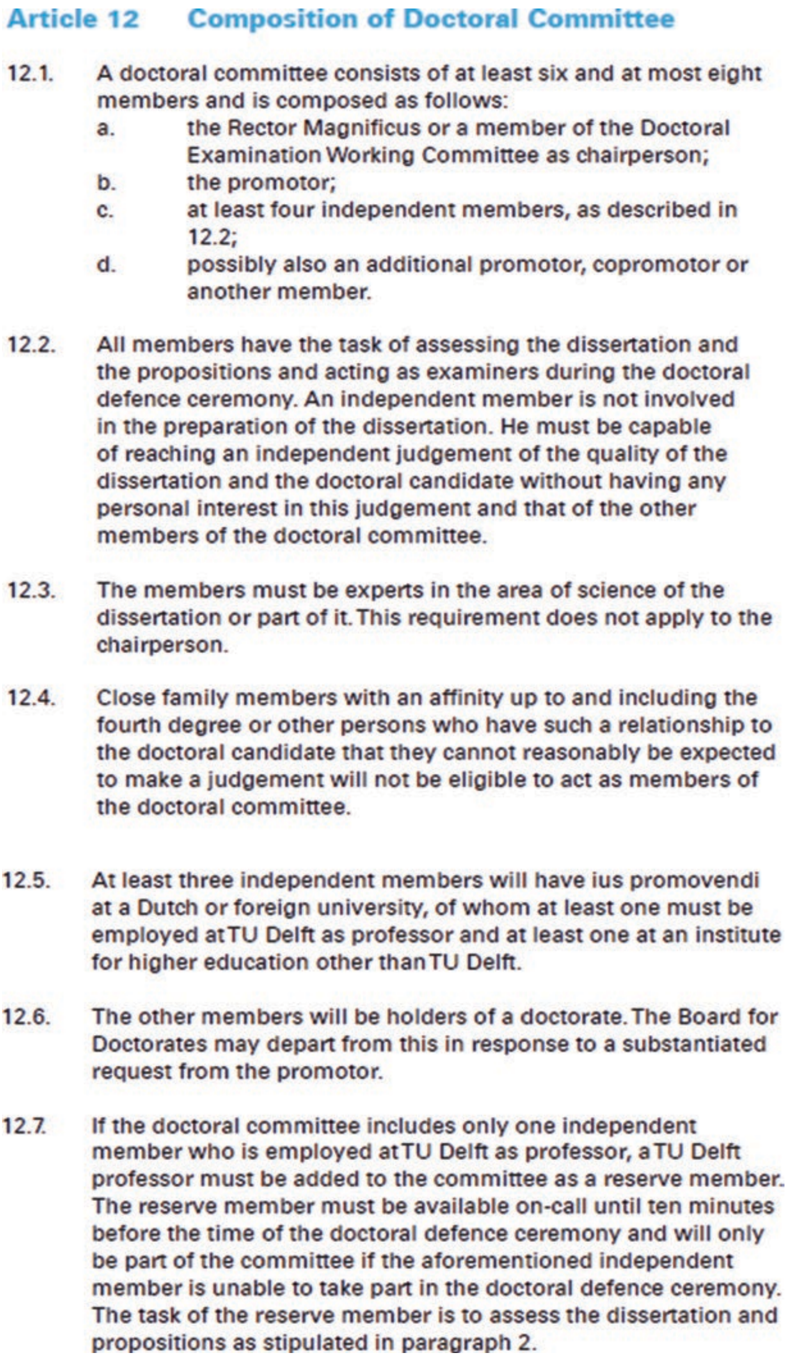
12.6 Implementing Comments of Committee Members

12.6.1 How to Compile a Balanced Committee

Depending on the guidelines of your university and the common practice in your country, you will either compile your committee at the beginning of your PhD trajectory, or towards the end. If your committee gets selected at the beginning of your PhD trajectory, it is unlikely that you will be able to provide a lot of input to your supervisor on your committee. At that point in your journey, you will still need to do the research and literature review to identify the important players in your field. Your supervisor will have an idea of the direction he/she wants you to explore for your research, and select the appropriate committee members. You will then work with your committee at several points during your PhD trajectory.

If your institution defines the task of your committee members as examiners towards the end of your PhD trajectory, you may assist your supervisor in compiling a balanced committee. Sometimes, fulfilling all the requirements for a committee can be quite cumbersome, and you may need to do some puzzling across categories to make it all fit. If you have a say in the selection of your committee, you can recommend people from different categories. For example, if your work has practical applications, having somebody from the industry or the government in your committee can be very beneficial. This person can advise you on how to formulate your recommendations for practice, how you can implement these, and perhaps help you find employment outside of academia after your defense. Other typical picks for a committee are: the researcher whose work you continued, or the professor whose PhD student is working on a similar topic as yours. If your work is interdisciplinary, make sure you have the different disciplines represented in your committee. If you have worked with a professor of a different research group or faculty during your PhD to address specific issues, he/she can also be a good pick for your committee. Once you have identified possible committee members, your supervisor will take the task upon him/her to ask if they are willing to join your committee. You typically have to puzzle a bit to fulfill all the requirements of your institution (for an example of the requirements of TU Delft, see Fig. 12.5).

One last hurdle in compiling your committee can be the defense date. In some universities, fixing a defense date is simply a matter of booking a meeting room and finding a time that suits everybody. In other places, like in the Netherlands, the university has one designated room for all defenses, and the availability of this room will dictate your defense day and time. It happened to me that I actually had to replace one committee member because he was not available on my defense day – and it turned out that changing the defense date would be harder than changing a committee member, because of the lack of room availability (and availability of the beadle, the person in charge of all protocoled elements of the defense).



Article 12 Composition of Doctoral Committee

12.1. A doctoral committee consists of at least six and at most eight members and is composed as follows:
  a. the Rector Magnificus or a member of the Doctoral Examination Working Committee as chairperson;
  b. the promotor;
  c. at least four independent members, as described in 12.2;
  d. possibly also an additional promotor, copromotor or another member.

12.2. All members have the task of assessing the dissertation and the propositions and acting as examiners during the doctoral defence ceremony. An independent member is not involved in the preparation of the dissertation. He must be capable of reaching an independent judgement of the quality of the dissertation and the doctoral candidate without having any personal interest in this judgement and that of the other members of the doctoral committee.

12.3. The members must be experts in the area of science of the dissertation or part of it. This requirement does not apply to the chairperson.

12.4. Close family members with an affinity up to and including the fourth degree or other persons who have such a relationship to the doctoral candidate that they cannot reasonably be expected to make a judgement will not be eligible to act as members of the doctoral committee.

12.5. At least three independent members will have ius promovendi at a Dutch or foreign university, of whom at least one must be employed at TU Delft as professor and at least one at an institute for higher education other than TU Delft.

12.6. The other members will be holders of a doctorate. The Board for Doctorates may depart from this in response to a substantiated request from the promotor.

12.7. If the doctoral committee includes only one independent member who is employed at TU Delft as professor, a TU Delft professor must be added to the committee as a reserve member. The reserve member must be available on-call until ten minutes before the time of the doctoral defence ceremony and will only be part of the committee if the aforementioned independent member is unable to take part in the doctoral defence ceremony. The task of the reserve member is to assess the dissertation and propositions as stipulated in paragraph 2.

Fig. 12.5 Excerpt of Doctoral Regulations of TU Delft with regard to the compilation of the committee [8]

12.6.2 How to Implement Comments of Your Committee

Depending on where you are studying for your PhD, your committee members can have different tasks. Similarly, the timing of your defense depends on your institution: some institutions require an approved and printed thesis prior to the defense, whereas other institutions require revisions to the dissertation after the defense. At some point during your PhD trajectory, however, you will receive comments from your committee members that you need to implement into your dissertation.[6]

Implementing the comments of your committee members can be similar to implementing the comments of reviewers for a journal article. The main difference though is that you know the identity of your committee members. You may be able to meet with them in person, and verbally address some of their comments. You may explain better what you meant, and agree together which parts you should rewrite. In such a meeting, you can also learn which part of your dissertation they find important (a possible hint for their questions on your defense). In such meetings you can talk about possible concerns of your committee members, and show sound technical reasons why there is no need for doubt. Make sure you can strengthen each argument with your work or with evidence from the literature. If your committee member points out a flaw, go back and do the necessary work.

For the comments of reviewers, you need to prepare a detailed reply to each and every comment. For the comments of your committee, it may not be necessary to have a written report of each small editorial comment that you worked through. Instead, you should focus on the main concerns of your committee with regard to your novel contributions, and prepare a written point-by-point explanation about how you addressed these concerns, together with more background to the literature or your own work to explain these concepts further. Be prepared to defend your point of view, with all the required evidence from the literature and your own work, during your defense.

12.7 Defending Your Thesis

12.7.1 From Finished Thesis to Defense

When all is said and done in your thesis, it is time to plan towards your defense. Again, the timing of dissertation and defense depends on the institutional policies. If you need to make changes to your dissertation after the defense, the defense itself will feel more like a part of the dissertation process. If your defense is the very last step between you and your diploma, there may be more time between finishing the dissertation and defending, and it may feel as that last looming heavy task on the horizon before you are finally done.

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[6] This section is written from the perspective that implementing the comments of the committee comes before the defense. You can implement this advice as well if you need to submit a revised version after your defense.

By now, you should know how to plan for everything – you've made it to the end of your journey, and I'm assuming your planning skills have helped you through. The final months of the PhD trajectory involve their own difficulties [9]. Whereas planning experiments and writing may be something you have grown accustomed to over the last years, the last months of the PhD trajectory are a whole different beast. Unless you are doing your PhD in your home country and will roll straight into a faculty position at your institution, you will be finishing your PhD, and at the same time searching for a job, moving out of your current place, boxing up all your stuff, and perhaps arranging international moving.

For me, too, it was an overwhelming time. In between getting my thesis to the printer on time, filling out HR forms for my next job, attending seven conferences to show the world the results of my research, finding babysits for my cat, ending all insurance and utilities contracts I had in the Netherlands, and buying plane tickets, there was not much time for breathing. And there was the constant fear of "what if I forget paperwork X or Y and get into administrative difficulties?"

Be prepared for the last months of your PhD trajectory to be intense, and incredibly messy. Know what is ahead of you, and face it full on. Keep your head clear, plan realistically, keep lists with to-dos to remember everything, and allow sufficient time for sleep and recovery so that you can remain sane throughout this whirlwind.

Once the wind calms down, and everything is settled and you have defended, don't be surprised to find yourself looking up and wondering "what now?" Many recent PhD graduates have mentioned that they feel some sort of a black hole after graduation. I described it as a minor post-partum depression from my dissertation-baby. You may feel a period of unidentifiable gloom, you may feel lost, even though you're still incredibly busy with moving. Just acknowledge the fact that you've just finished a long period in your life where you worked towards one goal, and that suddenly that goal has been achieved, and the solid ground of certainty is removed from beneath your feet. If these feelings visit you, don't despair, and don't be ashamed of them. Be kind to yourself, and give yourself time to get back to your feet.

12.7.2 How to Prepare for Your Thesis Defense

If we zoom into those last messy months of the PhD trajectory, regardless of your institutional requirements, there will always be your moment to shine, at your defense. So let's now have a closer look at how you can prepare yourself best for your defense [10]. Some colleagues may tell you that you don't need to do anything in preparation. Their argument is that you have been doing all the research over the past few years, and nobody knows your work as well as you do. However, going into your defense without any preparation at all may not be the right strategy. If you wrote your literature review chapter 2 years ago, you may need a refresher on some of the elements you discussed, and you may need to reread some key publications. Your defense will as well depend on your committee, so keep them in mind when preparing for your defense. The last reason why it is recommended to spend some time preparing for your defense, is that it helps you prepare mentally for the day itself. Chewing through possible questions in advance will give you some peace of mind.

When preparing for your defense, it is crucial to find the sweet spot between over-preparing and going without preparation. I certainly over-prepared: I spent a lot of time preparing for my defense, and not all activities were equally necessary for me. They were important for me at that time though, mostly to gain confidence towards the defense. I did the "check, check, doulecheck, triplecheck, quadruplecheck, quintuplecheck"-kinda thing, mostly to reassure myself that I could actually defend my work without fainting or suddenly being unable to speak English. If you need extra time, mostly to calm your nerves, then add in that time. If you want to prepare in a smart way for your defense, you should focus on the following:

- **Conferences:** Presenting your work at academic conferences is a crucial part of your PhD trajectory. If you've presented your work a few times for an international audience and answered questions, you are better prepared than when you'd never had the chance to travel and present your work. Every presentation adds a bit more confidence to your meter. Every time you present your work, you will have practiced and sharpened your presentation and presentation skills a bit more. Use your PhD time and available funding (or other sources, such as scholarships) to present at as many conferences, workshops, and industry events as possible. All this practice throughout your PhD trajectory will make you more prepared for D-Day (Defense Day).
- **Know your committee:** The questions you can expect during your defense will depend on your committee. As you prepare for your defense, don't make the mistake of navel-gazing at your own dissertation. Instead, take a step back and evaluate your work through the eyes of your committee member. Check out their most recent publications to be fully up-to-date with the work of your committee members: you don't want to be completely oblivious when a committee member hints at the fact that he/she worked on something interesting for your research very recently. Don't assume that you have read everything you need to know while you did your research; check out the latest and in press publications. If you've had a chance to meet with your committee members during your PhD, or while preparing for your defense, revise your meeting notes, and identify their main points of interest and of criticism to your work. Some committee members will tell you their exam questions in advance, whereas other members will leave you guessing. Try to come up with at least five possible questions per committee member, and prepare additional material to answer these questions where needed.
- **Revise crucial papers:** Brush up on your knowledge of the literature. Besides checking for the most recent work of your committee members, make sure that you do a brief search on recent publications in your field to have your knowledge of the literature up-to-date. Don't stop following the literature the day you finish your literature review chapter. Work on your general knowledge of the literature,

and also identify the papers that were most important for your work. Read these papers again to refresh your memory, and to address possible questions about the foundations of your work. Consider taking copies of the five to ten most important references you based your work on to your defense.

- **Prepare for broader questions:** Your committee members will ask questions from their perspective, and will perhaps ask questions that are at the periphery of your work, and much closer to their work. Another common type of questions is related to the assumptions and basic foundations of your work, and of the literature you based your work upon. Make sure you have a solid foundation to answer such questions. Besides questions that sit right outside the main focus of your work (and the answer to your research question), there are also questions that focus on the broader scope of your work, other fields of application for your methods, and future work. You can find a list of common general questions at the end of this section. Make sure you practice preparing answers to these questions, and bring additional material to your defense where needed.
- **Familiarize yourself with the defense room and available tools:** Sort out the logistics for the day of your defense in advance. You don't want to be running around campus, looking for a cable or laptop last-minute, or trying to fetch coffee for your committee members. Talk with a recently graduated post-doc to verify if you have thought of everything. Make sure you understand all procedures, and when in doubt, ask the office responsible for the defense. Know where you will defend, and which tools are available in the room. Will you be using a microphone? If you will be using a microphone, will you be using a hand-held microphone (and have only one hand left for writing/sketching/gesturing), or will you be using a headset microphone (and need to clip it onto your clothing somehow)? Will you be able to project visual materials and use audio in the room? Are there other tools available, such as a blackboard, flipover board, or overhead projector? In Delft, the defense room has a digital overhead projector, which you can use to show pages of your dissertation, sketches, and other material. Depending on the available tools, make sure to bring the right material to your defense.
- **Be yourself:** Don't get too stressed about the defense. If you get stressed, you'll have a harder time keeping your thoughts ordered and replying the questions in a way that is satisfactory for the committee. Many students start their defense nervous (I remember I did – or better: I was so nervous I can't remember the questions from the first committee member!). Once the first spike of nerves calm down and you remember to enjoy yourself, your defense will go much smoother. Make sure you've slept enough in the week(s) prior to the defense to have a clear head, and take good care of yourself by exercising and eating properly. Treat yourself as an athlete preparing for a big effort: make sure you are in your best shape to give it your all on the day of the defense.
- **Don't forget your party:** You may be tempted to prepare for your defense just in terms of replying the comments of your reviewers. But don't forget that your defense is a main event in your life that merits a proper celebration. Honor your friends and family (and committee members and colleagues) who have gathered

to watch you defend, to support you, and to celebrate this major achievement with you. Keep in mind the importance and value of this day for all attendees. Unless for weddings and perhaps special birthdays, there are not that many occasions where you can have that many of your loved ones together, to celebrate you and your professional success. Your family may be even traveling internationally to attend this special event, so make sure it becomes a special day for everyone attending. Arrange a reception and a nice dinner, for example, or any other form of celebration as you see it fit.

Here is a list of general questions you can use to prepare for your defense [11–13]:

- Why is your research question relevant to the industry / your field?
- How did you define and limit your research question?
- What was the most interesting aspect of your research? Which discovery surprised you most?
- Which author/researcher has been most influential in your field, and why?
- Is somebody else carrying out similar research to yours? What are the main similarities and differences?
- You have based your model/methods on paper X. Can you explain why you selected paper X as a starting point?
- How would you apply your method to Another Field?
- You have not used A More Commonly Accepted Theory. Can you explain why you decided to based your work on A Different Theory?
- Did you make any changes to your experimental setup (or other methods you used) during your experiments?
- How did you decide on the variables to be tested in your experiments?
- What is the statistical relevance of the number of experiments you carried out?
- How did you measure the important variables in your experiments?
- Are there variables that you have not tested that you recommend for future work?
- Did you have any negative outcomes?
- Which other methods could you have used for your study? Why did you opt for the method you used?
- Can you explain in more detail how you analyzed your data?
- Can you extrapolate your conclusions to other related problems?
- Can you summarize your main contribution in a few sentences?
- Can you discuss your novel contributions?
- Can you defend Proposition Number X?
- Do any of your results or conclusions confirm or contradict findings from the literature?
- What is the broader impact of your findings on the industry or society?
- If you are to continue this research, what would you do?
- Which other research topics in your field have you identified as relevant for future study?

12.7.3 Surviving Defense-Day

If you feel nervous about your defense day, write down your itinerary for the day. Leave plenty of time for every step. Keep in mind that you need time for eating at some point during the day, and that when your family arrives, you may want to have a chat with them instead of running away while muttering “I need to go get a few more things.” Take a snack with you to nibble on if you tend to get a bit dizzy when you haven’t eaten in a while. Have a bottle of water with you. Don’t forget all your preparation materials (including a printed version of your dissertation) and some empty sheets of paper for sketching when you reply the questions of the committee members (or a marker if you can use a whiteboard or flipover).

When you have everything you need for the defense, try to relax a bit. Know that you have prepared yourself properly for your defense, and that you are the expert in your work. If the nerves makes your breath short and jagged, place a hand on your abdomen and try to slow down your breath and breathe by using your diaphragm. If you need to isolate yourself a bit in the minutes prior to the start of your defense, go to a quiet place (as long as somebody knows that you didn’t just run off). If you prefer social interaction, chat with your friends and family and let their stories distract you from the upcoming defense.

During the defense itself, the key is not to rush into answering questions. First of all, you need to let your committee member state his/her entire question (that is just basic politeness). If the question is long or has subquestions, take notes. Then, if the question is long, formulate the question in your own words, and ask the committee member to confirm that you understood the question correctly. Make up a strategy on how you will answer the question in an organized fashion, and tell your committee member: “I will first address your point X, and then show you experimental result Y to support my statements, and literature source Z to give further background.” Then, explain every part clearly and with full detail. Don’t stretch time unnecessarily, but also don’t rush through your questions. Try to stay calm and composed, and keep your breathing under control. If you need to think for a moment to see how you will answer a question in a structured way, there’s no shame in saying: “Let me think about this for a moment, so I can see how I can answer this in a clear and structured way.” If you need to sketch something, tell them that you will first draw something, and then explain them. Just avoid the rabbit-staring-in-headlights look when you try to scramble your thoughts together.

12.8 Summary

In this chapter, we’ve covered all the steps related to planning, writing, and defending your dissertation. The first important topic was planning the writing of your dissertation. Writing a document of roughly 100,000 words is no small feat, so having a plan of how you will tackle this major task is not a luxury. We discussed which steps you can take in the years of your PhD trajectory to gather material that will help your writing advance more rapidly, and when during your PhD trajectory is a good time to start writing. For those of you who need to write a dissertation and propositions, we briefly discussed how you can prepare yourself to develop your propositions.

Once you have decided to start writing, you need to structure the contents of your dissertation around answering your research question. A dissertation is not a tale of what you did in all the years prior to your defense, and there may be plenty of calculations you made that won't end up in your final dissertation. Make sure you limit yourself to answering your research question and subquestions. We revisited the scheme that shows how your different chapters are related to guide you towards developing your contents further.

Once you are halfway through your dissertation, you may feel like you've been typing and typing your chapters for months on end, and you still have so much work to do. If thesis writing starts to feel like a drag, you can use a bit of motivation to help you through. We discussed how setting realistic goals for writing each day in terms of a word count can help you move your thesis forward slowly but surely. We also discussed how you can avoid to burn out while writing your dissertation, and stay motivated and balanced.

A special topic is the writing of the first and last chapter of your dissertation. The first chapter, your introduction, is the chapter that introduces all information that will be discussed in your dissertation. We discussed that it can be beneficial to draft this chapter before writing all other chapters to help you focus on answering your research question, and then rewrite this chapter after you've written the rest of your dissertation. The final chapter, your conclusions, should contain a summary of the main ideas and novel contributions introduced during your thesis. Moreover, your conclusions chapter will require a discussion of the effect of your research for practice, the industry of your field, and/or society. You'll also have to identify elements of future work.

Implementing the comments of committee members is similar to replying reviewers' comments in a sense that most often the comments will mean that you need to better explain certain parts of your thesis. The difference between replying reviewers' comments and comments of committee members is that you will know your committee members, and you will be able to visit them, discuss in person, and learn more directly what they consider the most interesting as well as the weakest elements of your dissertation. Identifying this information will help you prepare for your defense.

Finally, we discussed the topic of defending your thesis. We discussed the steps that lie between finishing your dissertation and the actual defense – which differ of course depending on the institutional regulations. To prepare for the defense, we discussed some strategies to avoid over-preparing as well as to avoid going with the wrong type of preparation. Remember that your defense questions will be posed by your committee members, so getting to know them and their research is a crucial part of preparing for your defense. Finally, we discussed some practical tips to keep your head cool on the day of the defense and answer all questions in a calm and structured manner.

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Chapter 13
Navigating Career Options After Your PhD

Abstract In the final chapter of this book we look at life after the PhD. The first topic is letting it all sink in after the defense. We talk about the emptiness some people feel after finishing their PhD, how to deal with this, and how to answer the question of "What is next in life". We also highlight the importance of celebrating the major achievement of getting your PhD, taking time to rest and reframe your thoughts, and then preparing for the next step in life. This discussion will bring us to the second topic: what are the options you have after your PhD? We look at preparing your resume, letter of purpose, and preparing for an interview – regardless of whether you are applying for a position inside or outside of academia. We will discuss how to highlight the skills you gained during the PhD, for example, to land a post-doc in a field that is only tangentially related to your PhD research, or to find a job in industry. The fourth topic discusses a career in academia, and how to win at it, combined with the fifth topic which contains tips for success in the industry. This chapter will close with the topic of getting an international perspective. We focus on exploring the international job market, academic nomadism, starting international collaborations, and the benefits and challenges working internationally brings.

Keywords Academia · Academic careers · Careers in industry · After the PhD · Resume · Job applications · International collaborations

13.1 Introduction and Learning Goals

In this chapter, we look ahead at life after the PhD. Don't wait until you have defended your PhD to read this chapter, but start asking yourself what you want after your PhD trajectory when you are halfway through your PhD. In this chapter, you get an overview of the different career options you can contemplate, and you learn to figure out which type of job would suit you, your personality, and your skills best. Sometimes, players in the industry consider a PhD as "lost years". In this chapter, you learn how to market your academic skills for jobs outside of academia. This chapter closes off with tips for success in academia and the industry, as well as some advice for international careers and collaborations.

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13.2 Life After the Defense

13.2.1 Letting It All Sink In

So you have defended your dissertation and you are a fresh "Dr." now. What is next? Just as the months prior to your defense can be very messy, the months following your defense can be messy and stressful, and you may be camping at your family's house for certain amounts of time, or finding that you need to rummage through your boxed-up stuff to find something you need.

If you have some time off between jobs after your PhD defense, and your energy is not getting fully drained by moving to another place, you may find yourself sinking into a black hole of emptiness. If you've finished a major life achievement like getting your PhD, you may feel a strange kind of sadness and moodiness that you can't explain. As I mentioned in Chap. 12, I tend to call this the post-partum depression of your PhD baby, and it is not uncommon at all. To avoid sinking into this black hole, make sure you know what to do with yourself and your time after graduation, and take plenty of time to celebrate your major achievement [1].

If you think life after your PhD defense will be spent on a tropical beach, sipping cocktails, and enjoying the good weather, you may be surprised to find out that paper deadlines don't care about the fact that you just graduated and may want to get away from it all. In short, the academic universe does not stop spinning when you become Dr. You. Yes, you will find some time to breathe and rest, but if you've taken on academic duties over the last years (service appointments for technical committees, serving as a journal reviewer…), those duties won't end. However, before the humdrum of life and work picks up full speed again, you can enjoy the extra time and space after defending your PhD with the following activities:

- **Clean**: If you are leaving your university, you will need to empty your university office, which is an ideal moment to decide what you want to take with you, and what you can get rid of. If you are staying at your university and in the same office, now is still a good moment to clean out the clutter of everything you have gathered during the years of your PhD trajectory. You may want to consider switching to a paperless office and go on a scanning spree. You can now happily drop all the draft dissertation versions you printed and proofread into the paper recycling container. Homeworks of courses that you were teaching as an assistant are not something you will ever need again if your students have graduated – into the recycling bin they go[1]! Even though your university has cleaning services, you may be surprised to find how dirty your desk can be behind all the piles of paper you amassed over the last years: grab some disinfecting product, wipe everything clean, and perhaps keep some more space on your desk for the future.
- **Distribute your dissertation**: I had my dissertation printed in 250 copies, and by now, I have about two more boxes of copies left – the rest has been distributed.

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[1] Unless your university regulations require archiving.

I took piles of my dissertation to conferences to give away to those interested in the year I graduated. I sent a copy of my dissertation to a large number of people: I went through all the business cards I collected at conferences, and sent a copy to everyone who might be interested, in addition to the famous professors in my field. Don't wait too long after finishing your dissertation to distribute your copies – in the months following your defense, you will become increasingly critical of the work you produced, and perhaps feel less inclined to distribute it.

- **Network**: The first way to get back in touch with your network after your hermit months is by getting in touch with your contacts and distributing your dissertation. Make time to plan appointments with friends and colleagues after your defense, and catch up with them. Write an e-mail to your contacts who are living farther away.
- **Spread the word**: Travel to a fair amount of conferences to share your ideas and distribute your dissertation. Bands tour after they release a new CD, so if you can fork out the money or get the funding, make a tour of conferences (the extra effort required in writing all the papers is worth it). Don't just think of academic conferences: now is a good time to give presentations at industry events, reach out to a local school about the value of your science, or give a TEDx talk. Show your work to the world and to everyone who wants to hear about it.
- **Celebrate**: We've talked at length about celebrating your successes. After a major achievement such as obtaining your PhD, make sure you do something memorable. Think about what you always wanted to do, visit, or learn, and do this activity to celebrate your PhD. Learn how to surf, go for a long backpacking holiday, or visit a place that is on your bucket list – make it memorable. I celebrated by going to Wacken Open Air, a festival I never got to visit because I never got tickets or transportation. A friend of mine took care of all the logistics about a year in advance, and we had a great time four days away from it all to celebrate and spend time together.
- **Update your CV**: Add your new degree to your CV, and see if all your information is up-to-date. You can now proudly add your title to all your academic online profiles, such as ResearchGate, Academia.edu, and LinkedIn.
- **Update your list of publications and presentations**: If you didn't keep track of your publications during your PhD, go through your material and compile your list of publications. You should keep this list up-to-date at all time – the easiest way to do this is by adding a new publication to your list whenever you start working on it. Now that you have graduated, your list of publications will be more important than ever. Make a list of all presentations you have given as well.
- **Rest**: Catch up on sleep, do everything you enjoy doing, and just take some time off – it's been an intense period after all. I tried to get back to writing about ten days after defending, and it was simply too early. Writing felt like a drag, and I couldn't squeeze out more than a paragraph a day – I had simply gotten tired of letters for a while. You need to allow yourself time to relax. You're the athlete who just finished that marathon; now do all the post-effort self-care activities you need to do to recover from this effort.

- **Plan your publishing strategy**: We've discussed how to develop a strategy for publishing in Chap. 11. If you haven't outlined yet which chapters of your thesis you will turn into papers, start to figure that out now. You don't need to dive into your writing right away, but just do some brainstorming about your writing. Who will be your coauthors? Which journal will you submit your work to? You can add all this information to an overview table, and outline when you want to finish your first draft of these papers, and by when you plan to submit. Make writing these papers your priority for the coming year, regardless of the career choice you make: if you go to the industry, you still want to publish your work in case you want to return to academia in the future and to communicate your results, and if you stay in academia you will need publications.
- **Something new**: You may have been in your research bubble for the last three or four years, so burst out of these limitations, and explore something new. Work on a new project to keep things interesting. Start a small project for your own interest. Work with a new collaborator (extra points if you can set up an international collaboration). Learn a new subject. Code in another language. Teach a course.

13.2.2 Figuring Out What to Do Next

If you haven't outlined yet which career options you will be pursuing, start by identifying your strengths and weaknesses, and try to match possible careers with your personal profile. Don't add too much weight to the question: "What is next in my life?"; after all, you are not signing away the rest of your working life when you sign your first contract after your PhD. Many researchers spend some time in the industry after their PhD and then return to academia, or start in academia and then switch to a policy-making job in the government. Don't focus your thoughts on a single career path, and know that it is likely that you will switch careers about three to seven times during your working life [2]. Economic crises, family situations, job opportunities, your partner's job: there are many reasons why you may need to make a career change.

Your PhD is the highest level of higher education. Leaving academia after a PhD and not becoming a professor does not make you a failure, as some people tend to believe. You received a versatile research-oriented training, developed skills, became very independent, and now you have a wide array of career options to choose from (more on these career options in the next section). Regardless of your choice of career, your PhD education will help you prepare for service to society: as an academic, in the government, in the industry, or in whichever form you decide to explore.

If you want to explore what you should do after your PhD in a broad sense [3], think about the following questions:

- What would you like to do after your PhD?
- What are your strengths and for which competences can you leverage your skills?
- Are you willing to move away from your current location? If so, consider the culture and location of the place where you would be applying for a job, and ask yourself if these elements would suit your personality.
- What type of lifestyle do you want to have?

Be prepared to explore different options, and remember that if you are just entering the job market, you start at the bottom like every starter [4]; and all beginnings are difficult. Just prepare yourself for a time of change and new starts, and don't consider your PhD degree as the winning lottery ticket to the perfect job right away. Every different job will require a different set of skills, and prior to getting a job, you will need to demonstrate your unique capabilities in the job interview. Prepare well, be ready to learn new things, and show your future employer what your research training can add as value to the company.

You can be creative and build a career as an independent researcher outside of the regular confines of academia, as Dr. Kelly explained in an interview [5]. I, too, explored different possibilities, and discussed this in an interview [6].

An excellent book on this topic is "80,000 hours" [7]. I strongly recommend reading this book, since it contains research-based evidence on how to build a career that does good and has an impact on the world.

13.3 Career Options

13.3.1 Overview of Options

If you want to have an idea which type of job you would like to apply for, it is good to make an overview of the different possibilities that you have. For your convenience, I have compiled a generic list of options to start from [8]. You'll tailor this list to your situation in the exercise following this paragraph. Here is an overview (see also Fig. 13.1) of possible career choices after receiving your PhD degree:

1. **Academia – post-doc:** Landing a post-doc position is maybe the most traditional step in academia. Post-doc contracts have varying lengths (between one year and four years, typically). One option is to stay at the institution where you got your PhD, and get a continuation project on your PhD research. You can use the years of your post-doc to publish the work you did during your PhD, develop publications of your new research, and grow your research network.
2. **Academia – faculty position:** Some people skip the post-doc step and land a faculty position right away. If you become a faculty member on a tenure-track program, fresh out of graduate school, you might be in a slightly disadvantaged position, because you don't have the post-doc years to up your publications. If a certain h-index is a requirement for tenure, you may want to have your post-doc years because it takes time before your research gets cited. Typically, as a

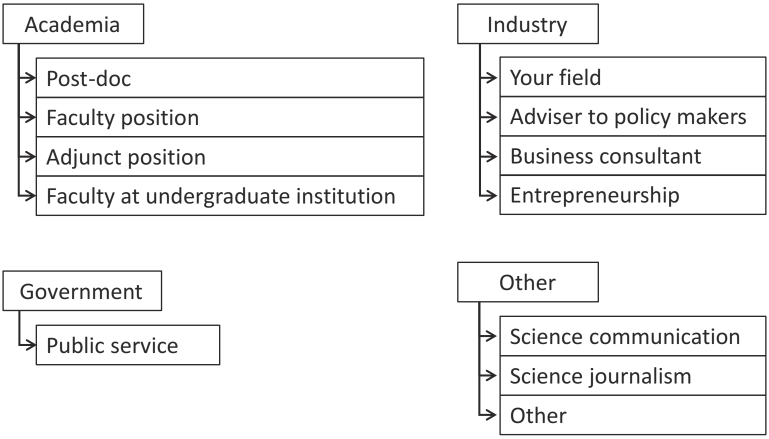

Academia
Post-doc
Faculty position
Adjunct position
Faculty at undergraduate institution
Industry
Your field
Adviser to policy makers
Business consultant
Entrepreneurship
Government
Public service
Other
Science communication
Science journalism
Other

Fig. 13.1 Overview of possible jobs after getting your PhD

young faculty member, you will spend quite some time on teaching, leaving less time for working on your publications. You might be thinking of landing a faculty position at the institution where you obtained your PhD, and you might know that the number of openings are very limited. At some institutions, positions only open when somebody retires, which may mean there won't be an opening in the next 30 years if they just hired some young faculty members. If this is the career path you are seeking, and you are willing to make a move and become an academic nomad, then you may find that other parts of the world are desperate to hire people with a PhD title to join their faculty. Developing countries are a good bet for this option. We'll discuss going abroad in detail later in this chapter.

3. **Academia – Adjunct position**: Adjunct positions are other non tenure-track positions at universities. While some universities abuse their adjunct faculty and overload them with educational responsibilities, other institutions treat their adjunct faculty as they are supposed to be treated: faculty members who deliver valuable contributions and have opted not to pursue tenure and the title of full professor. The job description for an adjunct professor is more flexible than for a tenure-track position. Whereas for a tenure-track position, you will need to develop a balanced portfolio between teaching, research, publications, and service appointments for your tenure review, for an adjunct position, it is possible that you focus more on one single element (for example, teaching). If you interview for an adjunct position, make sure the expectations are clear from both sides, to see if the proposed contents of the job suit you.
4. **Academia - teaching at an undergraduate institution:** In most parts of Europe, the institutions offering only undergraduate degrees (Hochschule, Hogeschool…) are separate from universities, where undergraduate and graduate degrees are offered. These institutions carry out shorter research projects that have a direct application into the industry, or form conjunctions with larger

universities. In other parts of the world, you find similar systems at institutions that are mostly teaching-oriented colleges. These institutions need people with PhDs to make up their teaching staff and carry out practical research. The ties between the industry and these institutions are typically more direct than at larger universities.

5. **Industry - your field of specialization:** Joining a company in your field of specialization (for a structural engineer that would be anything from a bridge design company to a large contractor) is an option. While some people tend to treat the PhD as a useless extra degree and a waste of time (you could have gained practical experience in this time period!), most companies do agree that employees with a PhD bring additional value to the company, and can tackle more complex problems or to put their highly refined skill set to work.
6. **Industry - adviser to policy makers:** The link between researchers and policy makers is a person who is familiar with the technical literature and recent research, and at the same time can communicate these results to policy makers and politicians to assist them in their choices. We want to carry out research to make this world a better place, but we also want our research to be actually put in practice. For this step, consultants to policy makers come into play.
7. **Industry - business consultant**: Perhaps you have a PhD in neuroscience, thinking that business is nothing for you, but large consultancy firms hire graduates with a PhD from all different fields. If you know how to manage large amounts of data, these companies will be looking out for you. If you want to get acquainted with the work of these companies, you can typically join them for a weekend in which you are challenged to solve a business case, to see if this type of work is something you'd want to consider.
8. **Industry - become an entrepreneur**: Why not start your own company and turn your research into a marketable product? Many universities host incubators to help you get started. You can also start a company that is not immediately related with your PhD research. PhD graduates start companies acting as professional proofreaders, as technical translators, as independent researchers and as career- and/or research-advisers to PhD students.
9. **Government:** You could be actually doing the research (academic jobs), you could be the link (nr. 6: adviser to policy makers), or you could decide to go in public service and use your knowledge in government institutions. You could be working at one of the ministries, where your understanding of complex problems helps making informed choices. You could also be working at the local level for a city, and use your analytical skills to make decisions on proposed policies across a range of topics. In transportation, for example, a good understanding of a complex transportation system is necessary to make the right choices. Or you could use your keen mind to work your way up in a political party and serve your country as -eventually, hopefully- a minister. Belgium's former prime minister, who is praised for steering the country through the Euro-crisis, holds a PhD in Chemistry.
10. **Science communication and science journalism:** Do you enjoy explaining your friends and family what are the broader implications of your work? A

career in science communication or science journalism might be for you. Universities need science communicators, who are the link between the researchers and the broader public. Newspapers and magazines rely on science journalists to keep up with recent publications, and turn these into a lighter and clearer read, focusing on the impact on the world around us.

11. **Whatever you wish:** You have the power to build your own career. You don't need to make one single choice (academia or industry), and stick with it for the rest of your life. You will make a number of job and career changes throughout your life. Pursue your interests. Follow your nose. Enjoy the ride. Recent PhD graduates sometimes work for academic publishers, go to work at other positions within the university (the library, the office of the dean of research…), or decide they need a break from science and become a fiction author or spin class teacher. If you are interested in different career paths and working styles, check out the "How I Work" series on PhD Talk.

Exercise

1. Consider the list of options given above. Which of these options are available in your field? Are there additional options you can think of?
2. Think about yourself. What is your working style? Do you like to work in teams or do you prefer to work by yourself? Are you an introverted or extroverted person? Do you enjoy teaching or research more? What are your strengths and weaknesses? If you are in doubt about your strengths, a classic read is StrengthsFinder 2.0 [9]. Think about why you started your PhD adventure in the first place – what attracted you to research, and what could attract you in the future to a job?
3. Make a table outlining each of the options you listed in part 1. Make columns of your strengths, or elements that you find important in a job. Now, add a tick mark wherever you have a match between the job description and your personality.
4. Have a look at the career paths that resulted in the largest number of tick marks. Now, start to think about the application of these career paths: where could you apply for these jobs? Which companies should you follow or get in touch with? Who in your network should you talk to?

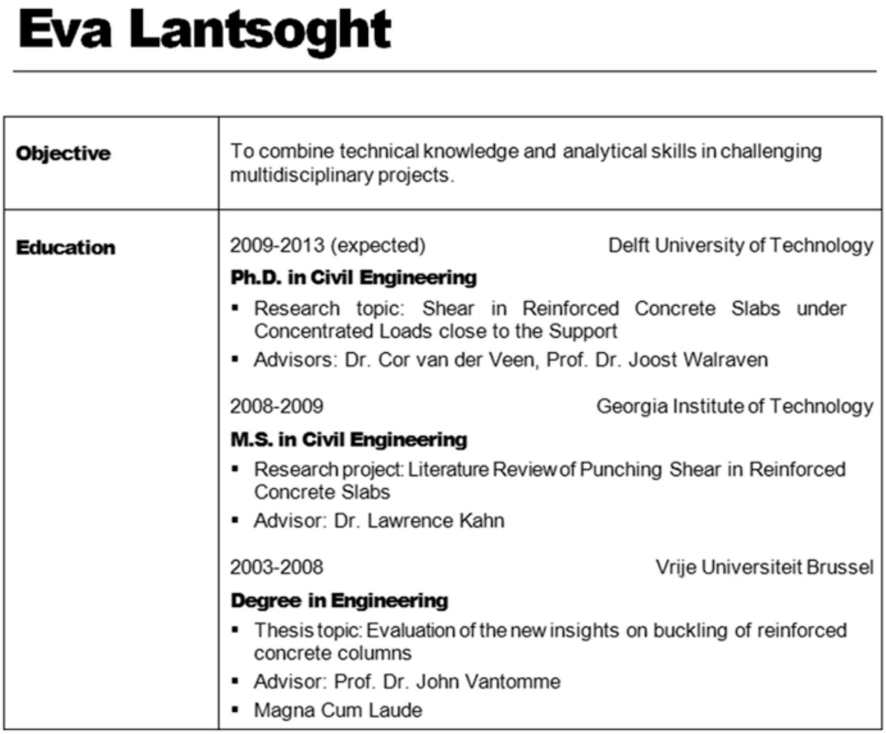
13.4 The Benefit of Your Academic Skills When Searching for a Job

13.4.1 Preparing Your Documents

What's the ultimate secret to finding a job after your PhD [10]? I'm not a crafter of magic potions, but I think the answer (as is the answer to numerous things in life) is to do the work. Tailor your resume and letter of purpose to each different position you are applying for. Don't apply before you have read about the company and have identified what they do exactly, and how you can contribute to their work. If you're applying for academic positions, familiarize yourself with the research of the current faculty and the courses offered, and see how you would fit into the existing work, and which new elements you can introduce. Prepare for each interview with equal earnestness. Don't assume you'll be lucky and something will be thrown into your lap. Your degree is not an entrance ticket to a job.

Besides the fact that you need to do the work to find a job, you also need to consider where you are in life at the moment, and see how you can find a job that fits your situation. For example, if both you and your partner are academics, the chance of both of you getting hired by the same institution and both finding your academic dream job is unlikely. If you decide to move abroad and apply at institutions in developing countries, where the demand for recent PhD graduates is larger, there may be always the rumor that one of the partners just got hired because they had to hire him/her to get the other one. When you interview with companies in your industry, you may find that you are either overqualified, or that you need to start at a lower position than you expected, and that the increase in salary you were hoping for after years of living as a student is really modest. In academia, you may be looking towards the uncertain future of a few years on a post-doc project here, and then another project in another country, without ever being able to settle down. To land a job, you need to apply some creative thinking and learn how to market your accomplishments.

Remember as well that you don't need to find your dream job right away. It might take you some time to figure out what you enjoy doing in your working life. There's no such thing as failure (you're not a failure if you decide that the high demands of academia are not what you need in your life, and you're not a failure if you end up in a completely different field over time). If you leave your first job after a relative short amount of time, you have certainly learned something about what does not work for you in your professional career. Keep iterating until you find your spot in the working world, and when you have found your spot, lean into your career.



Eva Lantsoght

Objective	To combine technical knowledge and analytical skills in challenging multidisciplinary projects.
Education	2009-2013 (expected) Delft University of Technology **Ph.D. in Civil Engineering** ▪ Research topic: Shear in Reinforced Concrete Slabs under Concentrated Loads close to the Support ▪ Advisors: Dr. Cor van der Veen, Prof. Dr. Joost Walraven 2008-2009 Georgia Institute of Technology **M.S. in Civil Engineering** ▪ Research project: Literature Review of Punching Shear in Reinforced Concrete Slabs ▪ Advisor: Dr. Lawrence Kahn 2003-2008 Vrije Universiteit Brussel **Degree in Engineering** ▪ Thesis topic: Evaluation of the new insights on buckling of reinforced concrete columns ▪ Advisor: Prof. Dr. John Vantomme ▪ Magna Cum Laude

Fig. 13.2 Resume for general industry positions, showing interest in challenging multidisciplinary projects

When you write your resume and letter of purpose, tailor it to the position you are applying to. For your resume, your introduction paragraph will be different for academic positions than for industry positions. The rest of your CV or resume, including work experience, education, and publications can be the same, but the first part the recruiter will read needs to be tweaked to catch the attention of the recruiter. As you can see, I used a more general objective statement when I explored the possibility of working for a business consultant (a path I did not end up pursuing, but there's no harm in exploring different paths during the last years of your PhD), see Fig. 13.2.

In your letter of purpose or job application letter, show that you have done your research about the company or university. Explain how your research degree has prepared you for the position you are applying to, highlight how your unique skills will service the company or institution, and give an honest assessment of the skills you may be lacking for the job you are applying for, accompanied with a plan of how you will acquire these skills.

If the company or institution calls you for an interview, prepare thoroughly. First, know what is expected from you. Will you have a standard interview that will last an hour, or will you need to take exams and psychological tests as well? Will you be expected to work on a business case and present it at the end of the day? Are you invited for a campus visit? Each of these types of "interviews" are all very different, so make sure you know what is expected from you. When in doubt, don't be afraid to check again. Grab a parent, friend, or colleague, and practice interview questions for a few afternoons. Know how to answer the questions in such a way that your answer is tailored to the job you are applying for. There are many lists with interview questions on the internet that you can collect to practice with [11]. Try to find a list of personnel or faculty with pictures, so you can have an idea who you are meeting and what they will look like. Prepare yourself to look impeccable (leave the torn jeans and shoes with holes at home, and iron your shirt) and give yourself some peptalk if you need it.

13.4.2 Highlighting Your Unique Academic Skills

If you are applying for a post-doc on a project that is closely related to your PhD topic, you won't have to do much "selling" of yourself into the position. However, if you are eyeing a post-doc in a field that is only tangentially related to the field of your PhD research, or if you are applying for a job in a company that does not often hire PhDs, you may need to spell it out to the recruiters why your academic skills are unique and an excellent preparation for the job you are applying for [12]. Often, you will need to explain why your research experience makes you different, and why doing the PhD was the correct choice for you, instead of applying for perhaps the same position with your Master's degree and use those years to get real-life experience. First of all, don't get upset or offended when recruiters in the industry inquire you about why you did a PhD instead of gaining experience. Take this opportunity to highlight the unique skills you learned when carrying out a large research project. During your PhD trajectory, you have learned to become an independent researcher, with a set of skills that are highly valuable in the industry, for the government, as well as in academia. Think about the following skills that place you ahead of other applicants:

1. **Analytical skills:** Whether your PhD research relies on qualitative or quantitative data analysis, there is almost always a large chunk of analytical work involved in PhD research. You either developed strong numerical skills, skills related to analyze your experimental data, and/or skills that allowed you to play with complex theoretical ideas. In fact, consultancy offices, private labs, and large technical companies all need employees with strong analytical skills, and people that can manage large amounts of data.

2. **Autonomy:** Getting a PhD is all about becoming an independent researcher. At some point during your PhD, you will notice that your supervisor gives you more autonomy, and simply trusts your results without needing to peak over your shoulder. You may be working weeks on end on something, trying out different paths, iterating, and making your own decisions. This large level of autonomy gives you the ability to work on larger projects, all by yourself, while being able to communicate your decisions and the reasons for these decisions to your supervisors later on. Many bosses in the industry will appreciate the fact that you are not asking them all the time what you are supposed to do now when you get stuck, but instead know to figure things out on your own.
3. **Ability to learn new topics and skills:** A very typical situation during your PhD studies is when you run into a subject that you don't know much about, or one in which you seem to be needing a different computer program or programming language to continue your research work. Instead of raising your shoulders and thinking: "Well, too bad, I don't know that...", you head out to the library to pick up a book on the subject, read a couple of papers on the subject, follow an online tutorial or start getting involved in a programmer's forum. This ability to learn new topics and skills by yourself, combined with your autonomy, gives you the ability to advance quickly in your career in almost any given field and to take on a wide variety of projects.
4. **Deep understanding of your field:** Since a doctoral degree is the highest level of education you can achieve, you can pride yourself in the fact that you know more about a certain topic than most other people. In fact, when it comes down to your sub-topic of research, you can claim that you are the expert in your field on that topic - you simply are the only person who knows all the ins and outs of the topic you chose for your PhD studies. In the industry, you may not need that in-depth knowledge on your specific topic, but the fact that you have a thorough understanding of your field will be very beneficial. You'll get extra kudos if you've attended a number of conferences over the past few years in which you may have learned about your field in general, if you have been working as a teaching assistant (having the material fresh in your mind is helpful), or if you have been reading more broadly in your field.
5. **Teamwork skills:** No PhD is born on its own. A PhD degree is virtually always the result of cooperation: with your supervisors, with funding institutions, with other researchers, and in the laboratory. Nobody ever graduated by brooding in his/her room in complete isolation for a couple of years and then spitting out 1000 pages of innovative research material. Being able to work in teams is one of the great skills you learn during your doctoral studies. Don't confuse introversion with an inability to work in teams – many introverts thrive in small teams, which are focused and concentrate on the depth of the matter.
6. **Writing skills:** Those papers and that thesis didn't write themselves, and they certainly did not get written without developing sound academic writing skills. With all the writing practice you get during your doctoral years, you will be able to whisk together reports and briefings faster and in a clearer style than your peers who did not go into a PhD program.

7. **Presentation skills:** Just like you received a good training in (academic) writing during your PhD, you also gained a good training at giving presentations. Here comes again the importance of being able to present your work as often as possible. Remember your very first presentation in graduate school? Remember how nervous you were, and how afterwards you learned how to better structure your talks until it almost became second nature? You need to realize that this communication skill is again very valuable to prospective employers: you will be able to show clients in a clearer way what the company can offer.
8. **Extra skills you learned during your PhD:** During your PhD years, you certainly picked up a few extra, general skills besides your analytical and communication skills. You may have taught yourself a programming language, you may have learned how to speed-read, or you may have taken a number of courses to sharpen your soft skills. Think about all these extra skills, and use them to your advantage to show the benefit of your years of doctoral study.

13.4.3 Attending Career Events

Another way to get in touch with companies is by attending career events [13]. The general principles of attending such events are valid for prospective PhD students, prospective post-docs, or if you want to meet possible future employers in the exhibition area of a conference. You may think that in the twenty-first century, your future job is something you will arrange all online. But good old career events are still a very popular choice for job seekers and employers to meet each other. One of the big advantages of going to such an event is that, while strolling along the stands and talking with representatives of different companies and universities, you actually learn about options you would have never thought about. Meeting in person with a representative of a company of university always puts you one step ahead of e-mailing them or calling them by phone. Attend presentations of different companies, even though you may think the company is not directly something for you - you may be surprised.

Talking to company representatives also gives you a glimpse of the corporate culture. Before going for my second master's degree, I attend a presentation of a company I was not directly interested in. But they showed me that in their company an engineer manages his/her project from the beginning to the end: bidding, design, planning, and then supervision in the field. In virtually all other construction companies, you have to choose between being in an office for doing designs, or being in the field to supervise construction activities. When talking to a representative, they were very welcome and open to discuss international perspectives. On the other hand, when I was talking to another company at the same event, they were much more ambivalent and clearly biased against women ("We have great jobs for women in our offices in Antwerp! Yes we treat them equally!" "But do you send women to manage their projects in the Middle East?" "We have great office jobs!" "….").

Once you passed the half-way point of your PhD program, start by informing about career events or talk to companies in the exhibition hall of a conference. Keep in mind that these opportunities don't arise every Tuesday on the town's market square, so you will need to plan about a year ahead for the career events or conferences with large exhibition halls that you want to attend. If you've found a career event that you want to attend, don't wait until the day of the actual event to go play tourist over there: plan, and make sure you can get the most out of it! Use the following ideas to prepare for the event:

- **Before the event:** As I said before, if you want to get most out of the event, make sure you plan ahead. Don't just take the train and show up, but do these few things in advance:

    1. *Revise your resume*: make sure you have your full resume up to date. With full resume, I mean a resume that describes you in a paragraph, has your educational background, your work experience, your publications, your professional memberships, your committee appointments, an overview of the journals you are a reviewer for, other service appointments, and perhaps something about your additional personal interests. Don't forget to mention your blog if you have one!
    2. *Summarize your resume*: A full resume can go on and on for pages - nobody who gets introduced to you for the first time would be interested in reading the entire thing. Put yourself in the shoes of the exhibitors at career events: they get stacks and stacks of resumes. So make sure you have a shortened resume - maximum one page, I'd say, but a resume that highlights your biggest achievements. Make it visually attractive. Print a large number of copies of this document. Make different versions of your short resume, for example for academic purposes (finding a post-doc or faculty position), for industry jobs in your field, and for consultancy jobs. Add a QR code on the bottom to link to your full resume or a representative online profile.
    3. *Check your online profiles*: If an employer is interested in you, chances are the recruiter will Google[2] you. If you are months before a career event, you have plenty of time to revise your online profiles, see what Google finds about you, and course correct if necessary. Revisit the material from Chap. 9 about online branding.
    4. *Read the descriptions of the employers and institutions in the exhibition*: Learn who will be there. It might take an entire afternoon, so go somewhere comfortable, get a coffee, read through the descriptions of the employers and institutions and look online for further information about them. Take some notes while preparing so you can refresh your memory the evening before the event to revise who does what again.
    5. *Identify the ten most important booths to visit*: Go through your notes, and see which are your top ten exhibitors to go and visit. Print out the map of the

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[2] Or search for you using another search engine.

exhibition area if the venue is large, and highlight the booths you need to visit. If you think you'll be short on time, make an itinerary.

6. *Identify your networking options*: Will there be a drink at the end of the day? Can you meet up with a certain group for lunch? Make sure you take advantage of your time at the event to network.
7. *See if there are presentations*: Presentations in which companies show what they are doing and give you a hint of their workplace culture are an excellent source of information. If there are presentations, make sure you attend some. If you're interested in a company, don't be afraid to ask questions at the end of the presentation and follow-up with the presenter. You can't wish for more direct access to the company.

- **During the event**

  1. *Hand out your resumes:* You printed a good number of your short resumes? Good! Now don't be afraid to hand them out to people at their booths.
  2. *Hand out your business card:* Your resume is not something you put into every one's hands, so make sure you also carry cards. If you make new acquaintances, it's good to have cards with you and hand out your contact information. If your institution provides you with business cards, use these cards. If you don't have cards, get professional-looking cards with your information.
  3. *Talk to people:* You're not going to the career event to hide behind a column. While for some of us, talking to people you don't know is intimidating, very few people dislike an interesting conversation. It can be awkward, but most often it is not. Just ask questions, and get people to talk about what they are passionate about, and the awkwardness will be gone soon.
  4. *Don't be scared to have a quick chat with booths that may not interest you:* You never know what you can learn from booths of companies that you originally did not plan to talk to. They might not directly be the holy grail for you, but they may have something interesting to share with one of your friends or colleagues.
  5. *Politely walk away from booths that are a disappointment:* If a company you were really interested in seems to be a disappointment once you start to talk to them, you don't need to keep talking to them. Find a polite way to back off, and go. If a company, for example, seems to have different rules for women, then you have no reason to keep talking to them. Just thank them for the explanation and leave.
  6. *Enjoy the networking events*: Enjoy the time of the drinks, meeting young people that are in the same situation as you, and loosen up a little bit. A career event can be stressful (and trying not to spill your coffee while you try to impress a recruiter can be a challenge), but at the end of the day you can take a breath, have a drink (never lose control and get drunk though), and have a chat with fellow soon-to-be-graduates or informally mingle with companies.

- **After the event**
  1. *Write thank you e-mails:* If you had a nice talk with an exhibitor or with a fellow young job seeker, don't be afraid of sending a short e-mail to thank them for the good conversation. There's nothing intrusive or wrong about sending a kind message.
  2. *Archive your information:* Archive flyers and information of interesting companies. If you need to take action on something, do so before you archive the information. Trash what you don't need anymore.
  3. *Connect with new contacts:* If you met new people, for example during the networking events, you can try to connect with them on LinkedIn, ResearchGate, or Academia.edu.
  4. *Follow-up:* If you left your resume, and an exhibitor told you he/she would contact you, but you haven't heard from them, say, after a month after the event, it can simply mean your one sheet of resume got lost. Don't be afraid to send an e-mail to follow-up and inquire if there is still interest from this company to explore future options with them.

13.5 Tips for Success in Academia

13.5.1 Transitioning from PhD Student to Faculty Member

If you are transitioning from PhD student to faculty member, you may be overwhelmed by all the new responsibilities that come your way. Upon finishing your PhD, you may think that when you have a job, you'll be working "normal" hours again. While I'm not advocating 100-hour weeks, the reality of academia does mean that you will always have a lot of work on your shoulders, and that you'll always be juggling different projects and duties at the same time [14]. As a faculty member, you will be combining more responsibilities than during your PhD. It is unlikely that you will ever get a full-time research project for three or four years again, as during a PhD, but that does not mean that you will have less responsibilities. The biggest hurdle now can be how to figure out your priorities when you get a ton of different tasks thrown in your direction: research (which you'll be expected to execute faster than a PhD student), supervising research of others, teaching, outreach, service, tons of admin work, and more. You'll need to develop new skills, and new ways to deal with your time – learning how to move all projects slowly but surely forward will be crucial for success.

Since finishing my PhD, I have combined a research position in the Netherlands with a faculty position in Ecuador (and the PhD Talk blog, and helping my husband with his structural engineering company). Moving to another country (more about this later in this chapter) can be a challenge. I expected to spend time arranging my paperwork in Ecuador. I knew it would be hard to find a place to stay during the summers in the Netherlands. I did not factor in that I would get sick with food poisoning and end up in the hospital many times in Ecuador, and I did not expect that I would have to rent a temporary room in Rotterdam and commute 13 kms each way by bike, each day for a full summer. Regardless of these setbacks, I received my tenure in Ecuador after three years of work, and was promoted to a special category of Full Professor of Research, with less teaching duties than the regular Full Professors here. Here are some recommendations on how to transition successfully from PhD student to faculty member:

- **Use the urgent-important matrix to set your priorities:** When you have a large number of responsibilities, it helps to first make a list of everything you have on your plate, and then see which of these are urgent, and which are important, as we discussed in Chap. 3. You'll end up with four categories:
    - Urgent and important: obviously, you need to be working on these tasks
    - Not urgent but important: the group of tasks that too easily slip to the background, such as your writing. Never let your writing slip to the background – it is the most important factor for academic success! Make sure you find time each and every day (or at least three to four times a week) to write for one or two hours.
    - Urgent but not important: visits, e-mails, phone calls, administration deadlines and more of the stuff you wish you didn't need to do but have to do to avoid trouble.
    - Not urgent and not important: stop doing these things - or just do them sparingly...
- **Get a streamlined time management system:** If you learned the drill about planning and time management in this book, you will have already developed a time management system during your PhD. Keep using this system, but if you need to make tweaks to adjust for your new position, don't be afraid to make changes. Focus on methods that are in the cloud and can sync across all your devices, carry a notebook for random ideas, or use online tools. Plan on a long-term basis (for example, towards your tenure), per semester, per week, and per day. Develop a weekly template to combine all your responsibilities, as we discussed in Chap. 3.
- **Do a brain-dump when you need it:** Even though you may have all your tasks and appointments in your calendar and on your to-do list, sometimes you can feel a mild to severe sense of panic coming over you as thoughts of everything you still need to do rush through your head. That's when it's time for a brain-dump. You can either take a pause and journal longhand about all the demands that are placed on you (and who wants what from you), or you can sit down and make a list of all you need to do, categorize all tasks according to the urgent-important matrix, and then review what you are going to do and when you are going to do it. After a few semesters, you will have a better hold of your time and the expectations placed upon you, and you'll be able to develop a realistic list of major tasks and projects per semester to guide your planning.

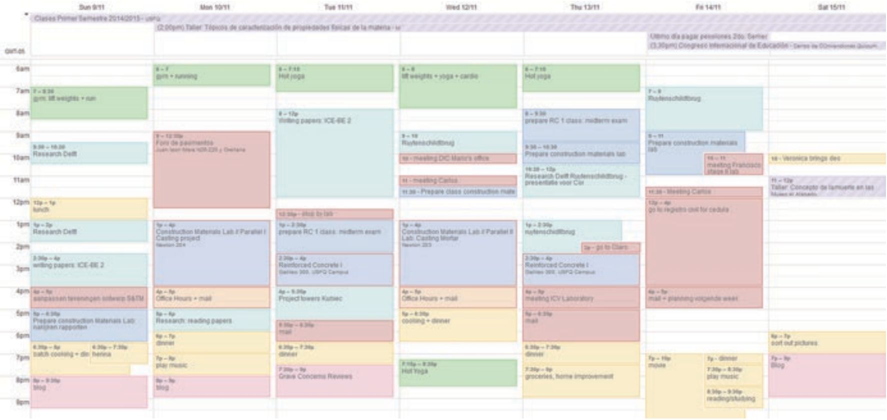

Fig. 13.3 A week during my second semester of teaching (as a faculty member)

- **Use time slots:** As a faculty member, you will need to learn to work in shorter bursts of time, as you simply will have to break up your day more often than as a PhD student. Teaching hours, meetings, office hours… will all cut into your day and will make it impossible to find a chunk of eight hours to quietly work on a project (unless you start to work during your nights as well, or on your weekends). When needing to deliver a conference paper, you will have to think in terms of an hour a day for a few weeks in a row, instead of a few long days and nights. It's time to gear up in terms of efficiency and being organized, and plan two-hour chunks of time daily (or a few times a week) for a few weeks to move your writing forward. The same advice holds true for any (new) research project that you will be working on. And of course, you'll have to schedule in blocks for preparing your classes, grading, office hours and all that - so you'll end up with a rather scattered time schedule, as you can see in Fig. 13.3. Leave enough buffer time between tasks as discussed in Chap. 3. Experiment with your optimum chunks of time.
- **Make smart choices**: As you advance in your career, you'll be met with more and more opportunities. But at a certain point, you'll have to start saying "no" to some opportunities and learn to make smart choices. If your schedule is more than full, accepting to review a paper may not be the right choice to make. Sometimes, however, the exact opposite could be true: reviewing that paper may be just the right move. Don't forget about the joy of science, don't lose the spark that made you chose this career path in the first place. Don't reach the point where you start to feel suffocated by all the "Have-Tos" and don't have any time left to fiddle around with ideas or play around in the lab. Stay true to yourself and what brings you joy in your work in the first place - and invest in those areas. These areas are your natural strengths, so ultimately prioritizing these aspects has a positive effect on your career as well.

- **Set an ending time to your day**: With an endless task list, you may feel as if the day is never over and you are never done, and you can keep working every single day until bedtime, or even beyond. Avoid this attitude, so that you can survive the semester without burning out. If you use your digital devices a lot, set a digital curfew time, about an hour before your bedtime.
- **Take good care of yourself:** Self-care is as important as it was during your PhD: eat well, exercise, get enough sleep, and go outside for fresh air and sunshine (vitamin D!). You really need to take these things seriously if want to see your productivity soar. It's all about feeling better, and having more focus. If you currently are living on TV dinners, find yourself surfing the internet late at night and then go to bed too late, and are out of breath after a flight of stairs - do not despair. Just take it slowly, change one habit at a time and try to stick with a new habit long enough before changing another aspect. Slowly but surely you'll see the difference, and then you'll never want to go back.

13.5.2 Becoming an Independent Researcher

As a PhD student, you have the help and guidance of your PhD advisor, and your research group [15]. Your advisor can give you ideas to further develop, can advise you on where to publish and which conferences to attend, and will teach you the ropes of the research trade. Unless you stay at your research group, or join a similar research group as a post-doc, you will be on your own upon graduation. You will need to become an independent scholar [16]. You are no longer "the PhD student of Prof. Advisor", but you are now Dr. Yourself, with your own field of expertise and your own network.

To reach the point of independence, you need to establish yourself as a researcher with a clear focus. You don't need to focus on one single topic as you did during your PhD, but you need to make your field of work clear. Within your area of study, you should branch out as much as possible: participate in projects with the industry, carry out desk research on tangentially related fields, and broaden your scope.

Besides your own brand of research, you also need your own network; so attend conferences and industry events. Publishing helps as well, as you will typically be invited as reviewer for the journal in which you published - a way to establish yourself more as an authority in your field.

In the following, you can find a few tips for becoming an independent scholar:

- **Collaborate with other institutions**: While it is nice to keep working with the researchers and professors with whom you worked during your PhD, it is time to discover other horizons as well. This certainly does not mean you should burn the bridges between your alma mater and yourself, but it is time to broaden your scope. These institutions can be situated somewhere else in the world, could be public research institutes, or could be industry partners. The more variation you can develop in your collaboration portfolio, the better.

- **Outreach**: You could consider outreach as a time-consuming fringe activity, but it certainly can be quite rewarding. Outreach can be blogging and tweeting about your research as we discussed in Chap. 9, it can be volunteering for charities with your technical knowledge, or it can mean getting involved in student support groups and on-campus networks. Consider outreach as an opportunity to show the world the value of your research and how your work makes this world a better place, or to help make academia a more welcoming place for all disadvantaged scholars.
- **Write research proposals**: It's time to figure out what you would like to work on now that you finished your big PhD project, identify the needs for such a project, and turn these needs into research proposals. It can be frightening to start your very own line of research, as you can feel inexperienced, but once you get working on it, you will feel how rewarding it is, and how your PhD training gave you all the tools and skills necessary. And think of it - you can fully choose what you find interesting to work on, without having to explore ideas that have been imposed onto you by your advisor.
- **Become active in your research community**: Review papers, participate in technical committees, publish your work, attend conferences - you know the drill, so do your part and volunteer to move your field forward. Showing up and working hard will show your peers that you are serious about your research and willing to moving things forward.
- **Read a lot**: Keep a finger on the pulse of your field by reading recently published papers frequently (you will also need this information when you write your proposals). Try to set aside a few hours a week (by reserving this time in your weekly template, for example) to read recent publications. Follow the important journals in your field, and read them to get an overview of which topics are being explored, and who is working on what. Identify the papers that are of particular interest for you, and read these in more detail. You can do a #365papers challenge, in which you try to read a paper each day for an entire year.
- **Pick your fights wisely**: What makes you really thick? Canalize your energy and devote time to the causes you consider important. Pick your fights wisely - you can't take all the worries of the world on your shoulders. Do you want to raise your voice in the way women are undervalued in academia? Would you prefer to put energy into the guidance of first-generation students? Take a cause to heart, and put your shoulders under it – but don't become an activist for each and every possible cause.
- **Develop your own writing voice**: In Chap. 7, we've discussed the voice you develop for your writing. As you become an independent scholar, defining your voice is a crucial element. You will notice that, as you gain more practice writing papers, and will receive less and less feedback from your coauthors, you will start to feel comfortable writing about your research in an authoritative voice that is distinctly yours.

13.6 Tips for Success in the Industry

To succeed in the industry, as in any career, the general advice for succeeding in academia is still valid. A good planning to finish your deliverables, a willingness to go the extra mile and work independently, and good communication skills will bring you a long way. Your publications are less important in the industry than they are in academia, but can still play an important role in your general service to your profession.

The advice and ideas in this section are based on a number of interviews carried out with PhD graduates who transitioned from academia to the industry.

To find employment outside of academia, Dr. Samuel Oduneye, who obtained his PhD in medical biophysics from the University of Toronto and now works as a healthcare consultant in management consulting, says there are three main elements [17]:

1. Your title is important. It shows your credentials and counts for a certain level that can be expected from you.
2. Your degree and title can help you get a foot in the door or get people to listen. However, you will still need to prove yourself and prove that you can deliver high quality work. Your degree alone won't make your career.
3. You need a plan to find a job.

Dr. Seán Mac Fhearraigh, who received his PhD in cell division from the University College Dublin and now runs an ELISA assay company, recommends [18] that you talk to recently graduated PhD students to learn more about the current job market, possible openings they may remember, and for their help with agencies and contacts for your job search. Talk to your professor as well, he says, so that he/she can support your move out of academia and give you tasks within the lab that would provide some industry experience. Your professor can also help you find a job through his/her network outside of academia. Seán recommends that you volunteer a few hours a week as an intern in a start-up company, or for scientific outreach events. This experience will be an extra bonus when you apply for jobs in the industry. A recruiter can be useful for helping you find a position, as well as in helping negotiating for salary and benefits.

Dr. Chris Humphrey, who holds a PhD in Medieval Studies from the University of York, transitioned to a business career and advices PhD students and recent PhD graduates on the subject of marketing yourself for a career outside of academia [19]. His main advice for PhD graduates who want to transition to the industry is to change your mindset accordingly. He warns against the long-lasting effects of taking low-paid academic positions such as part-time and adjunct positions, as they impact the financial situation of your family, health insurance (or lack thereof), and savings for future retirement. Ask yourself if you are willing to pay this price, he recommends. One element of your mindset that you need to change as you transition from PhD student to working in the industry, is that you go from delaying gratification (which can help you push through to the completion of your paper or dissertation) to embracing it: now you can have a family, buy and furnish a home, go on a holiday, and pay off debts. Factor in these elements when you negotiate a good salary and benefits package, and adopt a professional attitude. Learn to empower yourself economically, he advises.

13.7 Some Advice for Female PhDs

While female PhDs are not the only underrepresented group in academia, we will here focus on tips for female PhDs. The general ideas are valid for other underrepresented groups, whereas the discussion on how to deal with the two-body problem is typical for couples in academic careers [20].

For couples in academic careers, going abroad or finding employment in the same city or country may be a challenge. You can opt to have a long-distance relationship for a certain time during your academic career, but if you want to build a life together and start a family, that option may not be the best choice for you. You may need to pass on better opportunities and offers for the sake of your relationship or family, or change career path altogether. Think about the different options you have, and make an informed decision, weighing all of life's aspects. If going abroad is not an option for you at a certain point, you can still go for a short-term visit to a lab or research group you work with abroad. You can use conference travel to build your international network. The international members in your thesis committee can help you make contacts abroad without you needing to move. You can also opt to attend a course at another university or a summer school. Just keep in mind that the odds that you can build up an academic career are low, in every country, and if both of you want the same type of career, the odds are reduced even further. Remember that there are plenty of career paths outside of academia, and that your academic training can be of benefit to different career paths.

I also often get questions on how to combine a career in science or academia with a family. As some women remark, it is odd that nobody ever asks this question to a man. For women, the added complexity is that pregnancy and childbirth are simply physically and emotionally demanding, and that some programs do not allow women extra time on the tenure-track to compensate for the time "lost" during pregnancy and while raising a newborn [21]. Sometimes, young PhD students or aspiring PhD students ask me when is the right time to have children. My answer usually is that it depends on where you are in your relationship. Deciding to start a family should be a choice you and your partner make together, and not a choice that is made as a function of your career. With that said, considering the current regulations, having a child during the PhD or after getting tenure are better solutions that during the tenure-track, at least in the Netherlands. During the tenure-track, no extra time is given for pregnancy and raising a newborn child, while during the PhD trajectory extra time is given. Waiting until you have tenure is another option, but may require you to have children later in life, which can increase the risk of complications. In general, a career in science or academia is not harder to combine with a family than any other career. The added travel may be difficult on young parents. Some universities may be more forward-thinking in helping out parents (for example, having affordable day-care at the university).

For those of us who are female PhDs in a male-dominated field and stick out like a sore thumb, learning to live with the gender bias is daily reality [22–25]. The short story is: if you stick around long enough and make your contributions to your research field, eventually you will get some respect. You may still have people ask you for directions to the bathroom or for free pens, but some colleagues will eventually treat you as a colleague instead of a martian. Even though you will always have a share of rejected papers, missed opportunities, missed recognitions, and collaborations that you have been passed by for, you can do a few things to make the experience more pleasant:

- **Don't feed the trolls:** At every stage of our career, there will be trolls and haters and naysayers. You'll be watched more closely than your male colleagues, and judged based on random things like your clothing and hair. And while I'm the last person to say I've never been offended or shocked or outraged by certain comments, I have also learned that worrying and getting angry is not going to get you anywhere. Acknowledge that it is a hater's comment, accept how you feel about it, and then move on and prove them wrong.
- **Build a community and network:** Women are bad at networking, "they" say. While I generally think that dividing humans in "women do this" and "men do that" is overrated anyway, I think there are simply different networking styles. As an introvert, I personally am not the type of person to barge into people and wave my business card in front of their nose. But I genuinely care about the work of other people, and I enjoy a good research discussion like any other researcher. Your way of building a network could be different from mine, or similar, but it doesn't matter – as long as you find a way to connect to other researchers, you will be building up a community of like-minded (or like-interested) researchers. You don't need to suit up and shake hands all the time to build a network. You can have one-on-one conversations with other researchers at conferences. If you need a starting point, just ask someone who looks a bit lost what brought him/her to the conference and what he/she is working on. You can use online tools to reach out to other researchers and share information, if traveling to conferences is not an option for you. There are plenty of ways to get in touch with fellow scholars – just make sure you devote some time and energy to reaching out and building your community.
- **Find ways to reach out:** Similar to networking with fellow researchers in your field, find ways that work for you to reach out to fellow scholars (across disciplines), the industry, and the broader public. How about starting a blog about your research (see Chap. 9 for more information), or contact the organizer of a science podcast to talk about your work? How do you feel about writing a guest post for an existing blog, if the idea of maintaining a blog by yourself seems too time-consuming? In which medium does your voice resonate? Find your voice, and don't be afraid of letting it sound.

- **Volunteer:** Along with different styles of building community come different styles of contributing. If you tend to be quiet in meetings, and only speak a few sentences if you have an opinion that needs to be voiced, because your working style is more quiet focus on contributing with writing or compiling data. Find your way to contribute by volunteering when work needs to be done. Yes, your research and papers are important, and need a lot of your time, but showing up and doing work in different communities (university committees, technical committees, organizing events for your research group) will help you develop skills you need in your future career. Don't be shy. Raise your hand.
- **Don't drop the ball:** Not to worsen anybody's perfectionism here, but don't drop the ball on work you take on. If you raise your hand, make sure you can deliver on time. So while this advice might sound as if you have to work double as hard to show that you are a legit researcher, I think a lot comes down to managing your time and making smart choices. If you receive work, or a request to contribute to your scientific society, have a look at your planner, reserve some time for it where you can, and then communicate when you will be able to deliver. You'll build a favorable reputation this way.
- **Critique your own biases:** When you think a female researcher comes along as uncertain because of the higher pitch of her voice, immature, poorly dressed or whatever thought might pop into your head, acknowledge your cultural conditioning. And then send it to Pluto. The times won't change if women themselves get stuck in thinking poorly about other women.
- **Pay it forward:** Pay it forward and help the careers of fellow female researchers (or other minorities in the research community). If you're asked to suggest reviewers, see if you can bring some diversity in your nominations. If you see a female student doubting her abilities, talk to her. If you see a female graduate student doubting about whether or not she is PhD material, address her concerns. In the end, our research communities will function better if we can get all talent aboard, and if nobody falls off the wagon for not being the "right" gender or race.

For an interesting study on gender differences in standardized administration systems, refer to this research on the progress report [26].

13.8 Going Abroad as an Academic

13.8.1 The International Job Market

If you want to stay in academia, it is likely that you will need to move to another place. If moving to another place is not the right choice for you, don't spend too much time thinking about what your career would look like if you didn't have the restraints that keep you in one place. You can do great work wherever you are located, and whatever your career choice. Going into industry does not mean that you can't contribute to your field anymore – plenty of service appointments such as committee memberships are open to people from academia, industry, and the government. Find a career that satisfies you, but that also fits into your life.

With that said, if you want to explore the international job market, and this choice fits your current life, this paragraph is for you. Simply applying to positions in exotic countries, or applying to positions that are advertised on the other side of the Atlantic may be a long shot, just as reacting to any job posting online can be a long shot. If you want to go abroad, talk to people who can give you the right information. Talk to your supervisor about the fact that you want to stay in academia and are willing to move internationally, so he/she can keep his/her eyes and ears open for opportunities for you, talk to players in his/her network about helping you find a post-doc position or other academic position, and support you along the process.

For the international job market, there is a large difference between developing countries and developed countries. In developing countries, the higher education sector is growing rapidly, and larger numbers of job openings are available, especially for recent PhD graduates. Talk to fellow academics from developing countries to see how the higher education policies are changing in their home countries. In Ecuador, for example, the government determined that the number of professors with PhDs should increase drastically. Younger professors with only a bachelor's degree have been stimulated to go abroad to get their master's and doctorate. Ecuadorians with a higher education degree were offered an attractive package (including tax-free importation of personal belongings) to return home. Foreigners with PhDs were hired or given government scholarships to come work for a few years. Other countries that decide to invest heavily in higher education can have similar programs. Another example is the Gulf region, where the demand for PhD graduates to work in academia is high too [27].

In developed countries, the academic job market is more stagnant. Chances of landing a position by applying to a job opening are rather small, with sometimes 200 applicants or more for a single position. Here, you will need to use your network and contacts more than anything – not to make sure you are the person who gets that opening, but by informing very well about the possibilities, and actively trying to create your own opportunities. Don't focus only on regular openings. Other openings can be based on obtaining funding or by applying to scholarships for minorities. You can apply for personal grants that can be for example projects funded through the European Union. If you can work together with an international partner on securing funding for a project, you are actively working towards getting hired. If you are willing to move internationally, make sure you mention this to colleagues internationally. Don't pressure anybody into finding a job for you; just mention that you are about to graduate and inform about possible openings at their institution and in their country, or funding opportunities, so that you can get a better view of your possibilities. Keep an open mind, keep exploring possibilities, and start informing early on.

13.8.2 Academic Nomadism

Life in academia can take you from one temporary contract in country A to another challenge in country B, with stops for fieldwork in countries C and D and maybe a few months as a visiting scholar in country E. Most young academics are hired for a period of two to four years, prior to landing a tenure-track position, depending on the type of work that they might do. You can call this string of post-docs and other short contracts a modern form of nomadism, lived by a tribe of academic nomads [28]. When starting a PhD, most of us may not be expecting that we will end up living this ever-changing and ever-traveling lifestyle.

But then you get bitten by the research virus, and before you realize it, you are boxing up your life again and preparing to move. It's not uncommon for fellow academics to move from continent to continent, while amassing scholarships, joining international projects, or getting short-term contracts. I too have lived in four different countries now, moving between universities as the opportunities arose. I've donated bags full of things I could not take with me to different charities along the way, and have gone through the fun cycle of culture shock every time I moved. My original ambition was to get a job at the precast concrete company in my little hometown, but life took me on a different path. Before you know it, your love for research takes you by the hand and turns you into a nomad. If you are ready to go the nomad route, here are some tips for making your moves slightly more practical:

- **Go digital:** Books are heavy when you box up your belongings, so to avoid having to move by container all the time, try to buy as many books in digital form as you can. Similarly, get your music as digital files, scan your important notes, and go paperless. Make syncing a breeze by having as much files as possible in the cloud.
- **Fly with the same airline:** As an academic nomad, you will be flying a lot. Pick an airline, and be loyal to them in return for getting miles. Mileage status will give you extra perks over time, which will make international travel a bit less stressful and a bit more practical, and you can turn your miles in for a free flight.
- **Sort out your clutter:** Unless you want to keep a room filled with boxes in your parents' house "until you get a tenured position in your home country", you will need to sort through all your stuff and get rid of what you don't need anymore. Bring used but still functioning things to a charity, give stuff away to your friends and family if they can use them, and trash or recycle what nobody wants anymore.
- **Identify a few items that you value:** Even though hardcore minimalists disagree, I recommend you to have a couple of items that you cling to, and that you use to make your new place truly feel like your home. I have a number of totally random items, including my childhood teddy bear (a teddy raccoon actually), favorite tea mug, two sets of matryoshka dolls, and my cat that I drag along wherever I go. These little things just make me feel more comfortable wherever I try to settle for a little while.

- **Embrace the best of every country:** If you move, you get a culture shock. That's the plain truth, and it takes time to adapt. Every new start is difficult. But in order to overcome the I-hate-this-place phase, you'll have to learn to find the best in every country. Go out and explore the natural beauty of your new place, visit local festivities and events, and try to bond with the locals. Join activities outside of work, or meetup groups. Before you realize, you'll have yet another country that you'll miss when you're not there.

13.8.3 Challenges of Working at Different Institutions

One category within the academic nomads, are those of us who combine positions at different institutions, sometimes divided over different continents [29]. This combination is a popular choice for those academics that find a full-time position in a developing country, and then use their summer semesters for research as a visiting scholar in a developed country, or that have a part-time position at another institution for research purposes. While this method of working certainly has its advantages, it also poses quite some challenges for those of us who decide to take this path. Besides the complicated paperwork related to taxes and health insurance (in short: you'll just end up paying double everywhere), working across institutions and time zones also poses unique challenges to your research, yourself, and your family. The main question is how you can best streamline the process of dividing time between two parts of the world, knowing that you can never "pause" one job to work on another one. You will need to get a good hold of your planning in order to make it work, and to make sure you move projects for both institutions forward at a steady pace.

The first challenge is of course having access to your documents. A number of books I gathered over the years are not digital, and it has happened that I want to look up something, only to realize that the book I need is boxed up in another continent. Therefore, I recommend all academic nomads to get as much information as possible in digital form. Even if you buy a physical book, consider scanning the book for your records.

The second challenge may be your commute. You may be combining two positions that are within commuting distance of your one home, or you may be working across continents and only be able to shuttle back and forth a few times a year, staying at different places for an extended period of time, and perhaps needing to have a home in different countries. The advantage of extended periods of time at different places is that you will be able to bulk up time to move projects forward.

If you end up working across institutions, perhaps across continents, the following ideas can be helpful:

- **Go digital:** We already discussed the importance of having your documents digital, and preferably in the cloud when we talked about academic nomadism, and this advice becomes even more important when you work across institutions and continents. Keep all your references digital and accessible through a digital reference management system. Try to go paperless as much as possible. Invest in cloud space for storing all your documents: external hard drives don't like traveling around too much, and the panic you feel when your external hard drive starts to behave in a strange way is not something you need in your life.

- **Be flexible:** There will always be a fire in one institution while you are at the other one. Make peace with the fact that you can't clone yourself to have one of you in both places. If you are trying to keep a personal life and work life up and running on two continents, you simply can't be at both places at the same time. You will miss major events on both sides because you happen to be in place X and something major happens in place Y. This frustration is part of your choice to combine both jobs, so don't blame yourself for missing out.
- **Enjoy the best of both worlds:** Look up the bright side and try to enjoy the best of both worlds sequentially. Indulge in the best parts of one continent or institution while you are there, only to dive into the things you've missed from the other one once you return. The downside is that you'll always miss things about another country and place when you are not there, and that you will never really know what or where home is. Nonetheless, if you think about how cultural values of different places shape your experience, you appreciate how you can take some lessons from every place where you live and apply these into your own life, questioning things you may have never questioned before.

13.8.4 Initiating International Collaborations

If you have landed in one institution (at least for some time), that does not mean your collaborations for research should be limited to this institution, perhaps extended with the contacts you have from the institution where you obtained your PhD. Once you are graduated with your PhD and working in academia, it is time to establish yourself as an independent researcher, and start working with colleagues from different institutions. Here are different ways to initiate international collaborations:

- **Reach out to colleagues:** The colleagues you've met several times at conferences over the past years and had good talks with are potential collaborators. If you have a chance to talk to one of your colleagues at a conference, propose to work on a topic together. Don't be vague, but propose a topic that is of your mutual interest, that combines both your skills. Make sure you've read some of the work of your potential collaborator, so that you have a good grasp of what he/she has been working on recently. If you want to start small, propose to write a conference paper on a certain topic first, and then see where the results take you. If the collaboration is pleasant, you can consider applying for funding for a joint project.
- **Reach out after reading a paper:** If you've read an interesting paper, go ahead and reach out to the author to ask further questions. If the author proposes an interesting method, you can ask for supplementary material and suggest to

implement this method to your results, and develop a publication together. You'd be surprised how often fellow researchers react enthusiastically. Don't feel disappointed if the author gets back to you making it clear that he/she does not want to share additional thoughts and insights on the topic – if that's the attitude of this person, you won't have a good collaboration anyway.

- **Service appointments:** An excellent way of starting international collaborations is through service appointments, and in particular through technical committees. As technical committees develop technical documents, you get the opportunity to publish these documents either as committee documents, or by working in smaller task groups. If you are in your early career, don't let an opportunity slide to work on technical documents (provided that you have the time, and can deliver what you promised). Working in technical committees also gives you an opportunity to interact with colleagues from different institutions directly.
- **Apply for funding with colleagues:** If you have a colleague at a different institution with whom you've worked previously on a smaller project (eg. a conference paper), or have worked together through a technical committee, and you know your working styles are compatible, you may consider applying for funding together. You can apply for example for a European Union project (depending on where you are based), for which international collaborations are encouraged, or you can apply for special grants that encourage international collaboration (inform within your institution about the possibilities). Working together on a larger project with funding will require some trips back and forth, which will intensify your working relationship.
- **Jointly supervise students:** If funding is not an option, but your university offers exchange programs for your students (for example, to go do their bachelor's thesis at another institution), you can work together by supervising a student jointly. You can propose a topic that is of mutual interest, find a student interested in the topic, and then send the student for a few months to your colleague to work there. You can then decide to write the thesis in the form of a jointly written paper, or develop a paper later on from the thesis or project (depending on the requirements of your institution for the student's graduation).

13.9 Summary

In this chapter, we discussed the possibilities for your career after you graduate from your PhD program. The first topic we discussed is what to do after you defend your thesis and obtain your doctoral title. You need to give yourself some time to let it all sink in, and if possible, find a way to celebrate your success by doing something special.

There are plenty career options out there, and whenever you consider an option, you should check if it fits into your life. Will you have to move away from your family? Is this career option something that can be combined with your partner's career (if relevant)? Does this career choice influence your children (if any)? Consider how your career choice would affect your life, and see if this choice would make you happy and functioning properly in your career. This chapter gave you a list with examples of career options, inside and outside academia, to consider when you want to figure out which career path would suit you. For those of us going into the industry or trying to find a post-doc position in a field remotely related to yours, we have discussed how you can show employers the unique value of your academic skills. The key here is not to simply trust that your doctor's title will open all doors for you, but to actively show potential employers what you can bring to the table with your unique skill set, and why your years in academia were valuable.

We discussed the essential elements for success in academia, where you need to develop your voice and identity as an independent scholar after many years of working under the tutelage of your supervisor. We looked at strategies to move into a faculty position after being a PhD student, and how to find your place in the research world. As stressed many times before in this book, the importance of planning to balance all tasks is highlighted again. Similarly, we devoted a subchapter to tips for success in the industry, based on the experience of PhD graduates who made a successful move to the industry. The advice section is finalized with a section especially for female PhDs and minority PhDs, as they are still underrepresented in academia.

The final topic of this chapter looked at the challenges of an international academic career, hopping from one short-term contract to another funding opportunity. This lifestyle can take its toll on yourself and your family, so think through your options before you become alienated of everybody and everything you love. If you do decide to proceed into the lifestyle of the academic nomads, you will need to keep certain practical details in mind, as you will often be throwing away excess stuff and boxing up the rest. Going digital is the key to success when moving abroad, and becomes even more crucial if you work at several institutions simultaneously (perhaps located in different continents). The last element of going abroad as an academic deals with the topic of international collaborations, and how to initiate projects and authorship opportunities with colleagues at other institutions.

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Chapter 14
Epilogue

Abstract In this final chapter, an overview of the topics covered in the textbook is given, and sources for further reading are listed. The glossary A–Z of Part II is introduced in this part.

Keywords Epilogue · Summary · PhD · PhD trajectory

14.1 Summary

Congratulations on reaching the end of the first part of this book, dear readers! It's been quite a journey, reflecting on the entire PhD trajectory. We started from the very beginning, when we discussed in Chap. 2 how to get started with a PhD. Arriving to a new city and trying to grow roots there is the first step. Having the first meetings with your supervisor in order to talk about your mutual expectations should be a priority when you arrive. When you start working on your PhD, it is important that you start to document your work, and start to have a grip on your time. You want to move your work forward, without letting your work take over your life. Healthy habits and finding your non-negotiable self-care activities in the beginning of the PhD trajectory are key to long-term success.

In Chap. 3, we looked at the topic of planning. No, that doesn't mean that Chap. 3 is the only one that talks about planning – in fact, good planning habits are intertwined with all further topics in this book, to make sure you can deliver your projects and work on time. In Chap. 3, we introduced the basics of planning and time management. You took time to make a rough planning for the entire course of your PhD trajectory, identifying the major milestones you can expect along the way. Then, we zoomed into the current semester, identifying the tasks you need to finish in this semester. We made a further detailed planning for the current month, learned to set up a weekly template to fit your different tasks and responsibilities, and defined how to determine your daily to-do list. You learned to distinguish and prioritize different tasks based on the urgent-important matrix. We also looked at the digital and paper-based tools that you can use for this purpose. Your weekly template serves the additional purpose that it sets boundaries to the hours you work on a daily basis, so that you can maintain a healthy sleeping schedule, and have sufficient time to eat properly and exercise.

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Chapter 4 looks at the first step of your actual research: developing and then writing the literature review. The entire process of the literature review and its planning are the topic of this chapter. We discussed how to find the required references, how to store and process these, and when you have been reading enough to start writing your literature review. The first result of your literature review is the literature review report, which you will submit and discuss with your supervisor. Towards your graduation, you need to turn this report into a thesis chapter and/or a survey paper. This step is also discussed in Chap. 4.

After having a good grasp of the literature, you are ready to formulate your research question. This topic is discussed in Chap. 5. You learned how to use the gaps you identified in the literature to formulate a research question that is not too broad, and how to divide this question further into subquestions. These subquestions can then be translated into actionable tasks that you need to investigate further during your PhD trajectory. And of course, actionable tasks mean items you can integrate into your planning for the upcoming years of your PhD trajectory. The results of the analysis of your subquestions typically will become chapters of your dissertation. An important skill for formulating your research question is creativity, and we discussed how you can stimulate creativity to support your research in Chap. 5.

In Chap. 6, we went into the laboratory to look at planning and executing experiments for your doctoral research. You start again from your literature review, and from the experiments that have been carried out in the past, which can inspire you for the design of your test setup. Once you have an idea of your experiments, you need to plan the logistics of carrying out your experiments – the skills we discussed in Chap. 3 are very helpful for this topic. If you have the green light from your supervisor and funders to carry out the experiments, it is important to set up your data processing and storage protocols, and to start developing written documentation and a report of your work. For your graduation, you then will need to turn your report into a chapter of your dissertation and/or a journal paper. All pointers and advice on how to do this can be found in Chap. 6.

With Chap. 7 we take a break from the chronological order of the major milestones in your PhD trajectory, and discuss academic writing. Before you start writing, you need to have a plan for your writing and you need to know how to structure your writing accordingly. You also need to know your audience and why you are writing a certain document. The second issue related to writing is finding your voice in writing, a topic many beginning writers struggle with. We discuss the different writing styles for different types of documents, and how you can practice writing to develop your voice. If you are a non-native speaker of English, you can find guidance on how to improve your academic English in a subsection of Chap. 7. Since writing is part of the daily practice of academia, and a constant task for all academics, Chap. 7 rounds off with some tips on how to become a productive academic writer.

We continue the topic of academic skills in Chap. 8 by looking at presenting academic work. The road to a successful presentation involves sufficient time for preparing and practicing your presentation, so a good planning is important. Knowing the tools you have available at a presentation is another important element. To develop your actual presentation, we looked at different possible structures for your presentation, and the type of presentation these are suitable for. When developing your presentation, you need to know your audience too. As in Chap. 7, Chap. 8 contains a subsection for non-native speakers of English, to help them with specific issues related to presentations. We also look at presenting in different languages, and the additional preparation time this may involve. For all presenters, we discussed how to gain confidence in presentations, and how to give clear presentations. In a final section, we looked at what you can do with your presentation material after your presentation. If you share your presentation online, you can reach an audience that may be larger than the audience that was present at your presentation.

The last topic in the section about academic skills is communicating science in the twenty-first century, discussed in Chap. 9. The focus of this chapter is on the opportunities the internet offers for sharing your science with fellow academics, inside and outside your discipline, and the broader public. Particularly good tools for sharing your science are online weblogs and Twitter. We discussed how to use these platforms, as well as how to develop your brand.

We return to the major milestones of the PhD trajectory in Chap. 10 by looking at your first technical conference. All the steps you go through before, during, and after attending a conference are discussed – and of course, connected to planning the required timeline. We discussed how to select a suitable conference, and a suitable topic to present at a conference. For getting the most out of a conference, good preparation is key. Finally, when coming home, filing away your material, sharing your presentation online, and reaching out to the people you met at the conference are the last conference-related activities before you can return to the regular order of the day.

Another major milestone during your PhD trajectory is the writing and (eventually, hopefully) publication of your first journal article, which we discussed in Chap. 11. The first important step is to select the right journal. Then, to make sure you find time for writing and finalize your writing project, planning is crucial. We zoomed in on the abstract, since it is a vital part of your paper, and an important item to evaluate for the reviewers. You learned how to write a cover letter. After submission of your manuscript, you wait until you receive a notification. If the reviewers require modifications, it is important to address all their concerns in an appropriate manner. If your paper gets rejected, which happens to about two thirds of all manuscripts, take some time to get over this disappointment, and then revisit your work, improve it, and submit it elsewhere.

After these milestones comes the writing of your dissertation, discussed in Chap. 12. Again, to make sure you can finish all your writing on time, a realistic planning is necessary. Besides a planning, you also need a map of thesisland – for your case that would be the outline of your chapters. We discussed how you can use a simple diagram based on your research question and subquestions to develop a cohesive structure. Writing a big book style thesis can be a long process, so we talked about how to stay motivated when writing an entire dissertation, and learned that a certain amount of writing every day is the recipe for long-term success. Chapters that require special attention are the introduction and the conclusions, and we discussed effective ways for writing these chapters. After finalization of your draft and approval by your supervisor, you will need to make the changes requested by your committee members, and eventually defend your thesis. Depending on the guidelines of your institution, it is also possible that you defend first, and then submit your final thesis.

The last chapter in this book, Chap. 13, looks towards the future, to life and work after you finish your PhD trajectory. We first looked at how you can recover and give yourself some time to rest and relax after defending your PhD. To help you outline your career plan, we looked at different career paths that you can consider after your PhD. For success when applying to jobs, you learned how to show your future employer what you can bring to the table by highlighting your unique academic skills. The chapter also gave you tips for success in academia, tips for success in the industry, and tips for going abroad or developing international collaborations.

14.2 How to Use the Glossary A–Z of Part II

The second part of this book contains a glossary of topics that deal with the PhD, and forms the literal A–Z part of this book. When you need a refresher on a certain topic, you can look up the word in the glossary list, read the short description to get going again, or see where in Part I you can read more about this topic. If you've worked through this book in the form of a formal course, the glossary list serves as a list with short reminders.

14.3 Sources of Further Reading

Here you can find some references for further reading on different topics:

- General PhD research [1–11]
- Academic writing [12–18]
- Life in academia [19, 20]
- Productivity and planning [21–26]

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Part II
Glossary

Chapter 15
Glossary

15.1 A

Abstract
An abstract is a paragraph with a synopsis of a document (typically a paper). As a stylistic element, an abstract contains the following parts:

1. background and motivation,
2. problem statement (or research question of the presented paper),
3. methods,
4. results,
5. conclusions.

Prior to submitting a conference paper, you typically need to submit an abstract of anywhere between 100 and 400 words. If this abstract is accepted, you will be able to go ahead and write the entire paper. For conference papers, learning to write good abstracts is thus essential. For journal papers, the abstract is an important element in the evaluation of the reviewers. For learning more about how to write an abstract, refer to Chap. 11.

Academic Freedom
Academic freedom means the liberty to carry out research without the constraints of parties that have an interest in the outcome of your research. When industry players that have a clear interest in a certain outcome finance research, your academic freedom can be threatened. Academic freedom also means being able to think and explore research topics without limitations, as long as you respect ethical guidelines. As academic freedom represents the life of academics, it is also sometimes used to describe the (lack of) routine that academics have in their life, leaving them with the choice to work when they want and where they want. Make sure you don't let work seep into all parts of life. For a reminder on how to find your non-negotiable self-care routines, go to Chap. 2.

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Academic Schedules
Academics tend to work erratic schedules. Since academia is a much freer environment than a typical office job, you will see that some researchers start their day early (6 am sometimes), whereas others start only after lunch time. Before you adapt a schedule that is different from your colleagues, make sure your supervisor agrees, and that it does not impact your work negatively. For example, if you need to work with your fellow colleagues in the laboratory, and they all start at 8 am, then showing up only after lunch is not going to work in your team. Check if your university allows a completely free schedule. Employees at Dutch universities, for example, have to be present during certain blocks of time. The fact that academic schedules are much more flexible does not mean that academics work less than office workers. Often, the contrary is true. If you want to learn more about how different academics work and what their schedules look like, check out the "How I Work" series on PhD Talk. For advice on how to find a schedule that works for you, refer to Chap. 3. Keep in mind that your ideal schedule will change as your responsibilities change, or as your life situation changes.

Academic Writing
Since success in academia is often measured in terms of your scientific output, i.e. the peer-reviewed papers you have published, academic writing can be considered your most important skill. Writing requires practice and planning. If you don't work on improving your writing, you won't reach the maturity of voice that is required for a journal paper. If you don't plan your writing, you will typically postpone it for the future. I strongly recommend all PhD candidates to develop a daily writing practice, which is a good habit to carry on into your future academic career, and which helps you to slowly but surely develop the building bricks for your dissertation. To revise all elements of academic writing that we discussed, go to Chap. 7.

Acknowledgements
The acknowledgements section is the part where you can thank people and institutions that have helped you. For the acknowledgement section in a journal paper, the list is typically limited to your funding body, and perhaps people that have helped you in the laboratory or in the field. The acknowledgement section of your dissertation is typically a short chapter of about two pages in length, where you can express gratitude to all institutions, colleagues, professors, committee members, friends, family, deities, pets, and other things (coffee?) that have helped you through your research. Your acknowledgements may be the only part of your dissertation that your friends and family will ever read (and probably some other researchers in your field too). I always read the acknowledgements in a dissertation, as it gives you a glimpse into the life and personality of the person who wrote the dissertation. While acknowledgements typically have a lighter tone than the rest of the dissertation, it doesn't make writing them something you finish within 20 minutes.

When you are planning to write your chapters, you need to understand that compiling everything into the entire dissertation (i.e. the actual complete document) might take some additional time**.** You'll need to add not only your acknowledgements, but also your summary and CV,[1] and make sure everything is in the same layout. Sometimes I read a dissertation, and I can feel the despair of the final weeks of writing and getting everything finished in the acknowledgements. While I can totally relate to those feelings, you may perhaps not want to have that negative tone in your dissertation. The feelings will pass once you defend, but those words will remain there. Write your acknowledgements early on, as you prepare your first draft and are still away from the messy final months of writing. Start early, so that your acknowledgements won't echo the frustration and despair you may be feeling in the final weeks of finishing your dissertation.

Administration

Administration is not part of the regular job description of an academic, but unfortunately it is something nobody can escape from. With budget cuts to universities, more of the administrative burden ends up on the academics, as less supportive personnel is available. There are always forms to be filled out, stamped, delivered, and submitted. Administration takes time and is not part of your core business, but you can't ignore your administrative tasks. If you ignore your administration, you will end up with fines, lack of funding, or worse. I recommend that you reserve a daily time slot to deal with e-mail and administration (as part of your e-mail is administrative as well). Make sure you select a time slot during which the offices you typically have to visit are available. You could for example reserve an hour after your lunch break for e-mail and administration, provided that the people in the administrative offices of your university return from lunch when you do. For more discussion on planning time for dealing with urgent but not important task such as administration, refer to Chap. 3.

Analyzing Data

When you carry out experiments, you gather data. The next step does not necessarily come when you have carried out all your experiments, but instead when you have gathered at least some initial data that you can start to analyze. Here are a few key elements to consider when you start to analyze data:

- Before you start analyzing your data, consider again your research question and subquestions: what are the questions that you need to answer with these data? Knowing what you are looking for in your data helps you to decide how to analyze your data, instead of trying every possible mutation of your results.
- Typical calculations that you can carry out when analyzing data are parameter studies and comparisons to existing methods. Present these results in overview tables or graphs. Make sure your results are visual, and not in the same format as the spreadsheets in which you may have been carrying out the analysis.
- If you need to process large amounts of data, standardize your routines. Use programming software to automatize the process. Limit the amount of hours on

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[1] Depending on your institution. Some universities require you to add a summary in different languages. In Delft, a Dutch and English summary is required. For my M.Sc. thesis at the Vrije Universiteit Brussel, I had to add a summary in Dutch, French, and English. German was optional.

a day that you stare at massive spreadsheets of rows and columns full of numbers. Give your eyes a break regularly.
- Once you start to analyze your data, start to document how you analyze your data and how you came to your results. As you work towards the final report of your data analysis, make sure that your document is not a story of all the steps you carried out, but an organized written document that is centered around answering the subquestions of your research question that you addressed with your experiments.
- Once you have analyzed your data, draw conclusions and give recommendations. It is not sufficient to just present an analysis and then walk away from your research (sub)question. You want to use the data analysis you carried out to actually come up with an answer to your research (sub)question.

For more information on carrying out data analysis, check Chap. 6, or refer to textbooks on qualitative or quantitative methods or statistics.

Analytical Work
See also "Theoretical work." Analytical work includes a broad range of methods that are not experimental: the use of finite element models, theoretical calculations of varying lengths and using different tools – anything that is based on analytical deduction as opposed to empirical deduction. Most supervisors require that you not only come to the answers of your research (sub)questions based on experiments, but that you also carry out theoretical research. The key to this analytical work is that you need to have a deep understanding of the literature, so that you can use the concepts and tools developed by other researchers in a creative way. You may need to read broadly and deeply to find the right inspiration to develop a theory that can support your experimental observations, and that can analytically predict what you observed in your experiments. Having the task of developing a theory may be stressing you, as there is not much guidance on how to find the "right" approach. Use mindmapping and brainstorming methods to outline possible approaches, and then start trying out different methods. Only in doing the actual work and trying out different approaches will you be able to move forward – staring into space won't give you divine inspiration to answer your research question. Refer to Chap. 3 to revisit the literature review, and to Chap. 5 for a discussion on creativity in research.

Application, Practical
If your PhD research is aimed at solving a problem for society, you may want to add the practical application of your results to your dissertation. You can use practical case studies for this analysis, and use these case studies to come up with recommendations for the industry. You can use your experiments to derive improved methods for practice. If carrying out a case study was not a task required to answer your research question, you may still want to provide guidance to practitioners on how they can benefit from your results and conclusions. In this case, you can write general thoughts and observations on how practitioners can apply your results, and discuss the practical benefit of doing this. Make sure you also discuss the cases for which your results are not applicable, to avoid using your results and conclusions

outside of the boundaries of what you developed. Refer to Chap. 5 for a discussion on the research question, where you could develop a subquestion on how you can apply your research results to practice, and refer to Chap. 12 for a discussion of recommendations for practice in your dissertation.

Application into a Program

Depending on the institution, applying for a PhD program can be a long process that includes writing essays and taking exams, or it can be similar to going for a job interview. When you are planning to apply for a PhD position, make sure you know the requirements and the procedures. If you don't fulfill the requirements (eg. having the test scores of exams required for applying, a certain minimum grade or GPA in your master's), don't apply. If the application procedure includes the writing of essays, start ahead of time, so that you can write and rewrite your essay a number of times, and so that you can ask feedback from professors who are willing to help you with the application process. If your application consists of an interview, make sure you go well-prepared. You should know something about the research position you are applying for if the research is already defined because its proposal is funded. You should know something about the research group and the professor you want to work with. Revise a number of their most recent publications to get a better idea of their work. Prepare yourself in the same way as you would prepare yourself for a job interview. For more discussion on job interviews, see Chap. 13.

Archiving Data

When planning your experimental work, think about how you will collect, store, and archive your data. The worst thing that could happen is that you finalize your experiments, have all your data on your desktop computer, and then your computer dies or the building goes up in flames. Store your data on different hard disks, perhaps in your office, at home, at your parent's place, and somewhere safe to survive the zombie apocalypse. Invest in storage space in the cloud to store your data as well. Set up a clean system of folders and subfolders for archiving your data. Develop that tree architecture before you collect your data – don't wait until you have carried out 200 experiments to organize your hard drive. For more on storage and archiving protocols for your data, refer to Chap. 2.

Archiving Publications

Don't be the PhD candidate who saves all papers you read in the "PhD References" folder with file names such as "1-s2.0-S0141029616304655-main.pdf". You won't be able to find your papers back like this. Develop good habits in terms of archiving your publications. Name all your files in the same way, for example Title-FirstAuthor-Year.pdf. Archive the papers you read in a paper management system, such as Endnote, Zotero, or Mendeley. Take the effort to fill out all the required entries, and add research notes to make your references more searchable. An added benefit of using a paper management software is that it makes citing your references and developing the list of references in the right bibliographic style a breeze. For more information on how to archive publications after reading them, check out Chap. 4 on the literature review.

Asking for Help
When we hit a rough patch in our research, we tend to shut up and try to push through without telling anybody. Don't suffer in silence, but ask for help when you need it. Asking for help is not a sign of incompetence. Remember that as a PhD candidate you are the apprentice of your advisor, and that your PhD trajectory is a learning process. Every now and then, you will find yourself in a dead end, and you will need to ask your supervisor for his/her input. Don't stay holed up in that dead end, but schedule a meeting to discuss your struggles. Go well-prepared, so that you can show what you have tried, and how it did not work. Then, ask your supervisor for his/her thoughts. If you feel deeply stuck and are doubting if a PhD is for you, talk to your colleagues, friends, and family. If you are deep down in a black hole, seek professional help. For more about preparing for efficient meetings with your promotor, refer to Chap. 2.

Asking Questions
Asking questions at conferences or during meetings can be difficult, as you may feel that you are asking something "stupid". Don't feel intimidated by the presence of others, but instead start practicing the art of asking questions. For the presenter it is also nicer to answer a question from the audience than have the awkward situation in which nobody has a question and you wonder if they understood anything of your presentation. For more information on asking questions at conferences, refer to Chap. 10.

To develop your research and train your creativity, you should ask yourself questions. In fact, your entire research revolves around your research question, and the subquestions you outlined to guide you to find the answer to your research question. For more about your research question, check out Chap. 5.

Authenticity
When you grow up as a researcher, you may feel that you are not yourself. A bit of "faking it till you make it" can be necessary when you suffer from the imposter syndrome. However, when you start to feel that you are too far away from what really makes your heart blossom, reflect on what you are doing that makes you feel this way. Is the direction your research is taking not exciting you anymore? Make course-corrections so that you can stay close to your research passion. For a brief introduction on self-reflection in your work, revisit Chap. 2.

If you are sharing your research progress online through a blog or social media, it can be tempting and easy to create a persona. Some researchers who share their research progress online prefer not to mention their failures. However, to create a realistic image of academia, and relieve some of the high pressure in our field, I would like to urge you all to be as authentic as possible, and share the highs and lows. For more on the use of social media during your PhD for communicating research, see Chap. 9.

Authority
See also "Expertise" and "Gaining confidence". Part of developing your voice in your writing is related to becoming comfortable with speaking with authority on

your research topic. After spending some time doing research, you may feel like you have a better grip on your research topic. As such, you develop confidence in speaking about your topic in different situations. However, you may still feel completely overwhelmed when you start writing your dissertation. Remember that the dissertation is a writing style of its own, and if you've never written a doctoral dissertation before, you can be an expert in your research topic yet a neophyte when it comes to dissertation writing. You will notice that throughout your PhD trajectory, you may feel more experienced, and more of an authority in one element of your research, and still feel like you have a lot to learn about another element. This unequal growing is typical for the PhD trajectory. For more on writing with authority and developing your voice, see Chap. 7. For more on presenting with confidence and authority, see Chap. 8.

Authorship

Authorship can be a muddy issue. At its core, having authorship means that you and your coauthors wrote the paper. But the definition of the actual writing is more obscure. Should you include people that have worked with you closely on the research as authors, even though they did not actually write the paper? Should you include somebody from your funding institution? For how long after your graduation should you keep publishing with your PhD supervisor? And once you have outlined who will be getting authorship, what should be the order of the authors? Suppose you worked with a master's student, and he/she wrote his/her thesis about a certain topic, and you then developed this work into a journal paper, who should be the first author? Opinions on who deserves authorship, and the order of authors on a paper differ. Make sure you discuss this topic with your supervisor, and with fellow PhD students, to know the customs at your institution. Before you submit your first journal paper, discuss this topic with your advisor, to see who is expecting to be included as an author for your article. Revise Chap. 7 for a discussion of writing skills, and Chap. 11 for guidance on writing your first journal paper.

Autobiographical Essay

Depending on the institution where you are hoping to carry out your PhD research, you may need to write an autobiographical essay as part of your application procedure. Some scholarships also require that you write and submit an autobiographical essay. Here are some elements that can help you write a better autobiographical essay:

- Spend enough time on developing your autobiographical essay. Start early, so that you have enough time to write and rewrite your essay. For students in STEM fields, it is unlikely that you have experience writing essays besides the odd homework. Writing an essay about yourself may be a new challenge. Allow yourself enough time to find the right writing style and voice for your essay. Avoid the trap of just writing a description what you've done so far in your life: a list is not an essay!
- If you have enough time for writing and rewriting your essay, you also have time to ask a professor for advice on your essay. Look for somebody with a clear

writing style that can advise you on the nitty-gritty of writing the autobiographical essay.
- Let something of your personality shine through in your writing style and in the contents of your essay. If you have a fair amount of extracurricular activities outside of your general coursework, discuss these activities, how these activities have shaped you, and how they have influenced you as an academic hopeful. For example, if you play team sports, you have developed good skills as a team player. If you combine a busy schedule of extracurricular activities with your studies, you probably have developed good time management skills. If you studied classical composition, you are likely to have developed the required mathematical skills for composition.
- Use your personal interests and personality to distinguish yourself from all the other good students that are applying to the same program or for the same scholarship. Good grades are a minimum requirement to be able to apply in the first place. Understand that all other applicants have good grades too. Look for something that sets you apart from all the other good students, and that can be an added value to the program you are applying to.

Refer to “Application into a program” for more information on the application process. Revise Chap. 2 about getting started with a PhD program, and Chap. 7 for some advice on academic writing.

Autonomy
As you move through your PhD trajectory, you will develop more and more autonomy. As you learn more skills, and become more of an expert in your research topic, you will depend less and less on your supervisor. Becoming an independent scholar is part of your academic growth process, and a crucial part of your PhD trajectory. In the beginning, you are the apprentice of your PhD supervisor. Towards the end, you will be able to teach your supervisor what you have learned by doing your research. As you graduate from your PhD, you will be ready to carry out your own research. For a discussion of becoming an independent scholar after you graduate from your PhD program, refer to Chap. 13.

15.2 B

Background Knowledge for a PhD
What do you need to know when you start a PhD? The basic requirement is that you have a master’s degree in a relevant area, although there are some institutions where you can combine the master’s and PhD program and you enter this program with a bachelor’s degree. You need to know as well what type of PhD program you are applying for: some programs are research-only, while other programs combine coursework with research. If your program is research-only, you will need to fill the gaps in your knowledge with self-study, and you will not be taking formal courses anymore. A PhD is a strange kind of program: you are reaching the last step in the

formal system of university education, and at the same time you are entering the first step of a research-oriented career, regardless of the career choice you make after your PhD. Expect to feel a complete beginner again when it comes to new skills, such as designing experiments or writing a dissertation. For more information about starting your PhD, see Chap. 2.

Binaural Beats and White Noise
If you need to concentrate during your work, you may want to use noise-canceling headphones and listen to music. Instead of listening to music, you can use binaural beats or white noise. Binaural beats are supposed to help with concentration, or even bring you into a trance-like state, but so far, there is no scientific evidence to back up this statement. The explanations on why and how binaural beats work seem to lie in the realm of pseudoscience. Nonetheless, by placebo effect, binaural beats work wonders for some students. The activity of opening a document, putting on your headphones, and selecting a binaural beats track is enough for some of us as a ritual to mark that we are serious about our writing. You can find tracks with binaural beats on YouTube and in Spotify. If you want to try it out, I recommend you select a long track (say, one hour) and commit to a single task during the time of your track. Besides binaural beats, you can also use random noise: the sound of a fan, the sound of the rain, the sound of water, or white noise, pink noise, or brown noise (depending on the spectral profile of the noise you select). You can use cellphone apps, or tracks on YouTube or Spotify to block out external noise while listening to white noise. Check out Chap. 12 about staying motivated while writing an entire dissertation if you want a further discussion on writing motivation.

Blogging
During your PhD trajectory, you can blog about your research and about your insights into the research process. There are different ways in which you can use blogging, and different reasons to start blogging. You can use a blog to reflect on your research, to share your research with the world, to interact with other academics, and for a host of other reasons. You can blog to practice your writing, to communicate your science with a wider public, or for any other reason that motivates you. Adding blogging to your writing habits can be very beneficial: you practice a more direct writing style, which helps you to write clearer journal articles. You don't need to have your own blog, or write several posts a week. You can develop a joint blog with fellow researchers in your laboratory, you can write guest posts for other blogs, or you can look for other ways to collaborate with fellow scientists inside and outside of your field. Moreover, by using the internet as an additional platform to the regular platforms you may be frequenting (meetings, technical conferences…), you can get in touch with academics you wouldn't meet otherwise. Check out Chap. 7 for more about writing skills, and Chap. 9 about blogging and science communication.

Branding
See also "Online reputation". When you tell academics that they have to develop their "brand", many will walk away from you quickly. However, branding is more

than what we associate with the plain commercial advertisement world. In our increasingly digitized world, online branding is important. People form a first impression of you by simply putting your name in a search engine, and looking at the first five websites that show up. Even if you try to avoid social media and the internet as much as possible, it is likely that you have a digital footprint that people will find when they search your name. Therefore, I recommend that you take charge of your online profiles in such a way that they look like your digital business card: if somebody puts your name in a search engine, you want them to find you (and not confuse you with somebody else), and you want them to find some relevant information about what you work on (recent publications, a profile on your university website that describes your research experience and current projects). You simply want to have the right information available to those who need it (such as future employers). You don't want awkward pictures or random chats from internet fora to show up in the first place. If your online profile does not contain the right information, you can take charge and provide contents. Excellent ways for providing information are having a blog, building a personal website, having an updated LinkedIn profile, and curating your profile on Academia.edu or ResearchGate.[2] For more about online branding, check out the discussion in Chap. 9.

Broader Public

If you want to inform the broader public about the results of your research, you can use different paths. You can blog about your research in accessible language, so that any interested layperson can find your information. You can participate in science outreach events that share recent scientific discoveries with the public. You can focus on turning your research results into recommendations for practice or into government policies, so that the broader public will experience the benefit of your research results. The way in which you reach out to the broader public depends on your field of research and on your interests. Most universities use science communication experts to convert the findings of researchers to the broader public. If you are interested in joining the dialogue with the broader public, I recommend that you get in touch with the science communication experts of your institution to see how you can work closely together with them. I bet they will be very happy to see a scientist who actively wants to work with them. For more about science communication in the twenty-first century, check out Chap. 9.

Budgeting

See also "Saving money." A PhD salary is usually rather low, and will be considerably lower than what your peers earn who joined the industry after getting their master's degree. However, living on a PhD salary does not mean that you have to get in debt to survive. If you have family members or children who depend financially on you, it may be harder to make ends meet. Salaries are also quite different across institutions, and can even differ within institutions: in the Netherlands PhD candidates who have a contract with university and are hired as employees will make more than PhD candidates who have a scholarship from outside of the country or university. To live comfortably on your limited budget, you can think about the following:

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[2] Note: some scholars prefer not to use these sites as they are for-profit. You could also host preprints of your work on your website and/or blog to provide this information.

- Track your expenses, either by using a spreadsheet, or by using specialized software like YNAB. Write down every single thing you spend money on, and place it in the right category. You will be able to quickly analyze how much money you spend and need in each category on a monthly basis.
- Factor in your annual expenses: tuition and fees, car maintenance, housing taxes, vacation budget… Know how much money you have to set aside each month to be able to pay these larger bills, and know in which month you can expect them.
- If you know your monthly and annual expenses, you can plan your budget just in the same way you plan your time. Save for the large expenses, set aside a certain amount of money for eating out and going out, and make sure you don't overspend. Set a fixed (weekly) budget for your groceries, and keep track of the price while shopping.
- Besides all your known categories, set aside money every month for a rainy day. Even if you can only save 25 euros a month, make sure you save something every month, and make sure this saving process goes automatically. You can for example set up a separate savings account for difficult days, and have an automatic monthly payment into these savings.
- Analyze your expenses, and cut out all small expenses. Instead, focus on a larger expense (a book, a kitchen appliance) that would make your life better, and set money aside to buy this (budget allowing). Reward yourself for saving money, so that you can keep up this way of living.
- To save money, there are a number of small changes you can make to your usual habits:
    - Check out the sales in the supermarket when you make your grocery list, and plan your meals around the foods that are on sale this week. You can save up to 10% on your grocery expenses.
    - Bike or walk to campus. Avoid the cost of public transportation or the cost associated with having and using a car.
    - Leave out expensive food items, and cook your meals around cheaper items such as rice and beans, which have the added benefit that they don't easily expire and that you can buy them in bulk.
    - Save on your electricity and heating bills by switching off all the lights and heating at home, except in the room where you are.
    - Buy your furniture, clothes, books… in thrift stores or second-hand online. It's better for the environment too.
    - If you are single, avoid spending too much money on rent by sharing a house with others, preferably other PhD students.
    - Grow your own herbs: a pot of fresh basil can cost the double of a package of cut fresh basil, but will last a few months if you take proper care of the plant.
    - Avoid buying meals from restaurants, and take your own lunch and snacks to work. Bring your own drinks if your university charges for coffee and tea.

- Buy your presents online, and ahead of the holiday season. You can find better deals when you buy early, and you can compare the prices across websites.
- Only spend money on certain days of the week, and don't spend anything on other days. During my PhD, I was only spending money on Tuesday (groceries) and sometimes on Saturday (purchases from stores that are closed after 5 pm during the week).
- Replace bottles of soap and shampoo by bars: they are cheaper and last much longer.
- Cut costs on your beauty routines by doing as much as you can at home. I've been dying and cutting my hair since becoming a student, and by now simply can't figure out why I would pay someone for this.
- Find online deals for weekend getaways and massages when you want to invest in these bigger treats. You can look on websites such as Groupon, Actievandedag, Cuponaso or the likes if you want to score a good deal. Don't subscribe to the e-mail list, as you may be tempted to spend on something you don't need when you see a good deal in your mailbox.
- Buy products you like in bulk – buy deodorant, toothpaste, toothbrushes when they are on discount and then buy in large.
- Buy your vegetables in bulk when they are on sale, and just chop up and freeze the extra veggies for another time.
- Read books from the library instead of buying them.
- Replace bottled water with a water filter and tap water, provided that you live somewhere where the tap water is clean.
- For bigger purchases, such as electric appliances and shoes, buy quality rather than having to replace them after a few months. The initial investment may be larger, but they will last longer.
- Before you buy something, ask yourself "Do I really need this?".
- Don't buy a dryer: use a clothesline or drying rack instead – you also save on your electricity bill.
- Protect your valuables: use a surge protector for your electronics and a heavy lock on your bike.
- Keep an eye on when certain plans end, such as a profitable phone plan, and change to a cheaper plan before getting a hefty bill.
- Exchange clothes that don't fit you properly anymore with your friends and family for things they don't like anymore.
- Check out personal finance blogs for more information about budgeting and saving money.[3]

Building a Creative Habit

Research is creative work, and if creativity does not come to you naturally, you will have to put some time and effort into the development of your creativity. For students with a STEM background, creative work may be uncharted land. If doing creative work is new to you, spend some time every day in developing a creative habit. Pick up a hobby that stimulates your creativity. This hobby can be completely unrelated to your research. Learn to play an instrument, join improvisation theater, or take a course in fiction writing. You'll notice that such activities stimulate your creativity, which will eventually be beneficial for your research skills. For more information about creativity, revise Chap. 5 about the research question.

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[3] If you speak Dutch, look up "vrekkentips".

15.3 C

Career Events
Career events are an excellent opportunity to meet possible employers before you graduate. Make sure you prepare sufficiently to get the most out of the event. Try to be your best self on the day of the event. Don't forget to follow up after the event with recruiters and colleagues that you met at the event. If you are in the second half of your PhD trajectory, you need to start thinking about your future. Identify career events that you want to attend, and spend some time in the exhibition hall at technical conferences. To read more about how to prepare for these events, and how to get the most out of such events, check out Chap. 13.

Career Options
Starting a PhD trajectory does not mean that you want to or have to become a professor eventually. There are plenty of possible career paths that you can chose from after you obtain your PhD degree. You can stay in academia in different positions, you can join the industry in your field or as a business consultant, or you can focus on turning your research results into policy recommendations for the government, or become a politician. You can also decide you're done with your field and try out something completely different. The options after graduation are wide open. Refer to Chap. 13 for a list of possible career options.

Career Planning
A PhD does not mean that you will be doing research for the rest of your life, or that you have to stay in your field forever. Your career options are wide, and you can change career several times during your working life. In fact, the average worker makes three to seven career changes during his/her working life. If you want to plan a career by focusing on building a complete profile of skills (i.e. career capital), I recommend that you work with the book "80,000 hours" [1] to develop your personal career plan. For a short discussion on your career after graduating from your PhD program, check out Chap. 13.

Case Studies
Also see "Application, practical". If you want to link your research to practical problems faced by the industry, develop case studies in addition to the experimental and theoretical work that you carry out for your PhD research. Refer to Chap. 5 for a discussion on the research question, where you could develop a subquestion on how you can apply your research results to practice.

Circadian Rhythm

Your circadian rhythm is the natural rhythm of your body. Have you noticed that your concentration may be sharper in the morning, whereas your body's strength and flexibility seem to peak in the late afternoon? Knowing your best working hours, and the best hours for your body to rest is essential for optimizing your planning. If you understand the workings of your body, you can plan your activities accordingly. You may have an energy dip in the afternoon after lunch; and that time can be a good moment for less intensive tasks, such as processing e-mail and taking care of admin work. You can use that time for meetings or teaching as well, but perhaps not for writing and research. For a short discussion on your circadian rhythm, revise Chap. 2.

Citations

In the text of the documents you write, you can refer to the work of others by means of citations. Your citation can be either in the [Number] format or (Author, Date)[4] format. At the end of your document, you compile a list of references, where the full reference to these citations can be found. You can use reference management software to help you with this task.

When your work is cited by another author, this citation of your work will count towards the total number of citations of your work, provided that both your paper and the paper of the other author are listed in the same search engine (for example, Scopus, Google Scholar…). The number of citations of your work is also used to determine your h-index.

For more information about managing your references from the literature and citing these easily and properly through the use of referencing software, see Chap. 4.

Coauthoring

See also, Authorship. The people you write your papers with, or the people whose names appear on your papers are your coauthors. Ideally, coauthorship is a joint process, and a mutual learning process of writing. For PhD students, coauthoring means receiving feedback (most often from your PhD supervisor) on how to better structure your writing, which elements to add to your manuscript, or which elements to leave out, as well as comments on sentence structure, grammar, the appearance of tables and figures, and much more. Coauthoring then means that you as a PhD student draft the entire paper, but that your coauthor helps you improve the paper significantly. At later stages, or when you have worked together with another PhD candidate or post-doc, you can be coauthoring by subdividing the paper into different sections, and distributing the work across the authors. For more information about writing journal papers, refer to Chap. 11.

Coffee

Coffee is the grease that makes academia operate smoothly. Coffee can be the drug you turn to when you need a little pick-me-up in the morning or afternoon, or to keep going for a longer time when you need to finish some work. At some universities, having coffee (or tea) together is an important part of the day, to spend time with colleagues and talk about work and life. Whenever you grab your java, keep in mind that coffee is a drug, and that you can get dependent on it. If you notice difficulties to sleep at night, or headaches on the days when you don't drink coffee, it may be time to kick your addiction, go caffeine-free for some time, and then reintroduce coffee into your life in a conscious way. Consuming coffee in a conscious way means understanding the possible negative effects, and enjoying it responsibly and because you want to enjoy your coffee, not because you depend on it. This discussion is also valid for all other caffeinated drinks: black tea, energy drinks…

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[4] With or without the comma between "Author" and "Date".

Collaborations

Whenever you work with a colleague, you are in fact collaborating. Collaborations during your PhD trajectory are typically limited to working with your PhD supervisor, your daily supervisor (if you have one), and your fellow PhD students. As you move from PhD student to independent scholar, collaborations with colleagues worldwide become more important. To set up international networks of collaboration, you can start small by working on a joint conference paper, or by exchanging thesis students. Then you can grow to a larger scale by applying for funding together. You can also collaborate with colleagues through the framework of technical committees. For more discussion on how to initiate international collaborations, see Chap. 13.

Committees

Service appointments and serving on technical committees is part of the work you'll be doing in the final years of your PhD and beyond. In most cases, your PhD supervisor will propose you as a committee member for a technical committee in your field of research. If your PhD supervisor is too busy to help you with the advancement of your career, don't stay moping in the shadows but show your value to the world. If you have the opportunity to attend technical conferences where committees meet, and the committee meetings are open to the public, then make sure you attend these meetings and get in touch with the committee members. Many committees allow you to sign up as a "friend of the committee", or something similar, which will ensure that you receive the committee mailings. If you see something you can help out with, don't hesitate to volunteer. For more information about serving on technical committees, see Chap. 13.

Besides technical committees, it can also be valuable to serve on committees within your university that study different topics, such as improving the work environment, to serve as an employee representative, or to serve on selection committees for scholarships or new appointments.

Communicating Research

Carrying out research is one thing, but if you keep your research findings to yourself, nobody will ever benefit from your work. Therefore, communicating your research is an indispensable step in the research process. In fact, your dissertation and defense are works of writing and oral presentation that will determine if your work is worth a PhD. Use the years that you spend on the PhD trajectory to learn how to communicate your research: find your voice in writing, develop confidence in your technical presentations, and use online tools to reach out to other researchers. For most of us STEM people, communication skills are not a part of the standard curriculum. Some universities offer special courses and workshops to support the development of these skills for their PhD candidates. Take advantage of these resources if possible. By all means, invest time and effort in improving your communication skills to make sure you know how to write when you need to write your dissertation, and to make sure you know how to present with confidence when you need to defend your PhD. For more about academic writing, see Chap. 7. For more about presenting, see Chap. 8. For more about communicating science in the twenty-first century, see Chap. 9.

Community
If you are in a research-only program, you can feel lonely (at some point) during your PhD trajectory. When you start to feel isolation, when you start to think you are the only person who cares about your research topic and what's the point of it anyway, then it may be (more than) time to find your community. You can spend more time with fellow PhD students in your research group, or with students from other research groups. If you are a part-time PhD student or working remotely, you may feel geographically isolated. In that case, you can look for support online by joining Twitter chats with fellow PhD students (such as the #phdchat, #acwri, #scholarsunday, #withaphd and many similar environments). For more about the use of Twitter to find your academic community and a sense of belonging, see Chap. 9.

Concentration
See also "Flow", "Focus", and "Zone". Getting into a state of deep concentration can be challenging for PhD students. There are numerous temptations around (your smartphone, the internet, extra-long coffee breaks and chitchat with colleagues…) and your goals may seem vague and far into the future if you have a long period of time (three or four years) to "do" your PhD. A key element for being able to work concentrated is a good planning: if you know when you will be working on what, and what you want to achieve, you are setting yourself up for success. Revise Chap. 3 for planning tactics. Add to that an understanding of your energy levels, and your non-negotiable self-care routines (sufficient sleep, proper nutrition, exercise, meditation) and you will be able to go the extra five miles. Check out Chap. 2 for a revision of these concepts. If you need a quick (i.e. you'll see improvements in about one week of time) fix for your concentration, I recommend the following five steps:

1. Map your concentration span**:** Start by identifying the length of your concentration span. During a few work days, note down precisely how long you stay concentrated on one task. Whenever you take a break from the task, note this down. If you glance at your smartphone, you are going off task. The key here is to be absolutely honest with yourself. Knowing how your brain works is important to improve your concentration. Only when you know your starting point, you can work towards lengthening your concentration span.

2. Identify clear goals: This example should give you a sense for setting clear goals: compare "write thesis from 8 am to 6 pm" on your to do list to "write 400 words on paragraph 5.3.4 in thesis between 10 am and noon". Setting clear goals, and knowing what precisely you need to do in which time slot, allows for less drifting off.
3. Plan your breaks: If you want to have several hours of deep concentration in a work day, then it is important to unwind every now and then. In the Pomodoro technique, 25 minute sets of concentration are alternated with five minute breaks, and a longer break after three Pomodoros. If you try to force yourself to sit on your chair for hours and hours, your mind will start to wander and you'll make slower progress. The key is to take short but frequent breaks, so that you can stay at a decent level of concentration throughout the day. Make your breaks count: don't use them to stare at your smartphone screen, but walk around, get some fresh air, eat something, stretch…
4. Take care of your body: you can't concentrate when you're tired, sick or generally unwell. Therefore, it's important to find time to prepare wholesome food, work out, relax, and get your hours of sleep. Sleep deprivation is one of the most common reasons for poor concentration. Schedule time for taking care of yourself in your weekly template. If you have too many commitments, revise what is important and what not, so that you can safeguard your eight hours of sleep.
5. Develop a meditation practice: A long-term solution to getting your monkey mind under control is to develop a daily meditation practice. Meditation is indeed nothing more than a good workout for your brain. As a researcher, you're "paid to think", and therefore taking good care of your brain and optimizing its performance is important. Identify when during the day would be a good time to meditate, and commit to your daily practice. I recommend meditation in the morning to start the day feeling more centered.

Conclusion Writing, Dissertation

To write the final chapter of your dissertation, you need to bring back everything you discussed in the previous chapters and show how all these actions answer your research question. You can give the overview of what you discussed in your dissertation by summarizing each chapter separately, or by discussing the key concepts and novel contributions of your work per item, linking contents across chapters. Your conclusions chapter will also need an outlook for practice or a discussion of the broader implications of your work, as well as an overview of topics for future research. For more information on how to write the chapter of your conclusions, revisit Chap. 12.

Conclusion Writing, Paper

The summary and conclusions section of a paper is, together with the abstract, the part of the paper that most people will read to determine if your paper is worth spending some more time on. Therefore, it is important to write a clear section that conveys the main message and findings of your paper. I recommend students to write this section after the first round of proofreading. During this first round of proofreading, take notes of the main ideas of each section of your paper. Then, draft your summary and conclusions section based on these notes. Make sure you never introduce new ideas in this section. For more about writing journal papers, see Chap. 11.

Conference
Attending technical conferences and presenting your work is an essential part of the PhD trajectory. If your PhD advisor does not agree with this statement and won't provide funding for your travel, look for other sources of funding to be able to attend at least one conference per year during your PhD trajectory. To get the most out of your conference attendance, planning is essential. If you attend a conference, make sure you also submit and present a technical paper. If you don't get to travel frequently, try to submit two papers to a conference. Presenting your work at conferences is an excellent preparation step for your PhD defense. If you don't get to travel often, focus on conferences of which the proceedings are published in Scopus, so that you can start building your publication record. You can consider these papers as a lead for writing your journal papers. Reread Chap. 10 to see all elements related to preparing for your first conference.

Conference Paper
A conference paper is typically shorter than a journal paper. Whereas a conference paper is usually limited to anywhere between 4 and 12 pages, a journal paper is generally the double of this length (but defined by a word count). You can use a conference paper for preliminary analyses, and for showing concepts that you would like to discuss with the audience during your presentation. Many academics like to test some of their ideas first in a conference paper, receive the feedback from the scientific committee and audience at the conference, and then develop these ideas further in a journal paper. You can also show smaller pieces of work in a conference paper, which makes conferences a good venue to present your work at the beginning of your PhD trajectory. The added bonus is that you get to practice your writing skills. For more about writing your first conference paper, see Chap. 10.

Conference Paper Ideas
PhD students often feel that they are not ready to start writing a conference paper yet. Instead, I recommend you to present your work as early as possible. If you don't have all the results of your experimental work yet, for example, you can show some preliminary results and discuss how you designed your series of experiments. With a bit of luck, the audience of the conference or a member of the scientific committee will suggest you to test a parameter that you hadn't originally considered in your plan for testing. Here's an overview of possible ideas you can present in a conference paper:

- Case study: Take an example from practice, and use the deeper knowledge that you obtained while making your literature review to delve into this case.
- Review paper: The review paper is a classic but often overlooked type of paper. If you've spend the right energy on your literature review, you should be able to write a critical review paper.

- Mix & Match paper: Why not compare the test results from researcher X with the theory from researcher Y? Play around with existing data, and see if you can learn something new from this. Doing so will only deepen your understanding of your topic.
- Parameter study: Parameter studies can teach you a lot, and give you some good contents to write about. Even simple Excel-style exercises to study how a certain parameter is represented in different theories and how this is observed in experiments will be a valuable starting point.
- Bounds and Assumptions: If you've done your literature review correctly, you'll have identified the limitations and boundaries to the major existing theories in your field. You can use that insight and expand on it: what are the limiting assumptions and bounds of some of the most commonly used theories? What should we do as a research community to verify these bounds or to make sure the theory can be extended?
- Comparison of design methods: Maybe a typical idea for a structural engineering paper, but it's always interesting to compare different codes and design methods. Start with a simple case, and see what is the resulting design if you follow different codes. Make sure you discuss the boundaries and assumptions of the codes you considered.
- Computer modeling: For structural concrete, computer modeling is a topic of advanced PhD research. However, you can always start modeling an experiment from the literature, and discuss your observations with respect to the different (material) parameters that you need to assume. This technique will also give you the tools to model your own experiments more easily later on.

For more about conference paper writing, see Chap. 10.

Conference Planning

So your abstract is accepted and you can start thinking about writing your full conference paper, attending the conference, and presenting your paper? Time to start planning! You need to plan sufficient time prior to the conference for writing your conference paper and making sure your coauthors get enough time to help you improve your first draft. For your presentation, you also need enough time to make your slides or poster, and to practice your presentation to make sure you adhere to the time limits of the session. Prior to traveling to the conference venue, it is also important that you prepare your conference attendance by planning which sessions you will attend and who you want to talk to. For more about successfully planning for a conference, revise Chap. 10.

Conference Travel and Comfort

Traveling to conferences can be tiring. At times, you will be traveling across time zones, taking red eye flights, and then enthusiastically attend All The Stuffs at a conference from 8 am to 10 pm. Add to that all the interesting conversations, the ideas from the presentations, and all the new faces, and you can imagine that conference travel can be a bit overwhelming. One way to use your energy in a smart way during a conference is to plan in advance which sessions you need to attend and who you need to talk to. If being in crowds drains your energy, then see when during the day you can escape for a moment and recharge by reading a book or squeezing in a workout. Support yourself by making conscious food choices, making sure you get some movement during the day, and enjoy the presence of colleagues you haven't seen in a while. For more about conference travel, see Chap. 10.

Confidence
Feeling nervous for your presentations? Do you have difficulty voicing your opinion in meetings or during the Q&A session at conferences? Part of growing from PhD student into young academic is finding confidence in your work. For each of us, finding this confidence is a different process. You can feel more confident once you have published a number of journal papers in high-impact journals. You can feel more confident after having presented your research a fair number of times. You can feel more confident once senior researchers start entrusting projects to you and show that they believe in your capabilities. You may think that you have found your confidence, and then something happens and you are feeling like an imposter all over again. You may grow unequally in different directions: feeling confident at some point during your PhD trajectory about presenting your work because you've done this a number of times, but feeling a complete novice when it comes to writing your dissertation. If you don't feel confident about anything at all, you can try to fake it until you make it or entrust a friend with your doubts. For more about the confidence aspect of presenting your work, see Chap. 8.

Creativity
See also "Building a creative habit." Research is creative work. Therefore, PhD students who received high grades in courses because their learning style is oriented to learning existing processes may find themselves puzzled when they start research. Studying and research are quite different skills. Yes, research requires you to be able to study new concepts on your own, but at the same time it also requires you to be creative in the ways you approach your research question. You'll have to learn how to see a problem from different angles, and to try out different paths to see what can bring you closer to an answer to one of the subquestions of your research question. For more about the creative aspect of research, see Chap. 5 about the research question.

Culture Shock
See also "Expat" and "Homesickness". If you move to a new country and a new culture for your PhD, you will go through culture shock. Don't fool yourself by saying that you are flexible and that you will adapt – everybody goes through some form of culture shock when moving to another place, and through reverse culture shock when moving back home. Prepare yourself mentally for the four stages of culture shock:

1. Honeymoon: In this stage, everything about your new city and institution is fantastic. You love everything, explore all the new things, and feel dazzled by all the opportunities.

2. Frustration: Suddenly, you notice that adjusting becomes more of a struggle. Your work permit may take longer to get arranged, you start to feel weary of all the paperwork, or you simply get all upset about not finding a food item in the grocery store. Bottom line of all these experiences is that you feel frustrated with your move.
3. Adjustment: You start to get more familiar with your new surroundings, and you start not to feel so out of place anymore. Things gradually are getting better for you.
4. Acceptance: You've reached the stage in which you are comfortable in your new place. You have settled into a routine, you are enjoying the good things of your new place, and you acknowledge the things you miss from your home country.

For more about adjusting to a new country, revisit Chap. 2.

CV

Your CV, short for curriculum vitae, shows what you have done in your life. However, presenting a dry list of everything you've done in your life is not very attractive for future employers. While a CV is generally longer than a resume, you should still tailor your CV to the position you are applying for. Most employers will determine if they want to talk to you based on the short paragraph at the beginning of your CV that shows who you are and what you can bring to the table. After this paragraph, you should list your relevant work experience, education, and all other typical categories that belong to a CV. However, make sure that you highlight the skills that may be important for the job you are applying for throughout your CV. For more about preparing your paperwork when finding a job upon graduation, revisit Chap. 14.

15.4 D

Daily Checklist

What is important for you to do on a daily basis? Which habits are you trying to reinforce? You can select a number of tasks (for example: meditate, exercise, write, journal, draw, play music, run, play with your kids, play with your pets, reflect on your day, make a gratitude list, juice, learn something new, practice a new language…) and add these to your daily checklist. You can have a written checklist, a checklist on a blackboard, or use apps for reinforcing habits (such as Coach.me or Habitica) or apps for daily lists (such as ToDoist, Remember The Milk, Google Tasks..). If you try to develop new habits, start small with one habit. If you want to eat healthier, start for example by tracking if you had a healthy breakfast, or by tracking if you had your five servings of fruit and vegetables. Once you feel a habit has become solid, you can slowly add other habits. For more about finding what is important in your work and life, refer back to Chap. 2.

Data, Large Amounts
If you carry out large amounts of experiments, you will also gather large amounts of data. Data mining techniques can become important here to analyze your results and to manage your data. Another important aspect is that you need to keep track of your work and the manipulations you carry out with your data. Add notes in a version management tab in your spreadsheets and add sufficient comments to everything you code. Keep a research diary. Everything that seems obvious while you are doing it will seem impossible to understand once you start to explain your choices in your dissertation. Know where you store your raw data, your calculation files, and your reports. As you start gathering data, start processing your data. Don't wait until you have gathered all your experimental results to start your analysis; you'll drown in data. Similarly, don't wait until you've carried out all analysis before you start writing about it. See Chap. 6 for more information about experimental work.

Database Collection
Part of your literature review can include the collection of relevant experimental data from the literature. When can it be interesting to start compiling a database of experimental results from the literature? A database can be a good option if you notice that a lot of work in your field is experimental, and you start making small analyses of the results from the literature as compared to code calculation methods or other theoretical work. Before you develop your own database, check if there are no existing databases or working groups that are compiling databases, to avoid double work and to avoid errors in your data collection. For more about the literature review, refer to Chap. 4.

Deadlines
If you are in a research-only PhD program, you may have very few deadlines. In some cases, the only “deadline” is the end of your contract, when you are supposed to be finished with your PhD. Everything that comes in between can be your own decision. In other cases, you may need to present certain deliverables to your funding institution during your PhD trajectory. Important but not urgent work, such as writing your journal papers, has no deadline. It may be tempting to postpone important but not urgent tasks. To avoid missing important steps in your PhD trajectory, set deadlines or milestones for yourself, and take your self-imposed deadlines seriously. For more information about planning the milestones of your PhD trajectory, see Chap. 3.

Deep Work
Deep work is when you can focus on the contents of your research without disturbances. You may find yourself in a state of flow when you are writing, or you may find yourself losing track of time while you analyze your data. You are not interrupted by e-mails, phone calls, or other trivial things, but instead can move the contents of your work forward. If you find that most of the day your mind is all over the place, then redesign your daily routines to find time and space for deep work. For some people, it is sufficient to simply block timeslots during the day to work without disturbances. If your office environment is too distracting, you can consider

working a few hours from home in the morning, or you can work from a coffee shop or the library, wherever you can reach deep concentration. For more about optimizing your day to facilitate deep work, see Chap. 2.

Defense
See also "Viva." Depending on the requirements of your institution, the defense of your thesis may be the very last step in your PhD trajectory. At other institutions, you will be required to submit your dissertation after the defense, and to make amendments based on the comments that arose during the defense. By all means, your PhD defense is a special day. At most institutions, the PhD defense is (at least partially) public – and your defense can be a joyous event in the presence of your friends and family. You are examined by experts in your field on the contents of your dissertation, and, at some institutions, your propositions. For more information on how to prepare for your defense, refer to Chap. 12.

Digital Scholarship
Digital scholarship includes communicating your research online with the broader public and with fellow scholars. The tools you can use for digital scholarship are broad, and include blogs, ResearchGate, Academia.edu, Facebook, Twitter, LinkedIn, Google+, Slideshare, Storify, and many more. For a discussion on how to use the internet for communicating science, refer to Chap. 9.

Discussions in Journals
Besides journal articles, you can find "discussions" in most journals. A discussion is written by a reader of the journal, who may have additional questions about the research presented in a journal paper published in the journal, or who may have a different view on the research presented. If you read a journal paper, check if there is an associated discussion and authors' closure. Reading these discussions and different points of view will give you a deeper understanding of the literature. For more about the literature review, refer to Chap. 4. If you read an article, and not all information seems to be given, or you disagree with part of the analysis, don't hesitate to write a discussion – these discussions are a vital, yet seemingly declining element of our scholarship. Write a discussion in the same way as you would write a very short journal article. Make sure you thank the authors for their interesting article, even if you completely disagree with their analysis. The fact that you want to write a discussion shows that you took interest in their work. If you need to know just a few details, don't write a discussion, but instead send an e-mail to the corresponding author. For more about writing your first journal paper, see Chap. 12.

Disconnecting from the Internet
Do you have difficulties concentrating, and notice that your thoughts run off to the internet all the time? In that case, you may need to just disconnect from the internet for a while and redefine your focus. When I was a student, disconnecting was easier – I simply unplugged my internet cable and locked it away in a cupboard until I was ready with studying for the day. Nowadays, we are all connected via WiFi, and often we need to be connected to software licenses on the institutional server. You can decide to selectively block certain websites from your computer or install a tool

that blocks these websites if you've spent more than a certain preset amount of time on them. But then again, if you have a smartphone, you can simply shift your distractions from your computer to your phone. Therefore, most people have more success when they understand why they are procrastinating in the first place. Using the Pomodoro technique, or asking yourself "is this really necessary?" when you want to check the news again can be helpful. A good planning with shorter timeslots and well-defined goals can help you stay on track. For more about planning, revisit Chap. 3.

Dissertation
See also "Thesis". The dissertation or thesis is the document which answers your research question. At some institutions, the dissertation is a collection of journal papers, accompanied by an introduction chapter and a chapter with summary and conclusions. At other institutions, the dissertation is a "big book" style thesis, where students are asked to write a book outlining the answer to their research question. Both dissertation styles have their advantages and disadvantages. Writing a dissertation is typically something you have never done before until you start your PhD trajectory. As such, dissertation writing is difficult for everybody – it's the first (and often last) time in your life that you do this. For more information on writing a dissertation, revise Chap. 12.

Distractions
Distractions come in many forms. For some of us, chatting with our colleagues is our vice of choice, for others it is the internet, and for others it may be busy work (i.e. work that is not important, but that you are doing to seem busy). Distractions can come unplanned, with visitors stopping by or phone calls. When you get distracted and start doing things to procrastinate, it can be helpful to use the Pomodoro technique, or to use relatively short time slots and well-defined tasks to stay on track. For the unplanned distractions, you can evaluate if you can avoid some of these by switching off your phone at certain times during the day, or by working from a different location for a time slot at some point during the day. If some of these distractions are part of your job (such as attending to students), you may need to factor in that you can only work maximum 60% (or even less) of the time slot that you have planned. For more about planning realistically, refer to Chap. 3.

Diversity in Academia
See also "Gender." Academia is not a diverse environment. You may find that at the level of graduate school, you have colleagues from all over the world, from different socioeconomic backgrounds, different faiths, and different genders. But as you look higher up in the academic ladder, you will see that the vast majority of the "important" positions are taken by white men. If you happen not to be a white man, you may be faced with struggles that are uniquely yours. For a short discussion on being a minority in academia, refer to Chap. 13.

Dividing a Large Task into Subtasks
One key aspect to effective planning is being able to subdivide a large task into subtasks. For research specifically, you will need to subdivide your research

question into smaller subquestions. Of course, you can't sit down at the beginning of your PhD trajectory, and map out your next three or four years in detail – you simply have to do some research to know which paths to explore. Exploring these paths is an iterative, curious type of work. While planning is an important skill during your PhD trajectory, it is also very difficult to plan something as unpredictable as research. Therefore, you use major milestones in your long-term planning, and use your monthly and weekly planning for well-defined tasks. When you start your working day, it is important to have your subtasks defined, and to know exactly what you plan to achieve that day. Compare the following two tasks: "work on paper X from 8 am to 5 pm" or "write 700 words in paper X in paragraphs 3.4 and 3.5 and draw figure 6 of paper X". Which task description motivates you more to get working? And, if you are done early, it means you can leave a little earlier, since your work for the day is over. For more about managing your research project and describing tasks for your work, revisit Chap. 3.

Dress Codes in Academia

Depending on your research field, anything goes in academia. At some universities, you see graduate students who pretty much work in their pajamas. If you do a lot of laboratory work, you probably live in your old jeans and some worn out t-shirts. Dressing "right" in academia, during conferences or when you are teaching is a hot topic. There are no guidelines, in general. If you are a minority, people will observe you more closely – which may make you feel uncomfortable. You may think that you need to wear tweed and elbow patches to be a serious academic, but in some fields shorts and flip flops are perfectly OK. The question of what you should wear to different events can be stressful. However, there are a number of fashion bloggers out there who happen to be academics, and that can give you some ideas – look for their blogs online or check out their pictures on Instagram. If you don't feel like getting ideas from somebody else, just go for what makes you feel good, and let the stares to those who like to stare. For a short overview of some basic clothes for conferences, see Chap. 10.

15.5 E

Early Rising

If you are free to set your schedule in graduate school, why would you want to wake up early? The reason why rising early can be beneficial, is that you can achieve a number of things in the early morning, and still be early in the lab. If you wake up early, you can exercise and meditate in the morning, for example. You will have more energy for the rest of the day. By all means, I recommend you to develop a fixed schedule for sleeping and waking. Avoid the trap of starting to wake up later and later every day until you start to work through the entire night and then end up completely jetlagged. Set a fixed schedule for waking up every day. Try to be early to work to get a head start for the day, and to make sure you can leave on time and get some relaxation in the evening. For more about planning your days around your non-negotiable self-care activities, revisit Chap. 2.

Editing

Drafting text is one thing, editing text is what differentiates writing from spewing words onto paper. If you are a STEM student, it is unlikely you've ever had to edit your work in the past. You may have typed up your reports and homework in one go, and submitted your work as it was. However, when you start to write conference and journal papers, your writing style and the cohesion of your text become important. You'll only achieve this level of writing if you edit and edit and edit some more. In the beginning of your PhD trajectory, you can ask your supervisor for advice on how to improve your writing. As you move through your PhD trajectory, you need to learn how to edit your work yourself. If you can't get the support from your advisor or from an office specialized in academic writing at your institution, you may want to invest in the help of a professional editor. Look for a native speaker who is specialized in editing academic writing. Don't send you work to one of the predatory websites that promise to make your homework or claim they can write your dissertation of 300 pages in just 48 hours – their academic credibility is zero. When you plan your writing, keep in mind that drafting text takes about one third of your time, whereas the next two thirds will be used for editing and rewriting. For more about academic writing, revisit Chap. 7.

E-mail

"Ping" says your smartphone, and you immediately reach out to check your e-mail – even if chances are it is just an advertisement. You can spend your entire day in your mailbox. To avoid this distraction, I recommend you to process all e-mail during a set time slot in your day. Close your mailbox for the rest of the day. If you need to revise if something urgent has come up, have a quick glance at your smartphone once in a while during the day. Switch off the sound and notifications on your smartphone to avoid the endless ping-ing. If you receive a lot of unwanted e-mails, unsubscribe from as many lists as you can. Don't leave e-mails in your mailbox after you've replied them, but go for Inbox Zero instead. Read one mail message, reply that e-mail, and archive it in the correct folder. Set aside a larger timeslot if you've accumulated a backlog. For more information on planning time for taking care of e-mail, see Chap. 3.

Employment, During the PhD

If you work a full-time job in combination with your PhD, managing your time can be quite a challenge, especially if your day job is exhausting already. You may be left with just one or two hours each night to work on your PhD. You can also do a part-time PhD with support from your day job's company, where you will be alternating working days at university with days at your day job. In this case, you have more opportunities during your PhD to carry out laboratory work, for example. In all cases, if you work more than one job, it never happens that one job is busy and the other job is quiet. You'll have to learn how to juggle your responsibilities appropriately, and how to set limits to the demands of both jobs. If you need some extra income during your PhD, you may need to work a student job on the side, which is less challenging for your brain, but equally challenging to make your schedule work. As you may have understood from this discussion, the most important skill to make your PhD trajectory successful if you work as well, is to learn how to make a realistic planning. For more about planning, see Chap. 3.

Employment, After the PhD

As you start to reach the end of your PhD trajectory, it becomes time to think about what you will do afterwards. Take full advantage of the support your university offers in terms of helping you decide what type of career you'd like to pursue. Plan to attend career events or other events that your university organizes to get in touch with future employers. Let your supervisor and colleagues know that you've started your job hunt, as they may be able to get you in touch with possible employers. Identify for yourself what you are willing to do, and what you are not willing to do, such as moving internationally. Make sure you consider your current life situation when applying for jobs that may require a big change in your life. For more discussion about employment after the PhD, revisit Chap. 13.

Ethics

If you are planning to carry out research on living beings, or anything that may be controversial, make sure you check if you need permission from an ethical committee (along with other permissions for carrying out your research). Discuss possible ethical questions with your supervisor as well. When in doubt, ask for more information: it's better to check and double-check in advance than to be confronted with unpleasant consequences afterwards. For more about experimental work, refer to Chap. 6.

Exchange Programs During the PhD

International experience is generally considered as positive. If you have the opportunity to go abroad during your PhD, consider if this option would be for you. Factor in your current family situation, and the progress of your research. If you are tied to the lab, it may not be possible to pause your experiments for six months and go for an exchange. Consider what would be your goals for the exchange, how the exchange would help you answer your research question, and if you will have the opportunity to work in the right lab with the right researchers. In short, exchange programs have many benefits and look good on your CV, but evaluate if they will benefit you and your research when you get the opportunity to go. Weigh the pros and the cons of the option you have, and discuss it thoroughly with your supervisor. For more about international experience, refer to Chap. 13.

Exercise

The American Heart Association recommends 150 minutes of moderate exercise per week, combined with two strength training sessions for maintaining cardiovascular health. When we get busy during our PhD trajectory, exercise may be the first thing that you stop doing. Or you may simply never have exercised at all in the past, except during physical education at school. The benefits of exercise are many, so make movement a priority and fit it into your schedule. Plan at which time during which day you will do which type of exercise. Your options for exercise are very broad. For the 150 minutes of moderate exercise, anything that raises your heartrate into the fat burning zone (60–70% of your maximum heart rate) counts: walking, running, playing soccer with your kids, swimming, dancing… For your two strength-training sessions per week, you can lift weights, focus on bodyweight movements (calisthenics, yoga), or practice any sport that builds strength. Don't make the mistake of generalizing the fact that you don't like running to saying that exercise is not for you. If you find it hard to be motivated, you may want to enlist your fellow PhD students to attend two strength-training classes per week. Most universities offer different classes for a variety of sports, so try out a number of things until you find something that you enjoy. For more about the importance of exercise, see Chap. 2.

Expat
See also "Culture shock" and "Homesickness". If you start your PhD trajectory in a new country, you have become an expat. Being away from your friends and family and your regular environment can be an additional challenge on top of the regular challenges of the PhD trajectory. Acknowledge the fact that you will go through culture shock, and accept that you are away from home, and that at times you will be sad and homesick. If you are particularly homesick, you may want to reach out to people from your home country at your university and spend some time with them, and maybe visit a restaurant that offers food from home. It may not be the same as going home, but it may alleviate the pain for a while. If you don't have these options, cook some traditional food and share it with your fellow PhD students and colleagues. Share some songs from home or tell them about the history and politics of your country. You'll also have to face many more administrative issues than students that remain in their home country. Don't get upset with all these additional challenges, just try to remain patient and enjoy the good things of your new country. For some ideas on how to get settled in a new place, refer to Chap. 2.

Experiments
See also "Experimental Work." Most PhD research in STEM involves at least some degree of experimental work. You can be running physical experiments in the laboratory at a variety of scales, or you can be running numerical experiments in simulation software. Designing a good test setup and laying out the series of experiments you will carry out is as important as doing the actual experiments. For more information about all aspects related to experiments, refer to Chap. 6.

Experimental Work
See also "Experiments." Experimental work is an area of research that is different in its approach from analytical work. Experimental work can lead to empirical observations, which traditionally you will compare in your PhD trajectory to the theoretical predictions you derived with analytical work. Unless you had the chance to carry out extensive research during your master's degree, your PhD trajectory will be the first time when you will be designing and carrying out experiments. Experimental work is a skill in itself. For more information about experimental work, refer to Chap. 6.

Expertise
See also "Authority" and "Gaining confidence." During your PhD, you will be gaining expertise in your field of research, and at the end of your PhD trajectory you will be the expert in your research. The whole PhD trajectory is a learning path of different skills, which has as its final goal being able to carry out independent research. There will be a number of tasks you carry out for the first time in your life during your PhD, such as writing a dissertation. You may feel like a complete novice in dissertation-writing when you start. At the same time in your PhD trajectory, you may have carried out quite a number of experiments, and feel that you've gathered a certain amount of expertise in experimental work. Expertise does not grow equally across all the areas of your research. For more about writing with authority and expertise, refer to Chap. 7.

Everything Notebook
If you like pretty pens and binders, the everything notebook may be the right tool for your planning and time management work, which is similar to (but less linear than) the Bullet Journal system. Essentially, you don't use online tools, but instead note everything down in your everything notebook. You can use tabs to create sections, and make an entry with your goals for the day on a daily basis. You can devote space to your weekly, monthly, and annual planning. If you like having everything on physical notebooks, and if you think avoiding internet-based tools helps you stay more focused, be sure to look up this method. For more about planning, see Chap. 3.

15.6 F

Facebook
Facebook, the mostly rather useless website that many of us spend too much time on… If you feel you are getting a tad bit too addicted to memes and random videos (in Facebook, WhatsApp, Twitter), have an honest conversation with yourself about why you are spending time on Facebook. Does the time you spend on Facebook fulfill you, or do you feel tired and empty afterwards? Do you use Facebook to genuinely connect with your loved ones, or are you just randomly "liking" things, where a call or writing a letter would allow for a deeper connection? Ask yourself what you want to get out of the website, and avoid using it for other purposes. Use distracting internet websites as a tool that can facilitate communication, but avoid using them as a waste of your time and energy. If necessary, unplug for a while to see that the world does not collapse without Facebook. If you want to know how attached (or addicted) you are to the website, take a post it and mark down every time you open the website on a daily basis, or use a software tool, such as RescueTime, to calculate how much time you spend on a weekly basis on the website. You might be unpleasantly surprised by your own data.

Failures

Failure are part of life in academia. Papers get rejected more often than accepted. Experiments can go wrong. Proposal after proposal gets rejected, and finding funding is hard. And, since perfectionism is rampant in academia, and many of us are high-achievers, we can struggle emotionally with these failures. If you need support, it is likely that your university can offer the tools to cope with failures. If you just feel a bit blue, take the rest of the day off, and plan some activities that make you feel inspired and energized. Don't spend your free time on activities that you only do to fill time; make sure that you try to focus on something that will really refresh your brain. For a discussion on how to bounce back after receiving a paper rejection, refer to Chap. 11.

Fast Writing

We all have different habits when it comes to writing. However, if you experience writer's block, you may find it difficult to write any words at all. Therefore, practice writing freely and quickly across different styles and disciplines to mitigate this problem. When it comes to drafting the text of journal papers and conference papers, you can get a head start by planning your paper in detail: make the outline[5] of your paper, and add notes to each section that identify which ideas you want to discuss. If your writing is going slowly or is stuck completely, start with the "easy" sections. You can start for example by describing your experiments – chances are that you already have a good, but perhaps too lengthy, description in your experimental report. Once you get into gear, you can tackle the harder parts of the paper, such as the introduction. To practice free writing, you can journal about your life (long hand, or by using an online tool such as 750words.com), you can return to your research journal to just write about where you are in your research and the ideas you have, or you can explore fiction writing and write a short story to get your ideas flowing. For more about using journaling and your research journal, refer to Chap. 2.

Figures

One figure can say more than many paragraphs of text. Some of us are more talented in developing text, whereas others have a knack for drawing clear figures. If you have difficulties in presenting your research visually, spend extra time on developing this skill. Inquire as well if there is support within your university to get more professionally looking figures, especially when you develop your journal papers. For more about the importance of visual information, refer to Chap. 8.

Writing figure captions is a skill in itself. Your figure caption should contain all the information the reader needs to understand the figure, but it shouldn't be overly long (you don't want your caption to take up more space than your figure). A good figure caption both describes what you see in the figure, and should give an explanation of what the figure means. Keep in mind that somebody who will skim your article to determine if it's worth reading will typically read the introduction, check the figures and captions, and then skim through the summary and conclusions. Make sure your caption is connected to the text of your paper, so that the reader will be compelled to read more – without you explicitly saying this. For more information about academic writing, refer to Chap. 7.

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[5] Provided that outlines work for you.

Flex-Working
If your university offers options for flexibly working, you may want to explore these to see what works for you and your productivity. Flex-working includes a wide array of working arrangements, not limited to: allowing employees to work a certain number of days per week from home, offering flexible working spots on campus, offering intermediate meeting and work spaces at different locations… Everybody has a different working style, so what works for one employee may not work for another one. Some people thrive in large open plan offices without assigned seats, where a paperless policy is used, and every desk is cleaned up at the end of the day. Other people prefer to crawl away into a quiet corner to do their concentrated work. Try out different working styles to see what benefits you most. For more about different working styles, refer to Chap. 2.

Flow, or the Zone
See also "Concentration" and "Focus" and "Zone". Have you experienced this sense of deep concentration, when you are working and everything else around you seems to vanish? You feel no hunger, forget to get up and do anything else, and are completely engrossed in your work for hours on end? This state is typically called a state of "flow", or you can call it "being in the zone". It can be exhausting to spend a few hours in your state of flow, but you will have produced much more in those hours than you sometimes produce in an entire day. If you work in a busy office, or you have students walking in and out, it is more difficult to achieve this state of flow. If you have an afternoon for working in solitude, and you find that deep concentration, you experience this state of flow. For more about finding concentration and motivation, refer to Chap. 12.

Friction
See also "Setbacks" and "Making big changes in your research." It is not uncommon to get stuck in your research. Research, unlike many other types of work that we find in our modern, fast-paced society, can be slow-going. You need to chew on concepts thoroughly before you can move your research forward. There are no quick fixes for research problems, so you sometimes move very slowly, or stand in the same place before your work starts to move forward again. Friction, creative blocks, and general discomfort are part of the research process. This state may be unpleasant, and you may want to procrastinate and get a quick fix of pleasure from the internet. Be patient with yourself, acknowledge the situation, and keep on chewing on your research problem. Don't work extra long days as long as you are experiencing this block; instead, use your evening hours and weekends to refresh and refocus. I like to call this state of discomfort a state of friction. Remember that to make two planes slide, you need to overcome friction first. Likewise, in your research, you are not doing nothing, but you are building up the required strength to overcome friction and take a leap forward. For more about the research process, refer to Chap. 5.

Friday Habits
When you make your weekly planning, leave some time on Friday for wrapping up the week in a good way. On Friday, you can do the following:

- figure out your tasks for the next week,
- reflect on the past week by writing a longer entry in your research journal (focus on what went well and what did not go according to your plan, and adjust your plans for the next week accordingly),
- make your planning for the next week,
- clean up your desk,
- clean out your mailbox, and
- backup your data.

Having a set of activities you do at the end of every week, especially with regard to reflection, planning, and data storage, will help you to make these activities into habits. Plan time on Friday afternoon for your Friday habits to support your time management and productivity habits in a positive way. For more about planning, see Chap. 3.

Focus
See also "Concentration" and "Flow" and "Zone". The first step in finding focus is having a clear planning: knowing what you will be working on and what you want to achieve during each time slot. Once you have figured out what you are going to do, all you have to do is sit down and do the actual work. It sounds easy, but distractions are always there to tempt you. There may be social media, your smartphone, the news, food, the internet, your puppy, and your mother-in-law that all want your attention. Dedicate your attention to one task, and tune out all distractions. If you need an extra push, use the Pomodoro method to focus on one task for 25 minutes. If you find yourself having difficulties to focus, have an honest conversation with yourself: Why are you procrastinating? Are you tired? Is your research subquestion not well-defined? Do you need to make an effort to learn a new skill? What will you remember from this semester in two years from now (hint: it won't be a Buzzfeed video you mindlessly watched)? For more about concentration, see Chap. 12.

Food as Fuel
You may be very busy and stressed during your PhD, but that is not an excuse to eat unhealthy foods. Even though you feel tempted to eat them, and you feel that your willpower is running low after pushing yourself through a hard task for the entire day, make sure you eat a balanced diet. If you get all the micro- and macronutrients that you need, you will feel more energized and able to work in a more concentrated way during the day. I'm not saying that you have to eat "clean"[6] for 100% of your time. Make sure you get the right amounts of your required macro- and micronutrients, but also allow for room for an indulgence here and there. If you're not sure

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[6] Whatever that means – there are many self-proclaimed gurus out there, each with often absurd claims (Carbs kill you! Tomatoes cause cancer! Buy my supplements and you will be fit/healthy/smart/beautiful!), so don't fall for the pseudoscience trap.

about your intake of macro- and micronutrients, you can use an app (for example MyFitnessPal) to log what you eat for a week, and see if your diet is balanced or not. For more about the importance of self-care, see Chap. 2.

Formulating Questions
In research, questions are as important as answers. You first need to have a research question, and subdivide it into subquestions before you can start answering these. To identify your research question, you will need to have a good grasp of the literature. Your question will need to be formulated narrowly enough so you can answer the question during your PhD trajectory. On the other hand, it will have to broad enough, and should not state a hypothesis, so that you can explore a variety of ways to tackle the question.

Besides your research question, another type of questions that you should ask is questions at presentations, in meetings, and at conferences. You may feel intimidated at first, but asking questions is important, not only for scientific discussion, but also to activate your mind while you listen to somebody presenting.

For more about finding your research question, see Chap. 5. For more about asking questions at conferences, see Chap. 10.

Funding
Funding makes the research-world go around… If you apply for a PhD position, you may be expected to bring funding with you (for example, a scholarship from your home country), or you may apply to a position on a funded research project. Check out your funding options before you apply and before you start your program. In most cases, the provided funding will be sufficient for your expenses over the course of your PhD trajectory. In some cases, you will need to work on several small projects, and be applying for funding to keep yourself financially supported. Once you graduate and become an independent scholar, you will need to apply for funding yourself. You may have learned the ropes of applying for funding during your PhD, or you may be a complete novice. Always make sure you know the audience that will evaluate your proposal. For more information about life after the PhD, see Chap. 13.

15.7 G

Gaining Confidence
See also “Authority” and “Expertise.” As you move through your PhD trajectory, you will notice how you start to gain confidence in certain fields, whereas you will still feel as a complete novice in other aspects, such as writing your dissertation. If you haven’t found your confidence yet when you need to present your work, try peptalk, powerposing, or –just the opposite- try calming yourself by breathing slowly into your abdomen. Consciously slowing down your breath will slow down your heart rate, and that jagged feeling. For more about gaining confidence for presentations, refer to Chap. 8 about presentations and Chap. 10 about conferences.

Gender
See also "Diversity in academia." Academia is not yet a diverse place. Women and other minorities are still the exception, and the vast majority of full professors are white men. As such, it is not surprising that women and minorities are faced with particular challenges in their academic careers. Female instructors receive lower grades on their evaluations from students, and are less often invited as reviewers or editors for journals than their male counterparts. We still have a long way to go. If you experience discrimination because of your gender, report it to a trusted office or person at your university. Cherish the young women and minorities you are tutoring and teaching, and make them feel welcome. Support women and minorities in their careers, by inviting them to present, citing them, suggesting them as reviewers… If your workplace does not provide them, ask for a reserved parking spot for pregnant women and a room for pumping breastmilk. Note: you don't have to be a woman to ask your supervisors if these facilities exist at your university. For my five cents on how to deal with gender issues as a young woman in academia, refer to Chap. 13.

Go/No-Go
In the Netherlands, the Go/No-Go meeting is held at the end of the first year of the PhD trajectory. Your progress over the last year is evaluated. Your supervisor will decide if he/she wants to continue with your project for the next three years, or if your collaboration ends there. When you plan your PhD trajectory, the Go/No-Go meeting certainly is one of the major milestones on your planning. Make sure you hit the ground running in the first year, so that by your Go/No-Go meeting you have some results to show, instead of having just vague promises. You may not have started your experiments yet, because you are waiting for equipment or lab space, but you will need to show your supervisor that you have not been idle and twiddling your thumbs. You should be able to show your literature review, your research question and subquestions, and some exploratory calculations, finite element modeling, or theoretical exercises in your Go/No-Go meeting. Discuss early on with your supervisor what the expectations for your Go/No-Go meeting are, so that you can prepare accordingly. Do you need to prepare a report and/or presentation? For more about planning the major milestones during your PhD, refer to Chap. 3.

Goals
See also "Goal-setting." Your main goal during the PhD trajectory should be to finish your PhD (the dissertation, the defense, and other requirements, depending on your institution) within the allotted time. Of course, having one single goal four years into the future won't help you decide what you need to be working on each and every day. Therefore, subdivide your main goal (graduating!) into smaller goals, and each of these into smaller goals and tasks again, until you know exactly what you should be working on right now. If you are in the first year of your PhD trajectory, have your goals and tasks for every day this week outlined, and have larger goals (milestones) planned for the third year of your PhD trajectory. Certainly, you won't sit down on the first day of your PhD trajectory and make a detailed planning for each day of your PhD until your graduation – you will need to refine and reroute as your move through your program. Research is highly iterative and meandering

work. Make sure your goals and tasks are intertwined, in such a way that your task already defines your goal as the outcome for a certain time slot. For example, don't just plan that you will be "working on chapter 4". Instead, add your goal of writing 500 words in sections 4.3.2 and 4.3.3 to your task list. For more information about planning and managing your time, refer to Chap. 3.

Goal-Setting
See also "Goals." When you set your goals, make sure they are SMART:

- Specific,
- Measurable,
- Achievable,
- Realistic, and
- Time-bound.

For example, if you are doing your literature review, don't just outline that you will be spending your day reading some papers – everybody loses concentration after reading with full attention for a long time. Instead, set a goal of reading one paper in detail (a paper that you identified as important) during one hour, taking notes of the paper, and adding these notes to either a discussion document of the paper or to your draft literature review. This task may take you about two hours, for example. The other goal that you can set, is to skim through six papers in 1.5 hours and then note down the key ideas of each of these papers and add some notes into your paper reference management system. These two tasks could be the goals you want to achieve in the morning. Then, after lunch, you may want to reach Inbox Zero in one hour. Do you see how setting these small goals keeps you moving forward throughout the entire day? For more about planning and time management, refer to Chap. 3.

#GoScholarGo
#GoScholarGo is a Twitter hashtag introduced by Dr. Abigail Scheg, a Course Mentor for General Education Composition at Western Governors University and a Dissertation Chair for Northcentral University. She fondly remembers the supportive atmosphere of her PhD cohort, and at some point started adding "Go Scholar Go" in e-mails to colleagues writing about their projects. It's a simple way of encouraging others. Dr. Scheg explained: "Now that I am finished with my PhD, I still have a number of friends from the program who often use the phrase too. I've started using it on Twitter as a supportive hashtag #GoScholarGo because I've found that everyone has more work to do than time to do it. Doctoral students may very well need more hours in the day, but more importantly than that, they need individuals to believe in them when those moments of silent doubt consume their thoughts. And we've all been there." Since I personally love the idea of supporting and encouraging others, this hashtag certainly deserves a mention here – and I hope you will go and use it in e-mails or on social media to show some kindness and support to PhD students.

Google Scholar
Google Scholar is one of many platforms that you can use to showcase your research as well as to search for publications. If you don't have an account on Google Scholar yet, you should set it up – otherwise, your publications in Google Scholar will only show up in the results of a list of found entries, but Google Scholar won't show a profile. Setting up your account in Google Scholar is quite straight-forward. Note that your h-index in Google Scholar will be different from your h-index in Scopus, and that generally the Scopus h-index is considered as your actual h-index. The difference stems from the sources that are indexed in Google Scholar and Scopus. You can use Google Scholar as a search-engine for publications. Sometimes, changing search-engine will be the trick to find a paper that you couldn't find at first. For more about online research profiles, refer to Chap. 9.

Gremlins
Gremlins are those nasty negative feelings that creep up every now and then throughout your PhD trajectory. Your fear gremlin may be having a jolly good time on your shoulder, and whisper vile things into your ear, which make you feel sad, bad, depressed, exhausted, and more, and which make you procrastinate. If your gremlin comes out, you may need to face him and have a conversation with him. Why are you procrastinating and feeling fearful? What lies at the basis of this behavior? Did you not plan your day well? Are you trying to tackle a task that is rather large or rather difficult? Are you wondering if you can do it? Are you tired? Do you have things going on in your life outside of your PhD that cloud your thoughts? For more about essential self-care and your emotional state, refer to Chap. 2.

Guest Lecturing
During your PhD trajectory, it is unlikely that you will be assigned an entire course to teach. It is more likely that you will work as a teaching assistant (with varying levels of responsibility for the course), or that you will be invited as a guest lecturer on your research topic in a relevant course. If you are invited as a guest lecturer, you may be teaching for the first time. Preparing lectures takes a lot of time. If the topic is more general than your specific research topic, brush up on your knowledge about the topic in the first place. Then, outline the concepts that you want to teach, and perhaps develop a calculation example. You also need a timeline for your lecture, and hand-outs or slides to use during the lecture. All in all, preparing for your first lecture can take a lot of time. For the first guest lecture of two hours that I taught, I needed 30 hours of preparation. Certainly, once you teach an entire course, you won't be able to devote this much time to prepare your lectures. You need four hours of preparation time per lecture hour to set up a new course, or one to two hours of preparation time per lecture hour for a course you have taught before. For more about teaching, refer to Chap. 13.

15.8 H

H-Index

Your h-index represents how often your publications are cited. Your index has the value of h if you have h publications of a total of N publications that have been cited at least h times, and (N-h) publications that have been cited less than h times. Your h-index is a value that represents the importance of your work, and is often used when evaluating different candidates for an academic position. At some institutions, one of the requirements of the tenure track is to achieve a certain h-index during the tenure-track years. Keep in mind that an h-index is just one of many metrics that are used to analyze your output,[7] and that values differ across disciplines. If you are a historian, don't compare your h-index to the h-index of a theoretical physicist. Some research fields move more slowly than others, which makes it harder to build up an h-index at the beginning of your career. For example, if a prestigious journal in your field takes about three years between submission and publication, you can expect that it will take at least three years (not even counting the amount of time required to do the actual research on your results) before your paper can be cited in this journal. For more about writing journal papers, refer to Chap. 11.

Holidays and Rest

As important as the time you spend on research is the time you spend refreshing yourself and giving your brain time to let the dust settle. When you plan your PhD trajectory, it is important to factor in holidays. A lot depends on your supervisor and how much time off he/she allows you. If you can, take a holiday of at least three weeks in the summer, and take some extra weeks off here and there during the year. During my PhD, I took all my allowed time off (41 working days of paid leave). Not every institution will allow you to take this much time off. If you are not allowed much leave, plan for some long weekends to escape from the daily routine of your research. Try to bring yourself a bit of holiday feeling, that feeling associated with peace, energy, creativity, inspiration and relaxation. Make sure you take enough breaks, try something new every week, go outside during the day, turn off your phone and social media, and go for small escapes to a nearby national park to bring a bit of holiday-feeling into your life. For more about the importance of self-care, see Chap. 2. For more about long-term planning, see Chap. 3.

Homesickness

See also "Culture shock" and "Expat". Being away from your home country is challenging. In the beginning, you will love everything about your new place and new situation. After a while, you will face difficulties, and notice that you don't have any friends that are close enough to talk to about your struggles. You may be wishing you were home, where you have your close friends and family. You may be frustrated when you go grocery shopping, and can't find the foods and products you are used to. You may be missing certain places of your home country, or certain cultural aspects. In short, you are missing home. To avoid getting really homesick, travel home at regular intervals, so you can catch up with your friends and family. If you plan to return to your home country after your PhD, keep your professional ties in your home country strong, visit old fellow classmates and colleagues, and perhaps present what you are working on at your alma mater. If traveling home is not an option for you, be honest to your friends and family at home about how you are feeling, and plan to spend a long session on Skype to catch up, perhaps after cooking some typical food from home that you will eat while chatting with your loved ones. For more about adapting to a new place, see Chap. 2.

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[7] Remember Goodhart's law: "When a measure becomes a target, it ceases to be a good measure."

Hundred Thousand Words
The length of a typical PhD dissertation that is submitted as a "big book" style thesis is one hundred thousand words. With figures and tables, this length translates to about 300 pages. For most of us, the idea of having to write one hundred thousand words may be daunting. Therefore, split up your writing into bit-sized chunks. You can commit to writing a thousand words a day, if you start drafting your chapters about 1.5 years before the end of your PhD trajectory. You can write these words first thing in the morning, and then devote the rest of your day to other tasks, such as pending data analysis. Keep in mind that you will not only draft these words, but that you will also need to go through various rounds of proofreading and editing. For more about writing your PhD dissertation, see Chap. 12.

15.9 I

Imposter Syndrome
The imposter syndrome is defined as a trait common in high-achievers that are unable to internalize their achievements, and who are afraid of being exposed as a fraud. It's that nagging feeling when you enter a conference venue, that thought of not deserving or not belonging where you are. It's the voice in your head that shouts: "I told you, you are not good enough!" when you receive a rejection of a paper. It's normal to experience these feelings, as long as you can acknowledge that these feelings are a trait of high-achievers such as PhD students, and do not necessarily teach you something about yourself. For more about gaining confidence, refer to Chap. 10.

Inbox Zero
Inbox Zero is a productivity concept for dealing with e-mails. In the simplest explanation, Inbox Zero means having zero e-mails in your mailbox: a completely empty mailbox. One way of achieving Inbox Zero is selecting all e-mails and deleting them, but of course you risk losing important information. What Inbox Zero means, practically, is that you follow this process:

- Read the e-mail.
- Reply the e-mail. Before replying, evaluate if you should reply the e-mail. If it's not important, let it go. If it's from a mailing list, unsubscribe. If replying the

e-mail requires you to do some work, add this task on your to do list, and plan when you will be taking care of this work. You can either type a quick reply to let the writer know that you will follow up on a given day after doing the work, or you can postpone replying until then.

- File the e-mail. Place the e-mail in the right folder within your data structure.
- Delete the e-mail from your mailbox.

By following these steps, you won't have e-mails in your mailbox except those that you still need to read and process. The advantage of this system is that you always have your e-mails sorted in the right folders, and that you won't lose information when you change jobs and your old institutional e-mail account gets closed down. For a discussion on how to limit your time on e-mail each day, and how to add time for processing e-mail in your planning, refer to Chap. 3.

Industry Contacts

As you never know where life will take you after your PhD, it is important to build your network with fellow academics, industry contacts, and contacts in the government. To build contacts with the industry, there are a number of things you can do:

- Reach out to practitioners by volunteering to present the practical implications of your research at industry events or in study groups frequented by practitioners.
- Make contact with the industry during conferences by visiting practical presentations and by visiting the exhibition hall.
- Attend industry events.
- Keep in touch with your former classmates who are working in the industry.
- Invite a contact from the industry or the government to be on your thesis committee, so that you can get their more practical input.

For more information on building your career after your PhD trajectory, see Chap. 13.

Information Stream

The internet contains a constant stream of information. You may find that your favorite way of procrastinating is checking social media platforms or news websites. In the past, you received the newspaper once a day. Now, you can find new news items almost every minute. All this information may make you feel as if you are going to miss out on something if you don't check frequently, or it may make you feel overloaded. If you find yourself checking information constantly, ask yourself how you are feeling about this. Are you feeling really informed by checking short news articles? Or do you feel more informed when you read an in-depth analysis in a (print) magazine? Make conscious choices about the media you consume by analyzing what this information means to you, and what you learn from it. If you are feeling overwhelmed, ask yourself why you are still checking. If you are using the internet for your breaks, see what you can do during your breaks to refuel. For more information on planning your day for productive work, refer to Chap. 2.

Inner Resistance

If you have to solve a difficult subquestion in your research, when you need to start on a new topic, or when you need to address critical comments from reviewers that require a very thoughtful answer, you may experience some inner resistance. You procrastinate. If you find yourself procrastinating when you need to tackle a difficult task, ask yourself why you are feeling inner resistance to the task at hand. Are you afraid that you are not able to do it? Does the idea of having to focus deeply already make you tired before you have started? If necessary, take your research journal to write about your current block. Identify why you are feeling this inner resistance, and then slowly start to work on bringing this resistance down. If the task seems too difficult, make a list of possible ways of solving the task, and what you would learn when it turns out you can't find good results for each approach. If you feel too tired to tackle the problem, take the day off and get some rest. If you are faced with a boring task, and can't seem to get yourself started, break the task down into smaller tasks, use the Pomodoro technique, and promise yourself a certain reward after getting a certain number of Pomodoros finished. For more about planning your days optimally for your work habits, refer to Chap. 2.

International Travel
Attending conferences or visiting other research groups may require international travel. If you are traveling internationally, prepare yourself well in advance. Make sure you have all the required documents for your trip. Confirm that you have your flight, your registration, your hotel, and that you know how to get from the airport to your hotel. Take all your research documentation on your device and on a backup, and make sure you have your information accessible in the cloud. Before you leave, check if you have all your documents, as well as a hard copy of your paper and slides, if you are going to present a conference paper, or your poster if you are going to present a poster. Traveling internationally, especially if you have to cross different time zones, can be exhausting. If you are going to have a jetlag, consider its effect in your travel plans: it may be worth investing an extra day in your hotel by arriving earlier and allowing time to rest. If you have connecting flights to travel long distances, it is wise to travel a day early and pay for an extra night in the hotel. If you miss your connection at any point during the trip, you risk missing the first day of the conference, which comes at a higher cost than paying for an extra night in the hotel. For more about conference travel, refer to Chap. 10.

Interdisciplinary Research
Simply put, interdisciplinary research combines the concepts of different research fields. You can be using methods from a different field and apply these to a problem in your research field. You can find that your research lies at the intersection between different fields. When you carry out interdisciplinary research, you need to carry out your literature review across different disciplines as well. For more about the literature review, revise Chap. 4.

When you have done interdisciplinary research, have experts from these different disciplines in your committee. Make sure you prepare for questions coming from different angles when you prepare for your defense. For more information about your committee, see Chap. 12.

Interlibrary Loans
If you have difficulties finding a reference that seems important to you in your library, ask your librarian if he/she can help you with an interlibrary loan. An interlibrary loan means that your university will request the document from another university for a small fee. This document can either come as a physical book, which will be mailed to you or the library, or the other university library can scan the article and send it to you. By all means, if you have spotted a reference that seems to be important for your research, but you can't find it directly, don't give up searching. The best way to get help in accessing hard-to-find references is by visiting your library and asking a librarian for advice. For more information about the literature review, refer to Chap. 4.

Intervision
Intervision meetings are organized meetings of peers. In these meetings, you will be able to discuss issues with your peers. As such, intervision is different from supervision, in which you meet with somebody who is not your peer, but your superior in your institution. The benefit of intervision meetings is that you will be able to learn from your peers, whose experiences are similar to yours. Ask if your university facilitates intervision meetings. If your university offers this service, typically a coach or somebody from HR will be available during the first meeting, to help you learn how to hold these meetings in a structured way. For the subsequent meetings, the task of your university may be limited to helping you schedule a date, providing a meeting room, and perhaps offering some catering for the meeting. If your university does not offer intervision meetings, you can ask HR or your supervisor if your university would be willing to support and facilitate such meetings. If official support is lacking, you can try to set up an intervision group yourself, as intervision can be incredibly helpful during the PhD trajectory, at all the stages of the process, provided that all participants are willing to share their thoughts and ideas openly. For more about planning and preparing meetings, see Chap. 2.

Introversion
The general idea in our loud society is that introversion is not a desirable personality trait. If you do a quick search on the internet, you can find that there are a number of courses that offer a "cure" for introverts, so that they can become extroverted. You won't find courses the other way around. If you've looked around in your institution, you may find that a fair number of your colleagues clearly are introverts, and you may be one yourself. Academia is suited for introverts, as academia lets its employees be themselves, as long as they deliver the required results. If you are introverted, you can thrive in academia. Conferences and other public events can feel daunting, but you may feel quite fulfilled from the interesting conversations you have with colleagues during such events. You may feel comfortable staying the entire day working in your office with the door closed, without interacting with many people. Acknowledge your personality traits, how these affect your working habits, and how you can optimize your days and working environment based on yourself, your body and your personality. For more about the optimization of your days, refer to Chap. 2.

Insomnia
When you hit a rough patch during your PhD trajectory, are doubting your abilities and feel very stressed, insomnia can arise too. If you find that you can't fall asleep at night, or that you wake up in the middle of the night and are unable to go back to sleep, you don't have a healthy sleep. You need to acknowledge for yourself that you have insomnia if the situation is recurring. If you have difficulties sleeping, visit a doctor to rule out any medical cause. If you are extremely stressed, accept the situation and see how you can turn it around. Do you need to build in more time for self-care during the day? Is there a particular situation at work that causes stress, and should you talk to a person of confidence in your institution to improve the situation? Do you need professional help? Are you spending too much time looking at screens the entire day? For a better sleep, try the following basic tips:

- Cut down on caffeine or alcohol.
- Avoid eating late and sleeping on a full stomach.
- Make sure your room is clean, orderly, and ventilated.
- Go to bed at the same time and wake up at the same time each day.
- Avoid using digital devices during the last hour before going to bed.
- Meditate during the day.
- Have a night-time ritual to prepare your body and mind for sleep.

For more about organizing your days in an optimal way, see Chap. 2.

ISI Web of Knowledge
ISI web of knowledge and its daughter website ISI web of science are search engines for scientific articles by Thomson Reuters, and these websites are a paid service. The advantage of using ISI web of knowledge can be that all search results can be downloaded for the right citation management software package. Nowadays, the majority of journals offer this service on their website as well. Another advantage of using ISI web of knowledge is that this search engine is slightly different from Scopus and Google Scholar, and thus can help you find a reference that you may not be able to find in another search engine. For more about the literature review, see Chap. 4.

Ivory Tower
Academia is also called (a form of) the ivory tower. When academics are reproached of living in an ivory tower, it often means that academics are not aware of the issues of regular life and normal people. Certainly, the connotation of the ivory tower is negative. To break through this stereotype, it is important to reach out to the broader public with research results, either by taking care of this ourselves, or by working closely together with the communications departments of our institutions. For more about communicating science in the twenty-first century, see Chap. 9.

Ivory Tower – Staying In
Depending on your plans for the future, you may want to consider staying in the ivory tower. The benefits of staying in academia are that you can pursue a career built around your personal interests and research hobbies, in the ideal case. Once

you have tenure, you operate rather independently, and you work on topics of your interest, and on a schedule that you define for yourself. The privilege of working with talented young people is one of the many privileges of academia. However, by no means, being on the PhD trajectory should be a synonym of having to stay in academia. For more about life after the PhD, see Chap. 13.

Ivory Tower – Leaving
Just as staying in the ivory tower is an option, leaving the ivory tower and spreading your wings can be an option too. One reason for leaving the ivory tower may be that you have experienced a negative environment. Academia is competitive, and there can be bad elements out there that need to discredit your work and gossip behind your back to make themselves the candidate of choice for promotion when the time is right. Another element that contributes to a negative atmosphere can be financial difficulties of the institution: when the threat of lay-offs is in the air, it may become increasingly difficult and stressful to thrive. Threats for lay-offs can also bring out the survival instincts in other people, who will do everything to stay, which makes the environment even more corrosive. Getting rejected for funding a number of times may leave you disappointed in your options for a further academic career, and may be a reason for leaving the ivory tower. Or, you may simply feel ready to start to apply your insights into practice. For more about life after the PhD, refer to Chap. 13.

15.10 J

Juggling Projects
As a PhD student, you will be typically juggling a number of responsibilities: your research, the practical applications of your research, meetings with your funders, teaching duties, writing your conference and journal papers, and perhaps other tasks such as maintenance of the website of your research group. Your main priority will always be clear during your PhD trajectory: making sure you fulfill all your graduation requirements within the allotted time. As you move up in your academic career, you will be juggling even more tasks, and it may be harder to identify your number one priority: is it the proposals to ensure you get funding, or developing your journal papers? One option as you become a more senior scholar is to subdivide your research in smaller tasks, and give these tasks to your students. This approach requires you to have graduate students, and not all institutions have graduate programs. Besides delegating work, you need to decide on your priorities, focus on the important but not urgent tasks, and say no to everything that is not of your direct interest. For more about your (academic) career after the PhD, refer to Chap. 13.

Journal Paper
Journal papers are academia's currency. Perhaps the most important metric for the success of your academic career is the number of quality journal papers you have published. Important here are the audience of the journal, the ranking of the journal, and the impact factor of the journal. Journal papers are typically 10,000 words in

length (words and word equivalents). If your institution requires you to publish a certain number of papers as a requirement for graduation, you are ahead of the PhD candidates who have to write a "big book" style thesis, as you will have already submitted or published these papers by the time you graduate. Whatever happens, turning your work into journal papers should be one of your top priorities. For more about writing your first journal paper, see Chap. 11.

Journal Editor
The journal editor is the final responsible for accepting or rejecting a submitted manuscript. Being the editor of a journal is a prestigious position, even though it is virtually always a volunteering position. Very senior professors are the journal editors of the most prestigious journals in your field. The task of the editor is to revise the recommendations of the reviewers, and make a final decision with regard to acceptance or rejection of a manuscript based on the review reports. If you are dealing with conflicting reviews, the editor can advise you on how you should move forward. Cover letters are addressed to the journal editor. Only contact the editor when you experience difficulties with submission or accessing elements on the journal's platform that cannot be solved by technical services, or in the exceptional case when you need advice on dealing with certain comments of reviewers. For more about journal papers, see Chap. 11.

Journal Rankings
To have an idea of the quality of a certain journal, you can refer to the metrics that rank journals. There are different metrics available, and the most commonly used ones are the impact factor, the SJR ranking factor, and the categorization of journals within quartiles. These quartiles give you a relative idea of where in a research field a certain journal is ranked, and you should strive for publication in Q1 journals (journals in the top quartile of your field). The impact factor of a journal differs between fields: don't compare the impact factor of the top journals in your field with the impact factor in other fields. In my field, it is striking that the impact factor of journals that deal with structural engineering aspects of concrete structures are much lower than of journals that deal with material science aspects of concrete and concrete structures. This difference between the impact factors across fields tells us more about the citation and publication habits of researchers in a certain field than about how hard or how easy it is to publish papers in a certain journal or field. For an example about journal rankings in concrete structural engineering, see Chap. 11.

Journaling, Longhand
To get your writing flowing, or to reflect on your life, research, or the universe, journaling can be an excellent option. You can journal longhand or you can use digital applications. If you use a research journal, you can either write your daily observations and musings in a notebook, or you can use the template from Chap. 2, combine printed versions of this sheet into a binder, and fill out a form on a daily basis. Here are some of the reasons why you may want to consider writing your journal entries longhand:

- If you use a binder or notebook, it can be interesting to randomly flip through your journal and read some of your old entries.
- Writing longhand can make the flow of your writing easier, especially if you are trying to get through writer's block involved with writing in a word processing software package.
- Writing longhand eliminates the distractions of the internet, as you can take your notebook and sit somewhere away from your computer and phone.
- Writing longhand facilitates different elements: you can add sketches, make lists, add affirmations, make gratitude lists, or write paragraphs about your deeper thoughts.

The disadvantages of longhand writing are that it is slower than typing, and that you will need to take your notebook or binder along with you when you travel or work at different places (your journal will not be available in the cloud). For more about journaling, refer to Chap. 2.

Journaling, Digital
If you prefer to have your journal always available and in the cloud, opt for digital journaling. You can use a template in a notetaking software for your daily entries, such as Evernote, or you can use a designated app for journaling such as the 750words.com website. If you're not sure about which system works best for you, try out different systems first and then decide what suits your life and research at the moment (and of course, the right system for you can change over time). Some advantages of using a digital method for journaling are:

- If you use a designated app or website, you will see that the environment is clean and tailored to writing. It is free of distractions and looks like a clean sheet.
- You can access the app whenever you are connected to the internet, and as such you can switch from a paper you are writing to your journaling app or website to flesh out some ideas in the middle of the working day.
- Apps are perfect places to type out a rant.
- Most journaling apps and websites develop stats, which give you an idea about your writing speed, and can give you insight in the emotions in your writing.
- Your writing is more protected if you have a password on the app than if you have a notebook that everybody can look at.

The disadvantage of writing in a dedicated app or website is that, again, you will be looking at a screen, which may be tiring for your eyes. For more about journaling, refer to Chap. 2.

15.11 K

Keeping Up with the Literature
The constant output of journal articles, conference papers, and technical reports can be overwhelming. If you have finished your literature review, you are not finished

with reading about your research topic: you will have to keep up with recent work published throughout your PhD trajectory (and beyond). Here are some methods you can use to keep up with the literature:

- Use an RSS feed in a search engine based on the keywords of your research to get updated automatically about papers published with these keywords.
- Subscribe to updates of your favorite journal(s), and quickly revise the latest issue whenever it is published. Read the most important papers upon publication and skim through the other new publications to know what is going on in your field and who is working on which topic.
- Keep exploring the archives and historical papers. Whenever you read a journal article, check the references, and, when they look interesting, download the references and skim through these as well. You may come across a school of thought that was more popular in the past and that has some valuable ideas for your research.
- Don't just print out papers, or save them in a "to read" folder, but actually read them. If you need a bit of encouragement, start a challenge with your colleagues to read at least one paper a day (you can find this idea on Twitter with #365papers).
- Use Academia.edu and ResearchGate to stay up to date about recent publications by fellow researchers. You will receive an e-mail with an update when they publish new research. If you've disabled these notifications, you can still scroll through your timeline every now and then to see your recommendations for reading.

For more about the literature review, refer to Chap. 4.

15.12 L

Lab Book
If you carry out experimental work, you will need to keep all your observations and notes from your experiments organized in a lab book. You can use a notebook, or loose sheets that you add to a binder – especially if you work in a dirty lab environment that is not friendly for any of your electronics. If you prefer a digital approach, and your lab environment allows for it, use a notetaking app such as Evernote for your entries. Set up a template for your paper-based or digital notebook that you use for each experiment to report the parameters you tested, and to discuss your main observations. Don't assume that you will remember what you did in the lab, and make it a habit to always show up to your experiments with the right material prepared, and with material to take notes during the experiment. For more about setting up your lab book, see Chap. 2. For more about experimental work, see Chap. 6.

Lab Work
If you are carrying out a PhD in STEM, you will typically need to carry out experiments in the laboratory (or sometimes in the field). Lab work can be frustrating, fun,

fascinating, and boring at the same time. Before you start experiments, you need to be well-prepared: you need to know which information you want to learn from your experiments, and you need to be able to tie this information and your experiments to the existing body of knowledge from the literature. You will need to know which materials you need, and you need a good planning. Build enough flexibility into your experimental work to allow for delays (when ingredients do not reach you on time, for example), for failures (when your test setup does not work and you have to reconsider), and for surprises (when your results come out completely different and you want to continue investigating something you were not planning to spend much time on). Planning a series of experiments is the challenge of trying to plan to unpredictable – and this is the beauty of research: you are the first person trying out your experiments, so you can't know in advance what will happen. For more about experimental work, refer to Chap. 6.

Languages
The dominant language in academia is English at the moment. If you are not a native speaker of English, you will need to do an extra effort on improving your English writing and speaking skills, as these skills will be crucial for your career: you need your writing skills in order to publish your journal papers and dissertation, and you need your speaking skills in order to present your work at conferences, defend your thesis, and serve on technical committees. Another language besides English can be important in your field. In mine, German is an important language, with a considerable number of valuable references published only in German and without a translation. Identify which other languages are important in your field, and check out the main journals in these languages. If you have no knowledge of these languages, develop a basic knowledge of these languages to broaden your research perspectives. Most non-English journals publish the abstract in English, so you can check if the contents of a paper are interesting for you, and if you need to do the effort to read this paper in another language. If all else fails, get some help from Google Translate to get a first idea about the work. Check Chap. 7 for tips on writing academic English for non-native speakers, and Chap. 8 for tips on presenting in English for non-native speakers and for tips on presenting in a language that is not English.

Letting Go
Part of the research process is also learning how to let go: let go of hypotheses you had before you started your research, let go of perfectionism, let go of your work when it starts to eat your life, and let go of habits that no longer serve you. For some of us, the PhD trajectory coincides with important times in our lives: weddings, the loss of loved ones, and perhaps the birth of our children. As you move into this phase of life, you will notice that your PhD and studies, which were your complete priority in your early twenties, may slip down on your priority list, and that you start to prioritize self-care and your family. Don't feel guilty about reframing your priorities – at the end of the day it is your family and friends, and the time spent building beautiful memories, that will be the moments you cherish as you grow old. You won't be on your deathbed reminiscing with gratitude the nights you spent alone in

the lab, trying to fix your experiments. If you want to let go during your PhD, try the following:

- Take your friends or family members and go away for the weekend. You can simply visit them and spend time sipping tea and catching up, or you can go to a place together – whatever feels good for you. You'll notice after the weekend that your thinking will be clearer again for your research.
- If you feel like your PhD is dominating each and every single thought in your brain, take on a side project. Start a blog, or take one of your hobbies to the next level and devote more time on it. Your creativity will be stimulated, and your research will benefit from it.
- When your PhD is giving you nightmares, spend more time on other areas of your life. If you've been hiding away in the laboratory for too long, and can't even remember what you were doing outside of your PhD, make a list of your priorities outside of work, and spend more time on these to reframe yourself.
- If you feel overwhelmed by all the work you need to do during your PhD, have a conversation with those thoughts of panic. Why are you having these worrying thoughts? What should you do to avoid real panic? If something is important, when can you do it? Can you schedule it? Once you've scheduled the task you need to take care of, tell yourself it will be done and that you can stop worrying about it. Journal about the analysis of your overwhelm.
- Look for guided meditations around the theme of letting go.

For more about developing a healthy mindset during your PhD trajectory, refer to Chap. 2.

Learning New Skills
During your PhD trajectory, you typically will have to teach yourself new skills. The actual skill of learning new skills is something you may need to develop as well. If you have difficulties learning skills on your own, check out the excellent MOOC "Learning how to learn" on Coursera. During your PhD, you may need to learn a new programming language, or a new language to read publications in another language. You will have to work on your writing and presenting skills, and you will need to master certain concepts of your research field on your own. If your PhD trajectory is a research-only program, you need to study new concepts all on your own. You need to sit down with a textbook, teach yourself the concepts of this material, and work your way through the exercises on your own. It may be harder to motivate yourself to work through the material if there are no homeworks due and no exams that you need to take, but if you need the concepts for your research, you will need to take the time to do the work. Acknowledge that you are at a point in your career where you don't depend on professors and teachers anymore. You have to learn how to teach yourself new skills and concepts. Soon (if you chose an academic career), you will be teaching students too. For more about scheduling time for learning new skills, see Chap. 3.

Library

Even though you can access most papers now from the comfort of your office, or even from home if you can remotely connect to the network of your university, the library is still an important place in your university. Visit the library to check which books they have available in your field, to ask a librarian for advice with your literature review, or to work in a silent atmosphere. The digital library of your university typically has more than just access to journal articles, which you can access directly through a search engine such as Scopus. The website of the library of your university may also allow access to e-books, conference proceedings, and more. If you need an interlibrary loan, or help with finding an article, you will typically be able to fill out a request on the library website. Some universities also offer the option to chat with a librarian while you are looking for information on the library website. For more about the literature review, see Chap. 4.

LinkedIn

LinkedIn is most commonly used to have your CV online. For most users, LinkedIn is a bit of a static social network. The main reason why you should have a profile on LinkedIn, is to have a digital version of your CV, and to have this information available for whoever is looking you up online. Use LinkedIn to stay in touch with your business contacts. When I receive business cards at a conference, I will typically "process" these cards by searching for these people on LinkedIn and adding them to my network, so that I can stay in touch when they change positions and when their business e-mail address changes. If you want to get more out of LinkedIn, especially towards the end of your PhD trajectory when you start to look for jobs, you can use LinkedIn to see job advertisements in your field, you can become active in groups by asking questions or replying questions, and you can follow companies to learn more about what they are doing. Recruiters often use LinkedIn to find suitable candidates. If you are exploring options outside of academia, LinkedIn can be a valuable tool. Reach out to some of your senior business contacts and ask them if they would be willing to share their thoughts about your career opportunities over coffee or lunch. For more about using online tools for your research, see Chap. 9.

Literature Review

An important part of the first year of your PhD trajectory will be the literature review. If you have limited research experience, writing a literature review may be a challenging task. You may feel demotivated when you spend your days behind piles and piles of papers. Remember that carrying out a literature review is a new skill that you have to learn as a researcher, and it can be an uphill battle. If your background is in another field, you will need a lot of time to understand the first journal articles you read. It is not uncommon for starting PhD candidates to need about a week or more to chew through a single ten-page article. Needing time in the beginning to understand the concepts of the field in which you will carry out research is not abnormal at all, and it certainly does not mean that you don't have the capacities of doing the research. You're just putting all your thoughts and energy into mastering these new concepts. To avoid procrastinating and keeping your mind fresh while carrying out the literature review, switch up tasks during the day. Nobody will sit and read uninterrupted for eight hours straight when developing the literature review. Devote some time to deep reading of papers that contain important concepts, some time to downloading and skimming papers, some time to typing out your thoughts about the papers you read, and some time for other tasks you may need to take care of (e-mail, teaching…). Make a schedule for your days and limit the time spent on each task to maximum two hours. For more about the literature review, revise Chap. 4.

15.13 M

Making Big Changes in Your Research
See also "Friction" and "Setbacks." It can happen that you need to make big changes in your research. Here are some red flags to look for that tell you it is time to make big changes:

- You are manipulating your data. If you are manipulating data to fit your hypothesis, or even fabricating data, you need to be honest with yourself and your science and stop doing this. You don't want to go down the path of the academic fraudsters – remember that they all get caught in the end. Don't you think it is actually more exciting to figure out why your data and hypothesis don't match? Remember that negative results are progress too.
- Your results are very different from the results of others. If you look at results from the literature, and yours are completely different, you either have found a rare exception, or you may be doing something wrong. Revisit all the techniques that you are using. Recalibrate all your sensors. Review all the protocols you are using. Do a few classic benchmark tests to check if your setup is running properly. Talk to senior colleagues in your lab to see what you are missing, or get in touch with researchers from other labs to see why your results are different.
- When you can't think about new ways to approach your problem and are completely stuck in your research, you may be building up friction, or it may be time to acknowledge that you have reached a dead end. You try to mindmap and list possible actions, but you just keep spinning in circles. Talk to your advisor for input and to identify if you can move forward or need to back off out of a dead end.
- If your gut feelings tells you that something is wrong, try to figure out what is going on. If you don't feel excited about going to the lab anymore, if you are procrastinating more than ever, you may need a break, or you may need to make big changes in your research. Stop feeling miserable, admit for yourself that something is not working, and assess what you can do to mitigate this situation.
- When you are violating basic assumptions, you are doing something wrong as well. Whatever you are working on won't stand the test of time. If you are violating the basic assumptions of a certain theory, don't use it. Often, the basic assumptions make perfect sense at first sight, and you will immediately under-

stand their importance for your work. Sometimes they are a bit more obscure, and you will need to review the background of the method first.

- When you can't return to basic principles from the path you've taken, you get another big red flag. If you can't match a classic benchmark test, you are doing something wrong. If your method can't solve a very simple case, something is wrong. The beauty of science lies in clarity and simplicity. If you need a grocery list of assumptions and pages and pages of code, you are trying to fit a square peg in a round hole.
- When you apply methods outside of their bounds, or when your boundary conditions are not fulfilled, you are again outside of the application of the theory or method that you wanted to use. There are good reasons why theories have their bounds and basic assumptions. Unless you have a valid explanation why you should be able to apply them outside of these bounds, and can prove an extension of the theory or method, you should not be doing it.
- If your results become unexplainably complex, you may need to reframe and simplify too. See if you can find something simpler that approximates the same results.[8] Similarly, when you start to need extraordinary amounts of computational time, simplify your methods. Sure, nonlinear finite element models and Monte Carlo simulations can take a lot of time to run. But if you can't reduce your problem to something that is easier to describe so you can explore the basic physics or mechanics of the problem, then you have strayed away from the good path.
- If the solution of your calculations returns irrational values, you must be violating assumptions or boundary conditions, except when your work lies in the complex domain.
- If you start to feel protective of your work, it may be time to let it go and try something else. Never forget to embrace the uncertainty that is an essential part of science. Don't see people that have a different theory as your enemies; remember that you all share the goal of moving your field forward.

If for any of these reasons you need to go ahead and make big changes in your research, here is what you can consider doing:

1. Trace back your trail to the point where you got lost. Your research journal can be helpful for this. Not all your work was in vain, just the last part that did not lead to good results should be reconsidered.
2. Take stock of what you have done, which results you can still use, and what you need to do to move forward again. Which sources from the literature should you revisit? Make an honest assessment of where you stand and what you have available.
3. Take a break from your work for at least a day to let it all sink in.

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[8] Rule of thumb: with a hand calculation approximation you should be able to be within 20 – 30% of the more advanced methods. Note that the range of 20 – 30% is valid for structural engineering – talk to your colleagues to find the accepted bounds for your field.

4. Revisit your “failed” attempt. Why did it fail? What did you learn from it? Can you publish your negative results, perhaps through a blog post? Use your research journal to explore these questions.
5. If you don’t know how to move forward again from the point where you got stuck, talk about your options with your supervisor. Show what didn’t work, show why you think this method didn’t work, and ask for input on how to try another method.
6. Before you decide on moving forward, ask yourself critical questions. Analyze thoroughly what went wrong, and then make an informed decision on how to restart in your work. Reread entries in your research journal for this analysis.

Mastermind Groups
Mastermind groups can be a great tool for your personal and career development. Napoleon Hill created the concept in his book “The Law of Success”[9] [2]. You can join a group that meets in the city where you are living to be held accountable for your goals and receive input from your peers. The idea is that smart people together can achieve more than alone: put the brains of smart people in a room together, and you can create a “mastermind”. The idea of these groups is that you support each other’s projects, and that you can expand your network. You can hold each other accountable for your (lack of) progress on your goals. If no group is available, you can consider creating a group and meeting once a month. If it is hard to get a cohesive group where you are living, you can consider joining an online group.

Meditation
I strongly recommend all PhD candidates to develop a meditation practice to get a clearer mind, provided that you do not have any underlying trauma or mental health issue that can be aggravated by meditation. Start your meditation practice small, with perhaps just two minutes every day in the morning. More than anything, try to make the habit stick in the beginning. As you start to get comfortable with your practice, extend the time spent in meditation. You can use guided meditations that are available online, join a course to learn the principles of meditation, or you can use an app for guided meditations. The method you use is not important; building the habit is crucial. Once you have a steady meditation practice, you will feel the difference in clarity of mind between the days when you have practiced and those mornings when you oversleep and rush out of the door in a frenzy. For more about building non-negotiable self-care activities into your daily schedule, revise Chap. 2.

Meetings
Regular meetings with your supervisor are important during your PhD trajectory. At the beginning of your PhD trajectory, talk with your advisor about your mutual expectations. How often will you meet? How much time in advance should you send your supervisor material to revise before the meeting? How will you conduct the meetings? You may find that as you progress through your PhD trajectory that you will need less guidance and will need to meet less often or have shorter

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[9] I didn’t quite enjoy reading this book, but I liked the idea of mastermind groups.

meetings. For more about preparing your meetings and a template for taking notes during your meetings, see Chap. 2.

For meetings that are not related to your PhD, you need to identify if it is important to have the meeting in the first place. As a young faculty member, you can spend the entire day talking about stuff in meetings but not doing any actual research work. Avoid this situation at all cost, and only attend meetings that you really have to attend, or that are with inspiring groups that are important for your research, such as technical committees. For more about transitioning from PhD student to faculty member, see Chap. 13.

Mental Health

Mental health issues are still a taboo in academia [3], even though the length of the PhD trajectory and its relative isolation, combined with the fact that many PhD candidates are high achievers, are a recipe for disaster. If you don't feel well mentally, tell your supervisor. If he/she laughs at you and says that you are imagining it, you may not be working with the right person.[10] If you need help, check the services of your university. More and more, universities are aware of the mental health issues of their talented young people, and are willing to provide all the support necessary. Don't suffer in silence. If you want to build good self-care habits into your daily schedules, revisit Chap. 2.

Mentoring

Universities typically offer a service where, besides your supervisor(s), you can have a mentor. A mentor is a senior faculty member, who is not directly related to your research, but who can give you advice on how to do research, how to move your career forward, and which choices to make. If you have a professor from your undergraduate days or Master's studies with whom you have a good contact, you can rekindle the contact and meet for input every now and then. You don't have to formally ask this person if he/she wants to be your mentor. If you don't have anybody to guide you, you can ask HR or another office in your university to get you in touch with somebody who would be willing to mentor you. A mentor can also help navigate difficult situations, such as a conflict with your supervisor.

Milestones

The most important milestone during your PhD trajectory is the actual fulfillment of all requirements to obtain your doctoral degree, which is sometimes limited to the publication of your PhD thesis and the defense. Some institutions include also a qualifying exam for the PhD, the defense of your research proposal, and coursework requirements. Fulfilling each of these requirements means reaching another milestone. Other typical milestones that you may look forward to during your PhD trajectory are: finishing your literature review, defining your research question, finalizing your experiments, attending your first conference, giving your first technical presentation, and writing your first journal paper. The deliverables of your project to the funding body are also milestones to consider. You will need to plan your PhD trajectory in such a way that you can accommodate all these milestones within your allotted time. For more about planning the milestones of your PhD trajectory, see Chap. 3.

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[10] Don't listen to anybody who treats you like that – you, and only you, know when you don't feel like yourself.

Mindfulness
Mindfulness often refers to mindfulness meditation, a popular type of meditation that is based around the concept of a focal point (for example, your breathing), and observing the thoughts that come into your mind while you focus on your focal point. You then are asked not to get caught up in these thoughts, but instead observe them, let them go, and return your attention to your focal point. In a broader sense, mindfulness means giving full attention to your task at hand. A common example is washing the dishes: when you are washing the dishes, don't let your thoughts drift off, don't watch TV, but instead, pay full attention to the action of washing the dishes. Besides the traditional sitting meditation, mindfulness practitioners also include walking meditations. I recommend that you try out mindfulness meditation (provided that you have no unsolved trauma or mental health issue, which can be aggravated by any meditation practice) and see if including this habit into your daily life has a beneficial effect on your clarity of mind. Refer to Chap. 2 on how to build self-care habits into your days.

Monitoring Your Progress
When you are in the midst of your PhD trajectory, it may feel as if your process is slow-going. In order to have an idea of what you have achieved and what not, I recommend that you develop a practice of weekly or monthly reflection on your progress. You can develop a template for your research journal to spend some extra time at the end of every month (or week, but the monthly scale is preferable) to monitor your progress [4]. Write down what you planned to do this month (you can copy these tasks from your plan from the previous month), and then analyze what you actually managed to achieve. If you managed to achieve a certain amount of tasks, what went well? If you had to postpone certain tasks to next month, why did you postpone them? Did you simply plan too many tasks to handle? Did another task come up last minute? Did you plan poorly? What went wrong? Journal about it. Then, add the tasks you had to postpone to the list of tasks you need to achieve in the coming month, and if needed, add other tasks that you have to take care of in the coming month. Make a planning of which tasks you will tackle in which week. For more about setting up templates to evaluate your work, refer to Chap. 2.

Mornings, and Good Starts
Your mornings are important, as they set the tone for the rest of your day. While only Instagram-accounts have mornings filled with sunshine, yoga, meditation, green juice, acai bowls, and running on the beach, you do can identify what you can do in your mornings to set yourself up for success during the day. Try out different morning routines to see what works for you. We all agree that rushing out of the door without breakfast, already feeling stressed, is perhaps not the right way to start the day. Staying in bed for long and reading tweets on your smartphone is an

approach that sets you up for distractions during the day. Look at your non-negotiable self-care habits, and see which of these you can enjoy in the morning. If you want to have at least one meal per day with your entire family, you can try to have breakfast together. On the topic of breakfast, you can try out different breakfasts and see which gives you the best focus and keeps you full until lunch. For most people, a balance of carbs, fats, and protein keeps your blood sugar balanced and without spikes and sugar rushes, and without plummeting to the point where you need coffee and something sweet again in the middle of the morning. Other actions that you can consider shifting to the morning are journaling (to set yourself up for writing), meditation (to start with a calm mind), exercise (to make sure movement fits it into your day, whatever happens next), or working on your journal papers (before heading to the office). For more about outlining your days for success, revisit Chap. 2.

Motivating Yourself

Research is an incremental process, and with all the distractions out there, it is hard to stay motivated and concentrated on your goals. One excellent way to stay motivated is by having a good planning, having your tasks for the day defined and having your goals identified. If you use a time-management system that is based on tasks and goals, make sure you are spending enough time on your “important and urgent” and “important and not urgent” tasks. You will see your research move forward, slowly but surely. Knowing clearly what you need to achieve in a day also helps you head home at the end of the day with the right feeling: feeling that you have achieved what you had to do, and that you don’t have to worry about what you actually did all day. When you go through a particularly rough patch in your PhD trajectory, consider scheduling a fun activity at the end of the day, so that you can work through your task list and then go do something that you actually look forward to. If you’ve finished an important task, go celebrate it with your friends or family or lab mates. Monitor your progress so that you can see on a monthly basis what you have achieved, and that you indeed are moving forward. If you need an extra bit of motivation, you can make your goal public. The success of #acwrimo (academic writing month, usually in November), lies in the fact that the participants make their writing goal for that month public, and share their progress in a shared spreadsheet on a daily basis. The extra motivation from the community can be just what you need to get your stalled writing moving forward again. For more about motivating yourself, applied to the case when you need to write an entire dissertation, revisit Chap. 12.

15.14 N

Napping

If you get tired in the afternoon, it may be helpful to take a nap. For some people, napping in the afternoon makes them drowsy and unable to sleep at night. For other people, a nap is just what they need to get a second burst of energy in the afternoon.

Some experts recommend that you keep your naps short, as powernaps of about 20 minutes. Other experts say that a full sleep cycle of 90 minutes is the optimal time to sleep during the day. If naps work for you, use them to your benefit, and plan your day accordingly. You may for example want to consider taking a longer lunch break, and accommodate your naptime in that timeslot. For more about organizing your day in an optimal way, refer to Chap. 2.

Narrative
In academic writing, just as in fiction writing, having a main narrative is important. In a fiction story, the main narrative is the plot of the story. In your dissertation, the main narrative will be the answer to your research question. Don't make the mistake of thinking that academic writing does not need a narrative; in fact, it is one of the most important attributes for all writing. If having a narrative behind your writing is difficult for you, practice different writing styles to get the playfulness back into your writing. For more about academic writing, revisit Chap. 7.

National Outreach
Sharing your science with the broader public is important at the national and international level. If you move to another country for your PhD, it can be more difficult to get in touch with players in your field at a national level. You can ask the communications office of your university for some advice on how to reach the national audience. Typically that will also require you to communicate your work in the language of the country where you are doing your PhD, which may be an added hurdle if you just moved there. For more about communicating science in the twenty-first century, see Chap. 9.

Networking
Networking is important for your career. Forget the notion of white guys in 1980s power suits shaking each other's hands and leaving everybody else out: networking is broader than that. For us, as academics, what matters most is building up meaningful connections with fellow researchers. There is the joy of having a deep conversation with somebody who really understands what you are working on, which is one of the pleasures of research. There are the fun conversations with PhD students from other universities, maybe even from other fields, in which you recognize that your PhD supervisors have the same character. There's the pleasure of meeting friends who have moved to other countries and other institutions at conferences, and learning about how their life is going. All these different types of conversations can be understood as networking. In fact, reaching out to fellow academics online or by sending the author of a paper you read an e-mail can also be considered as networking. There are plenty of different ways to reach out to your peers, so figure out what works best for you, and don't force yourself to be inauthentic for the sake of "networking". For more about networking at conferences, see Chap. 10.

Nomadism
You may have done your undergraduate studies in one country, got a scholarship for your master's in another country, and then you may have landed a PhD position in yet another country. Then, you may be gathering a string of post-docs on short-term

contracts, and constantly move from place to place. Before you realize, you will look back on the past years, and try to count the number of times you've had to move, and you won't be able to remember. For some of us, this nomadic lifestyle is simply the consequence of the opportunities we've had, and we've grown accustomed to it. For others, this lifestyle is impossible, as we have a family that depends on us and doesn't like to get uprooted all the time. Figure out what works for you in your life. Nomadism is considered as positive in academia, but it is not a must. You can build a great academic career without moving all the time. You can initiate international collaborations from where you are, and perhaps fit in a short stay at another institution when needed, without needing to move and uproot everybody around you. For more about academic nomadism, see Chap. 13.

Note-Taking

At the beginning of your PhD trajectory, start developing a standardized method for taking notes of the papers you read, the calculations you make, and the courses you attend. Having a standardized method for taking notes will keep your work more orderly, and as such, will make it easier for you to find your notes back and understand what you developed in your notes when you need to revise the material later. There are different templates that are generally recommended for taking notes. One of them is the Cornell method [5]. I personally prefer to develop a system just for myself, which is tailored to the needs of the project or topic that I am working on, but you can start by trying out different standard note-taking systems, and then gradually move to a system that is fully tailored to your needs. Identify in the beginning how you will take notes: by writing longhand or by making digital notes. If you chose longhand, will you write on loose leafs organized in binders, or in notebooks? If you chose digital notes, will you use a specific app for your notes, or will you save separate files in folders on your hard drive? If you choose longhand, scan your notes periodically just in case. If you use a digital method, make sure your work is backed up often. For more about developing templates for your work at the beginning of your PhD trajectory, refer to Chap. 2.

15.15 O

Online Reputation

See also “Branding.” Your online reputation is the impression somebody gets of you based on your online profiles. The easiest way to determine your online reputation is by putting your name in a search engine, and seeing which websites or results show up on the first page. Somebody who is interested in finding out more about you will rarely go to the second page or beyond. Once you have the results of the search, check the available information carefully. Is this the information you would want a fellow researcher to find if he/she wants to get in touch with you? In other words, does the search lead to your e-mail address, contact information, or an online profile (ResearchGate, Academia.edu, LinkedIn or similar) that he/she can use to get in touch with you? Or does the search result in very random information about the hobby club of which you are the treasurer and that you signed a random petition online three years ago? If you like what you see, identify how you can improve what can be found about you online. If you don't like what you see, start generating content that shows who you are and what you do. If you use online platforms a lot to interact with others, use your common sense. Don't spam others, and don't troll. Instead, be cordial and authentic. For more about online branding, see Chap. 9.

Organizing Your Work
If you want to move your research forward at a constant pace, even though you have a lot of time for finishing your research project, you need to be organized. If you start your day without a plan, it is easy to flip from task to task, leaving a trail of unfinished half-started tasks throughout the day. When you go home in the evening, you'll wonder how you spent your entire day. It's easy to plan to finish a task, but get distracted by your mailbox, reply a few mails, and then start downloading some papers – all haphazard and without structure. Yes, academia is a place of freedom and where you can do as you please. But for your peace of mind, a bit of organization (just for yourself) can go a long way – and can save you many hours each week. Work in an organized manner, plan your work, and plan your time. You'll be able to work in a more focused way. For more about planning your work, refer to Chap. 3.

Organizing Your Day
One thing is being organized in your tasks. Another thing is identifying for yourself what is the right time for which task. If you feel tired and sluggish after lunch, that time may not be the best for deep work. Do you feel like you don't have any energy for anything in the afternoon? A nap may be the solution – but make sure you plan your day accordingly. Figure out what works in terms of waking and sleeping hours, and when you have your best concentration. As a PhD student, you are free to plan your time, provided that you don't have to do your lab work with others, and depending on the requirements in your contract (you may be required to spend a certain amount of hours of the day in your office if you attend to students). You don't have to work deep into the night because all the other PhD students do so. As long as your work moves forward and you are on schedule, and you produce results, you should be able to work the schedule that suits you. For more about organizing your day according to your physiology, see Chap. 2.

Outline of Paper
When you start writing a paper, the first thing you need to do is to identify what you want to tell in your paper and who is your audience. Then, you need to figure out how you are going to structure your story: this structure is the outline of your paper.[11] Virtually every scientific paper starts with an introduction section and ends with a summary and conclusions sections. Often, the second section contains a literature review, followed by a description of your methods, your results, and a discussion of these results. Other sections that are usually added are a list of notations,

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[11] Remember that outlines don't work for every writer.

a list of references, acknowledgements, a list of tables, and a list of figures. Refer to the formatting guidelines of the venue you will be submitting your work to to see which of these sections has to go where in the paper. If you are writing a paper for a conference after acceptance of the abstract, you can use the information in the abstract to outline your paper. You can develop the titles of the sections of your paper based on the sentences in the abstract, and copy and paste these under the titles in your outline, to have a starting point for your text. For developing the outline of a journal paper, start from the research question that your paper answers, and find the outline and titles for the sections based on the subquestions of that research question. For more about writing a paper, refer to Chap. 11.

Outline of Dissertation

Developing the outline[12] of a dissertation is the first step before you start writing your dissertation. Most supervisors will ask their students to make a table of contents for their dissertation before they start writing the actual chapters. When you develop this table of contents, you can use the same procedures as discussed in "Outline of paper." The difference here, however, is that you will be developing a document of about 100,000 words, and that keeping your narrative constant and centered around answering your research question may be a challenge. Therefore, start the development of this outline from your research question and subquestions. You can make a sketch to show in a simplified way how the contents of your thesis will be linked together. Avoid the mistake of wanting to tell everything you did during your PhD in your dissertation; just focus on the material that answers your research question. For more about developing the outline of a dissertation, refer to Chap. 12.

Outreach

In general terms, outreach encompasses all activities that get you in touch with society. Outreach can be geared towards using your professional skills for the development of struggling communities, it can be sharing your research results with the broader public, or it can be the collaboration through service positions or to the industry. If you develop an academic career, outreach will be one of the three pillars that your work should be centered upon. Start to get involved in outreach opportunities during your PhD trajectory to develop the required skills for your future career. If you decide to stay in academia, you will be able to continue your outreach efforts, and if you decide to move to the industry you can bring your outreach skills to the table for your future employer. For more about communicating your work with the broader public, see Chap. 9. For more about service appointments, refer to Chap. 13.

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[12] Outlines don't work for everybody. You can let your dissertation grow in a more organic way and/or use mindmaps to structure your writing.

15.16 P

Pacing Yourself

When you run a marathon, you may have seen a “pacer”, somebody who sticks to a certain pace and gathers a group of runners that have the same pace in mind around him/her. Carrying out your PhD research and writing a PhD dissertation are a bit like running a marathon: you need to be in it for the long run. Set goals that are achievable on a daily basis, but that don’t burn you out. You can set your goals in terms of a word count for the number of words that you want to write on a given day. You can set goals in terms of the number of papers that you want to read on a daily basis. The key here is to find a number that is comfortable for you, and that you can keep up day after day. Find a balance between work and life that keeps you healthy and inspired for a long time. Learn to pace yourself, and to be at peace with the pace you have chosen if you see the results of your work. This process of learning to pace yourself is something that requires tweaks and changes throughout your PhD itinerary until you settle upon a comfortable working pace; one that also brings you all the results you need. For more about setting goals, refer to Chap. 3.

Pacing Around While Reading

If you tend to get sleepy while you read, especially if you are proofreading your dissertation for the umpteenth time, you may want to activate your body while reading by pacing around. The editing and proofreading stages of your PhD dissertation towards the very end can be a complete drag: you may feel like there is no end to this whole process, and the intensity of the previous months may have left your body and mind tired. Similarly, if you need to study a text-heavy course, walking around may be helpful to keep your brain activated. Bonus point: you’ll get in some extra steps for your day too. You can even switch up the walking around with some squats or standing yoga poses, just to keep your body from feeling sleepy. You will feel more energized, less tempted to reach for your smartphone, and you will find that your concentration improves. Try it out if you need to proofread your work, or if you need to study text-heavy material. For more about organizing your work and day around your physiology, refer to Chap. 2.

Paper

A paper is a piece of academic writing, which can be submitted to a conference, a journal, or to another venue. Some graduate courses require their students to write papers: typically summaries or discussions of the material covered in class. These papers will not be published as your scientific output. Not all conference papers are indexed in all academic search engines, so they don’t always count towards the number of papers you have published. All high-impact journal papers are indexed in all academic search engines, and count towards your scientific output. During your PhD trajectory, you will always be surrounded by papers: the publications of others that you need to read to know what they were working on and to see if you find something useful for your research, and your own paper-writing projects. Eventually, your papers will be the measure for evaluation of your work. For more about writing papers, see Chap. 11.

Paper Reference System

You will need a paper reference system during your PhD trajectory. Use a designated software in which you can create the database of all reports and articles that you have read. Make these references easily accessible. Some of the available software packages include Mendeley, Endnote, and Zotero. Inform which system is most commonly used in your university at the beginning of your PhD trajectory by asking the more senior PhD students in your research group or your librarian. The added benefit of most of these software packages is that they will make citing references in any word processing software a breeze, as they provide plugins for citing and developing your list of references. For more about the literature review, refer to Chap. 4.

Pets

You may think that you don't have the time nor money for a pet during your PhD. If you spend large amounts of time working from home during your PhD, for example to write in silence, having a pet around may be very nice. Your pet can be there to sleep on your lap while you are writing, or to come remind you in a gentle way that it is time for a break for both of you: make your pet run behind a ball, take him/her for a walk, or play with a stuffed mouse. You will feel less lonely with a pet around. If you live in a university dorm that does not allow pets, maybe it is time to find a place that feels more like a real home and not a temporary place to stay, and have a lovely pet to come home to. Remember that there are many animals in shelters that would be very happy to give you all their love.

Perseverance

There will be times during your PhD trajectory when the going gets tough. If you are working and not finding the results you are hoping for, but you don't see any of the red flags that signal it is time to change course in your research, you may need to grind your teeth and keep going for just a little longer. For example, when you are working on your literature review, you may reach a point where you have the impression you will never finish reading all the papers you need to read. Or when you are working on the analysis of your experimental data, you may have the impression that you live for numbers, and that you will never find the exit. In short, perseverance may be needed when you have to drag yourself through a tedious task. While you are going step by step through the swamp, keep the bigger picture in mind – this tedious task is just one stage of the way to finding the answer to your research question. If you need some motivation, track your progress by logging your word count, the numbers of papers you've read, or the number of experiments you have analyzed so far. If you find the work very tedious, you may need to subdivide it into a number of smaller tasks, and tackle one task per day. You may limit yourself for example to two blocks of time of two hours, and spend the rest of your day on moving other aspects of your research forward. For tedious tasks, you will notice as well that it is simply harder to stay focused for a long time. Make yourself as comfortable as possible with a nice coffee, juice, or cup of tea, and good music (if you like working with music). If you try to do all at once, the risk of making mistakes increases. Eat that elephant by taking one bite every day. Once you reach your target for the day, reward yourself. For more about planning, see Chap. 3.

Plagiarism
According to Wikipedia [6], plagiarism is defined as the wrongful appropriation and stealing and publication of another author's language, thoughts, ideas or expressions and the representation of them as one's own and original work. In the academic world, there are two types of plagiarism to discuss. The first type is when you take a course and deliver a project that is copied from another student. If you are caught doing this, you can expect to be sent to the honor committee. Don't take the risk and always do your own work. Remember that the goal of your projects is for you to learn the necessary skills. In academic writing, plagiarism refers to the use of material from other publications without the proper attribution. If you want to restate a statement from another author, place the statement between "quotation marks" and provide the reference to the citation in the text. Whenever you discuss ideas of other authors, make sure you properly cite their work. For more about academic writing, refer to Chap. 7.

Planning
Planning is an essential skill during your PhD trajectory. Of course it is difficult to plan a project of which you don't know how it is going to evolve. Use the major milestones of the PhD trajectory to lay out a general planning for the time of your PhD trajectory, and then refine your planning per semester, month, week, and day. Allow for enough space and air in your planning for when your work does not come together as expected. Leave time for holidays and leisure when you plan. For more about planning, revise Chap. 3.

Power Posing
Power posing means taking on a posture that is typically associated with strength and power. You can power pose in the bathroom, in your hotel room, or in the morning, and it is supposed to boost your confidence for the rest of the day (note that the original research has been debunked by now). On a more practical note for your PhD trajectory, if you feel insecure at a conference or in another stressful situation, don't let your body language tell others how you are feeling. Keep your back straight and your shoulders low, take long strides when you step, don't fidget, and try to speak slowly and confidently. While this may sound ridiculous, keep in mind that if you feel insecure, you'll need to fake it until you make it, or fake it until you become it. For more tips about succeeding at conferences, refer to Chap. 10.

Pomodoro
The Pomodoro technique is a time management technique that is based on using a kitchen timer in the shape of a tomato, hence the name Pomodoro. The basic idea of the Pomodoro technique is that you focus on one single task for 25 minutes, and then take a break of five minutes. If you get distracted during the Pomodoro (while the timer is ticking), you have to stop your Pomodoro, and start again. After three

Pomodoro sessions, you are encouraged to take a longer break of 30 minutes. If you have difficulties concentrating, the Pomodoro technique may be an excellent way to make progress in your work. It also helps to define your task clearly. It is equally recommended for students who are memorizing a course. Keep in mind that using the Pomodoro technique is intense, and that getting to six or eight successful Pomodoros in a regular working day is already quite a feat. For more about planning, see Chap. 3.

Positive Thinking

If you are homesick and feeling isolated during your PhD, you may need to spend some energy on taking care of your mental health. Positive thinking may be a way to start seeing the silver lining in your world again. You can use your journal or research journal to write down the things that went well during your day, or the things you are grateful for. If you have too many things on your task list, and you never achieve your goals, you may feel weighed down by your work. Change the way you plan, and try to lighten your load by focusing only on the “important and urgent”, and “important and not urgent” tasks. Do at least one thing every day that you enjoy. You can plan an activity with friends or fellow PhD students in the evening to look forward to. If you have been feeling blue for a while, you may need to change your routine or go for a holiday. If you have a mental health issue that needs professional help, never postpone seeking the help you need. Refer to Chap. 2 for developing healthy habits.

Poster – Making a Poster

Poster presentations are a skill in itself. Making a poster that draws the attention of the people walking by can be challenging. Don’t place too much text on your poster: visual material is more attractive than a poster full of text. Stick to a limited number of colors and fonts, to make your poster look uniform. Outline your poster around a flowchart or a geometric form, so that the poster has one general look to itself instead of a number of scattered elements. If you are making a poster for the first time, allow yourself sufficient time to prepare. Ask you friends and colleagues for their opinion on how to improve your poster. For more about poster presentations, refer to Chap. 8.

Poster – Presenting a Poster

Poster presentations can be both awkward and enjoyable. They can be awkward because you may be standing next to your poster, and you need to “attract” people to come over. They can be enjoyable, since a poster presentation allows for much more direct contact with your audience than a lectern session. In a poster presentation, you may find yourself chatting with someone who is carrying out similar research, and explaining him/her what you have been working on and what you learned, while at the same time learning from him/her. If you are presenting to a small group of visitors, the audience can ask more questions than in a regular lectern session, since the format allows for more interaction. Take business cards and small prints of your poster to your poster presentation to give your visitors. For more about poster presentations, refer to Chap. 8.

Practical Applications
A way of bridging the gap between the ivory tower and the real world, is to develop practical applications for the results of your research. Depending on your field, you can either develop recommendations for practice that can be implemented right away, or you could think about ways in which the results of your research would affect the industry at a more abstract level. Especially if you are considering making a move to the industry or becoming a policy maker, it can be good to at least think about how the results of your research will have an effect on the world around you. If you developed case studies that resulted in recommendations for practice, you can devote a chapter of your dissertation to this topic. Otherwise, you can discuss a practical outlook in your final chapter. For more about writing your dissertation, refer to Chap. 12.

Preparing Experiments
Preparing experiments is a complex task, and something you will typically not have done during your previous education. Don't be afraid to ask the more experienced PhD students and post-docs for advice – there is always something that you forgot about in your preparation. You need to prepare your test setup, your specimens, the actual testing, the sensor plan, and perhaps additional tests to determine some properties of your specimens or materials. You need to plan your logistics in such a way that you have all necessary ingredients for your experiments at the right time, and so that you can carry out your series of experiments without large delays. Leave enough space in your planning to have time to play around with things that you discover while doing your experiments. Understand that experimental work is almost always team-work, and that you will be working with people who are better than you at different things – don't let your ego get in your way. For more about experimental work, see Chap. 6.

Presenting Research
Communicating your research is the last step of the research cycle, and the step where your results are measured. Publications are important, as are presentations. Use presentations at different venues for sharing your results with different audiences: the audience across conferences may be different, and you should consider presenting your results to the industry and perhaps government. Take on all opportunities to present your work, even if you are afraid to do so. It is by practicing this skill that you will make progress. For more about presentations, check out Chap. 8.

Presenting Math-Heavy Stuff
If you need to present a mathematical proof, you can follow the typical structure of a mathematical proof: lemma, the actual proof, and then the implications of the fact that this lemma is now proven. Now, if you want to present a mathematical proof, you may feel tempted to throw all your formulas on your slides. For your audience, that may be hard to chew. Ask yourself first if it is important for you to present the actual proof, or if your audience may be more interested in the implications and background. The contents of your presentation really depend on the audience: fellow academics in your field may be inspired by your proof, but practitioners may

check out if you present a lot of formulas. If you chose to present formulas, take your audience by the hand. Highlight the different parameters in your formula for an in-depth explanation. Explain how you went from one step to the other in your derivation. Avoid throwing your formulas on your slide, and mumbling nothing more than "If we do this, then we find this formula." You will need to explain your audience what you did, in such a way that they can actually understand what you did – otherwise there's no point in presenting your formulas in the first place. For more about presentations, check out Chap. 8.

Presenting Without Slides
When you need to present without slides, for example when you give a tour in your lab, you may still need some time to prepare your presentation. In this case, have an overview of the different elements that you want to explain during your presentation. Don't leave your presentation to whatever comes to your mind the moment you take the visitors through the lab. Of course, if your visitors are research collaborators, your presentation may develop more into a conversation. But if your visitors are government officials, or the parents of future students, prepare yourself to use the right language to make your work understandable. An excellent way of doing so is by referring to sizes and weights of everyday objects, just like National Geographic does in their documentaries: sizes are compared to "this many soccer fields", and weights are compared to "this many elephants". For more about presentations, check out Chap. 8.

Presentation Structure
A typical presentation follows the structure of a paper: background (introduction and literature review), research question, methods, results, discussion, and conclusions. To make sure your audience grasps the main idea of your presentation, focus only on what you need to show to support your main message, and leave out all other details. You can mention that more details can be found in the paper or in a research report. Make sure you spend enough time (and slides) on your introduction, to convince your audience of how interesting and important the problem you studied is. For more about presentations, check out Chap. 8.

Prioritizing
To prioritize your work, you can use the urgent-important matrix, or you can rank your different tasks according to priority, and how important it is that you carry out the task (can you delegate it?). Whenever you feel overwhelmed by the number of tasks you have at hand, write them down, and see what really needs your attention. If you divide your tasks into the urgent-important matrix, pay special attention to the tasks in the important-not urgent category. This category contains the projects that are crucial for your career, such as the development of your journal papers, which have no submission deadline. For a discussion of the urgent-important matrix, refer to Chap. 3.

Processing Lab Data
When you carry out experiments, make sure you don't wait too long to process your data. In fact, set up a protocol for processing your data after each experiment. This

processing protocol can include the following: finishing the entry in your lab book, taking the measurement data and saving these in the cloud, adding the most important results to a general overview table of your work, post-processing the raw measurement data, and writing an entry about the experiment in your measurement report. Make sure you have identified before the experiments how you will process your data. You can alter your processing method as you proceed through your series of experiments, but you should have thought through how you will process your results before you start. In doing so, you may identify a parameter that is not covered by your sensor plan. For more about experimental work, see Chap. 6.

Procrastination
Procrastination is the middle name of many PhD students. When you have an ocean of time to graduate, you may not feel the pressure to deliver a certain amount of work on a daily basis. When the task in front of you seems large, you may feel more tempted to procrastinate and look for something that makes you feel good, instantly. A bit of procrastination is normal – nobody is a machine who is 100% "on" during the entire day, eight hours or more every working day. But if you are spending more time looking at kittens online than you are looking at the graphs from your data, you need to change something. An excellent method to tackle procrastination is to use the Pomodoro technique, and concentrate on a single task for 25 minutes. Make sure the tasks you tackle are well-defined and have a measurable goal. Doing so will help you be more motivated. For more about staying motivated, check out Chap. 12.

Productivity
In academia, productivity is measured in terms of output. You can spend 12 hours each day in the office, and not be very productive. You can work seven hours, but produce all the output you need, and be an example of productivity. Make sure you work smart and focus on your output. Focus on the work that matters. You can sit in meetings and brainstorm until you grow old and weary, but if you don't do the actual work, you'll never deliver results. If you are planning to stay in academia, make writing journal papers (and doing the work that leads to publications) your main objective. Put your time and money in the tasks that will create results. For more about planning so that you can be productive, see Chap. 3.

Project Management
Your PhD research project is a large research project, so you can't let it run loose and hope that at the end of your allotted time, you will have the results and thesis to graduate. You will need to manage your project. The first step for this process is to take ownership of your PhD project. Your research, and its progress towards completion, depends on you. You will be guided by your PhD supervisor, but the final responsibility lies with you. The number of conferences you attend, the number of papers you publish during your PhD trajectory – it all depends on you. Identify what you want to achieve during your PhD trajectory, identify the steps you need to take to achieve these goals, and estimate the time required for completing these steps. Planning research is less straight-forward than planning, say, the construction of a building, but you can still identify the milestones in your PhD trajectory, and take

the necessary steps to complete these milestones. For more about planning and management of your research, see Chap. 3.

Proofreading

Proofreading is an essential part of writing. During your PhD trajectory, you will notice that you don't have a teacher anymore who will "grade" your essays, and give you a second chance to improve them if your first trial missed the point. You need to be your own teacher, and improve your writing on your own. Depending on the involvement of your PhD advisor, he/she may teach you the ropes of writing in the beginning of your trajectory, or may prefer to see if you can figure it out on your own. To improve your writing, you will need to learn to be critical of your own work, and to thoroughly proofread and edit your work. Don't proofread right after you finish writing your first draft. Let time help you in creating more distance between your first draft and your critical eye. Check for common errors in grammar, perhaps typical for speakers of your native language. Check the flow of the text overall, per paragraph, and per sentence. For more about academic writing, see Chap. 7. For more about writing your dissertation, refer to Chap. 12.

Propositions

Some institutions require you to not only deliver a dissertation at the end of your PhD trajectory, but also a list of propositions. This tradition stems from the past, when only the propositions were used during a defense. The propositions are a list of statements that the PhD candidate should be able to argue in favor of during his/her defense. Some of these propositions should be derived directly from the work done during the PhD trajectory, some propositions should relate to the broader field in which the candidate did his/her research, and some propositions should be used to show that the candidate can verbally defend a point of view on a topic not related to his/her field of studies, such as a statement related to higher education policies, politics, sports – anything goes in this last category. For more about the dissertation, see Chap. 12.

Programming

If you are a PhD candidate in STEM, and programming is not your strength, work on this skill. You don't have to learn to program during your PhD trajectory to pass a certain class, but you will need it to support your research. You will need to program routines to automatize some of your data processing. You will need to go outside the bounds of most commercial software packages, and program your own routines for implementation. The initial learning curve may be steep when you start coding your procedures, but keep in mind that having a few lines of clean code results in much less errors in your work, and will make your life easier in the long run. To teach yourself a certain programming language, you can take a formal course, ask a senior PhD candidate for help, work your way through a book or tutorials, peruse the help file of the software and the internet, or use YouTube and other video channels or MOOCs to learn the language. For more information on teaching yourself new skills, refer to Chap. 3.

Promotor

See also "Supervisor." Also called your PhD advisor, or PhD supervisor, the promotor of your PhD is the professor who will guide you during your PhD, who will have secured the funding for your project, and who will be the head of your PhD committee. Just keep in mind that the final responsibility for your graduation lies with you, not with your promotor. In research-only programs, the PhD candidate and promotor may work together as apprentice and master in the skill of research. Promotors with a large number of PhD candidates may appoint a daily supervisor, who can become the copromotor of the student, and with whom the PhD candidate will work more closely. In countries like the Netherlands, only a full professor has the "ius promovendi", the right to promote a PhD candidate to Doctor. The copromotor can be an assistant or associate professor. For more information on working with your promotor, revise Chap. 2.

Publications

The most important factor for evaluation of your academic work are your publications: the number of publications in high-impact journals, how often these publications are cited, your resulting h-index, and the people you have published with. If you are hoping to build an academic career after your PhD trajectory, go the extra mile during your PhD trajectory to work on your publications, even though they may not be a requirement for your graduation. Practice with conference papers and reports to find your voice. Use your conference papers as a starting point for your first journal paper. Conference papers will typically have a deadline, whereas for a journal paper you will have to impose a deadline on yourself. Don't confuse work that has no deadline with unimportant work. It may not be urgent, but it is certainly important. For more about academic writing, see Chap. 7. For more about writing your first journal paper, see Chap. 11.

Publication Strategy and Planning Them

If you reach the end of your PhD trajectory, and you have written a "big book"-style thesis, it is time to identify which journal papers you will write. Ideally, you will have already developed some of your work into a journal paper, or more than one journal paper, by the time you finish your dissertation. Many PhD candidates, however, write their journal papers after the dissertation. Some promotors don't even allow the publication of journal papers before the defense of the dissertation. So, if you have all the material of your dissertation, you need a planning and strategy for how and when you will develop your papers. You can revise the material of your PhD dissertation by chapter or by original contribution. You can decide to turn each chapter into a journal paper, if suitable, or identify your main original contributions, and develop these into journal papers. Once you have outlined the topics, identify the right audience for this topic. If, for example, your work strongly related to European practice, avoid sending your work to a North American journal, or vice versa. If your work is empirical, don't send it to a journal focused on modeling. Find the right journal for each topic. Then, make a planning. Which papers will you write first? When would you like to finish each draft? What will your job situation look like, and how much time will you be able to spend on writing? For more about writing journal papers, see Chap. 11.

Public Speaking
Public speaking can be considered as presenting your work to a broader audience. See if you can get the opportunity during your PhD trajectory to not only present your work at academic conferences, but to also present your work, or the broader view of your field, to a non-technical audience. Possibilities for such presentations arise at industry events, during TEDx conferences, at science outreach events, and more. If you want some guidance on this matter, reach out to the communications office of your university. Prepare differently for such a presentation than for your typical academic presentation. Use the rule of thumb that a minute of public speaking takes about an hour of preparation. If necessary, practice your movements and body language as well, and learn your text more or less by heart. For more about presenting, see Chap. 8.

Publication Bias
Publication bias means the tendency of journals to only publish positive results. This bias is most worrying in medicine, where studies that show that a certain product works to cure a disease will have a better chance at getting published than studies that show that a certain product does not work to do so. To disrupt publication bias, it is important to look for other venues to publish negative results. See if you can publish a method that did not lead to good results as a conference paper, or if you can describe it in a blog post, so that other researchers have access to the information and know what not to try out. For more about blogging as a means to tackle publication bias, see Chap. 9.

15.17 Q

Qualifying Exam
At some institutions, passing the qualifying exam is one of the requirements for graduation. The form of this qualifying exam can be written, oral, or a combination of both, depending on the requirements of the institution. The objective of this exam is to test the knowledge of a PhD candidate of his/her field of study. It typically requires revising the material of a number of important courses that you took during your previous studies. Generally, a qualifying exam does not test the research capacities of a student, and is therefore sometimes criticized as not the right tool to assess if a PhD candidate will be successful in research. The qualifying exam can be considered as the point where you move from being a student to being a researcher. For more about planning the milestones of your PhD trajectory, refer to Chap. 3.

Qualitative Methods
Qualitative methods go beyond what we can measure directly with sensors. If you need to assess how a certain layout of a store will influence the experience of the

customers, we cannot simply attach a sensor to people to figure out their impression. We will need to rely on, for example, interviews. Qualitative methods are less often used in STEM, and most PhD candidates in the STEM fields have no training in the use of qualitative methods. However, to link research results and the effect of policy changes, qualitative methods can be important. If your research includes the use of qualitative methods, take a course or read a book on qualitative methods, and how to analyze your qualitative results – don’t assume that the procedures will be the same as what you’ve always used. For more about methods, see Chap. 6.

Quantitative Methods
Quantitative methods are based on variables that can be directly measured with sensors. When you test physical specimens in a laboratory settings, you will be able to attach sensors to your specimen, or measure properties with non-contact methods. Your data will consist of the sensor output. You will answer your research question by designing a test setup, carrying out experiments and obtaining data, processing these results, drawing conclusions from your measurements, and then perhaps interpreting these measurements in the light of available theories. Doing so will require the correct use of statistics. If your knowledge of statistics is insufficient, revise the topic on your own. For more about experimental work, see Chap. 6.

15.18 R

Reading Papers and the Phases of Reading
Your reading will be most intense during the stage of developing the literature review during your PhD trajectory. However, you will never stop reading. You need to make sure that all important recent references are analyzed and cited in your final dissertation. To read regularly, schedule timeslots for reading on a weekly basis. You can schedule short time slots a few times a week, you can try to commit to reading a paper per day, or you can set aside part of your weekend for catching up with your reading. As you read to develop your literature review, you will notice that you go through different phases of reading. At the beginning, it will take you weeks to chew through one paper and understand the concepts. As you read more material on the topic, you will start to find it more accessible, and eventually you will be nodding along in agreement, or grumbling and drawing a question mark in the sideline because another paper had contrasting data. The last stage of reading is when you read a paper only to get the main idea, or to snatch a piece of information from it. By then, you won’t need to read the entire paper anymore, but you can just storm in, and grab whatever is cooking off the stove. For more about reading, see Chap. 4.

Reference Management Software
See also “Storing literature.” As you develop your literature review, it is important to identify how you will store the papers you’ve read. A hand-written list, or a table in Excel are not the right tools to have an overview of the papers you’ve read. You

will need specialized software for this task. Examples of software include Endnote, Zotero, and Mendeley. These software packages will require you to add all the details of a paper, and possibly attach the paper itself to the entry in the database. Most journals now offer the option of downloading the metadata of a paper, so that you don't have to manually insert this information anymore. An additional benefit of these software packages is that they allow you to cite papers and develop a list of references very easily, provided that you've entered all required papers in your reference management software. For more about managing the documents you have read, see Chap. 4.

Research Proposal

Some institutions require their PhD candidates to present a research proposal to evaluate if sufficient work has already been done, and to see if the proposed method will lead to results and graduation. In PhD programs that include coursework, the proposal is typically presented halfway through the PhD trajectory. In these programs, the first half of the PhD trajectory contains the bulk of the courses the student has to pass. You defend your proposal before you start to do actual experiments and before you start collecting data. Therefore, the proposal typically contains the following elements:

- Literature review: you have to show in your proposal that you understand your field, and that you have been able to frame the work you will carry out in the body of knowledge of the field, and the lack of understanding on a certain topic.
- Problem description: what is the problem that you will study? What do we know so far (from your literature review)? Why do we care about the problem? Where will your research possibly take us?
- Research question: presenting your research question is the core of your proposal.
- Methods: which methods do you propose to find the answer to your research question and subquestions? Show your knowledge of the literature, and show how the methods you propose fit into what is available in the literature.
- Backup plan: if your initial plan for methods does not work, what else can you do? Show that you have thought through what can go wrong with your suggested methods, and what would be your plan B.
- Planning: give an overview of your planning so that you can apply your methods, perhaps go to your backup plan, analyze the results, and write your dissertation in the time you have left until you need to graduate.

For more about planning the milestones of your PhD trajectory, refer to Chap. 3. For more about defining your research question, see Chap. 5.

Research Question

Your research question is the heart of your research. You will define your research question based on a need that is identified in the literature or that you identified while developing your literature review. You will then think about how you will go about answering your research question by dividing this question into different subquestions. Each subquestion may require a different approach to reach an answer.

When you write your dissertation, the answer to your research question should be the narrative throughout your dissertation. For more about the research question, revise Chap. 5.

Resume
As you prepare yourself for life after the PhD, you need to make your resume. Ideally, you periodically update your resume during your PhD trajectory, so that at the end of your trajectory you don't have to try and remember all the things you did over the past few years. Your resume is a summary of your full CV. Try to fit all information on maximum two pages, showing only the most relevant information, such as your education, work experience, and, if you plan to apply for an academic position, a selection of your publications. Make sure the layout is uniform. If you have doubts about the formatting of your resume, or if you are planning to apply for jobs in another country and you are not sure how the customs for writing resumes there are,[13] get in touch with the career center of your university for support. For more about finding employment after finishing your PhD trajectory, refer to Chap. 13.

Restarting
If you've started a PhD program, but for whatever reason you decided to stop your program, and go somewhere else for your PhD, perhaps after several years, you will be a novice as well as somebody with already some research experience. You may have worked on a similar topic in the past, but if you restart after a considerable amount of time, you may find that the work you did is not so relevant for your field anymore. You may already have some experience with academic publishing. However, if your PhD advisor is different, and you essentially start over again, approach your new PhD with a beginner's mind. Perhaps you progress more quickly because of the experience that you have, but you should question everything to see if it is still suitable in your new situation. For more about the beginning of your PhD, see Chap. 2.

Reviewers
If you submit a journal paper, you will spend some time (weeks? months?) waiting for feedback. In the meantime, your paper is with the reviewers: experts in your field and on your topic who will evaluate your paper based on its technical merit and its presentation (your writing skills). These reviewers will then prepare a report that will be sent to the editor. This report typically starts with a general impression of your manuscript, discussing the main elements of your paper (literature review, methods, conclusions, figures, writing). The report then gives a recommendation for publication, revision, or rejection, and possibly ends with more specific technical and editorial comments, often presented as a table with page numbers and line numbers. The editor will revise the reports of the reviewers and make a decision with regard to publication, and communicate this decision with you. Keep in mind that in

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[13] For example: include a headshot or not?

general two thirds of all papers are rejected. For more about writing a journal paper, see Chap. 11.

Reviewers’ Comments
If your paper is not rejected, you will need to implement the comments of the reviewers before you resubmit your work. Receiving the decision that your manuscript requires major revisions and further peer review is an invitation to take the comments of your reviewers very seriously to improve your manuscript and to convince the reviewers (who will re-review your paper) that you manuscript is worthy of publication. Treat your reviewers with respect: they have taken the time and effort to evaluate your work and give suggestions for improvement, and you need to show them that you have equally taken the time and effort to improve your manuscript based on these suggestions. As a reviewer, I find nothing more frustrating than typing a detailed review report, and then not receiving a detailed reply to my report, or receiving replies such as “the reviewer is wrong”, without showing me why I am wrong. If you disagree with a comment of the reviewer, stay polite, and add references to literature sources that contradict the statement of the reviewer. Always prepare an item-by-item response to address each comment of each reviewer. For more about dealing with reviewers’ comments, see Chap. 11.

Rewarding Yourself
If you meet your daily goals, reward yourself. If you reach a major milestone in your PhD trajectory, celebrate in style. On a daily basis, you can reward yourself with something small: take the entire evening off to do whatever you feel like doing, buy yourself a nice dessert, have a cup of wine, or go do something fun with friends. Try to have something to look forward to on a daily basis, as small as it may be, to reward yourself at the end of the day. You’ll see that you move through the day in a more efficient way, especially if you also define your end time for the day. If six pm is your end time, you may be doing the same amount of work as when you’d be staying until ten pm and procrastinate a lot. When you reach a major milestone of your PhD trajectory, take the time to celebrate your success. Organize a drink in the lab when you finish your first experiments. Have a beer with your friends when your first journal paper gets accepted. Go away for a weekend or longer after finishing the first draft of your dissertation. Make sure you have enough fun during your PhD trajectory and don’t push yourself too hard if you have perfectionist tendencies. For more about planning, refer to Chap. 3. For more about motivation, refer to Chap. 12.

Rewriting Your Thesis
If you finish your first draft, the time spent waiting for input from your supervisor can be nerve-wracking. In the best case, your supervisor will be completely in love with what you did and have nothing more than a few editorial comments. In the worst case, your supervisor will say your work is not ready yet. In a scenario that is close to the worst case, your supervisor will tell you that your work has merit, but that your writing does not, and he/she will require you to rewrite your entire thesis. You can avoid this unpleasant situation by discussing your chapters as you develop them, and start writing early enough so that your supervisor can course-correct your

writing where necessary. Additionally, if you spend time and effort on improving your writing, and on developing conference and journal papers, you will already have more practice in your writing. It then will be less likely that your supervisor requests a complete rewrite. If possible, take a course on academic writing during your PhD trajectory to sharpen this skill. If the damage is done, and you need to rewrite your complete thesis, don't panic. Talk with your supervisor about his/her expectations for your rewrite. Propose a new outline and structure, and perhaps work together with your supervisor to have a structure that he/she agrees with. Then, ask for precise advice on how to improve your writing. What is lacking: structure in your paragraphs, coherence between paragraphs, grammar, or the way in which you explain concepts? Make sure you understand well which aspects of your writing need improvement, and actively work towards improving these elements. When you work on your rewrite, start with (a part of) one chapter, and then meet with your supervisor to see if your new attempt goes in the right direction. Don't just nod and disappear for a few months, rewriting the entire thing without understanding very well what you should actually improve. For more about writing your thesis, see Chap. 12.

15.19 S

Salami Slicing

Salami slicing, or publishing incremental work, is discouraged in academia. Given the tremendous pressure on young academics to publish as much as possible in as little time as possible, it can happen that work from one project is published across papers, using parts of the data set separately. The name salami slicing refers to thin slices of salami – and is thus related to small amounts of work that get developed into a journal article. In general, it is recommended that you develop each publication around an original research idea, or a separate analysis that you worked on. If you want to practice reporting a smaller amount of results when you have not yet finished all your experiments during your PhD, a conference paper can be the right means for this purpose. You can practice your writing and bounce off your initial analysis results on the audience of the conference. Once you have all experimental results, and have finished analyzing these, you can develop this information into a journal paper. For more about writing journal papers, refer to Chap. 12.

Saving Money

See also “Budgeting.” Depending on the type of contract you have for your PhD, you may be either extremely short on money, or just regularly short on money. Being smart with your expenses will be of the utmost importance. However small the budget you need to live on, try to save money every month for unexpected expenses, so that you are prepared to roll with the punches of life. Keep in mind that you may not find a job right away when you finish your PhD trajectory. You may also be hired before you finish your PhD trajectory, but the starting date of your new position may not coincide with the end date of your PhD trajectory. This situation especially occurs if you move to a new academic institution where you will start for example at the beginning of a new semester. Make sure you have a buffer with savings to get through these months in between jobs. Try to save money so that you can survive for six months without an income, even if you currently are living from paycheck to paycheck. Analyze all your expenses in detail to identify where you can reduce your expenses.

Science Communication

Most universities have a team of communication experts to help translate research findings to the press and the broader public. If you are interested in learning this skill for yourself, you can ask for guidance of your institution's communication office, and you can practice this skill in different ways: by presenting the discoveries of your broader field in an accessible way to school children, by giving informative talks for the broader public (such as through the TEDx platform), or by starting a blog about your research. More and more, scientists are required to be able to express themselves to a broader public. Being able to explain the relevance of your research in plain English will improve the clarity of the research proposals that you submit for funding. Often, panels have mixed backgrounds, so avoiding jargon in these applications is crucial. The least effort you can do is try to have a minimum training in science communication, so that you can explain your family and friends what you are working on. Some PhD students enjoy outreach and science communication so much that after their PhD trajectory they will move on to a career in this field. As such, they combine the best of both worlds: strong communication skills with a solid scientific background. For more about communicating science in the twenty-first century, refer to Chap. 9.

Scholarships

If you are admitted to a PhD program, the next question is usually: "How will I pay for this?" In some countries, like the Netherlands, PhD candidates are sometimes hired as employees of the university, which means they will pay taxes and have social security. Other students have scholarships that may cover some or all elements of the cost of education during the PhD trajectory. A full scholarship can include tuition, fees, living expenses, travel expenses, and health and accident insurance. These scholarships typically do not cover the cost of experimental work. If you are admitted in a program, but have not been able to secure funding yet, you will need to consider your options. Keep in mind that most applications for a scholarship take quite some time, and that in some cases you need to apply almost two years before you can start your program. Possible scholarships include excellence scholarships offered by the institution where you would like to study, Fulbright scholarships from and to the United States, scholarships offered by the government of your country or of the country of your institution, and scholarships offered by companies or universities, who will in turn request you to return and work a few years for them upon your graduation. For more about the basic requirements and starting a PhD, refer to Chap. 2.

Scopus

Scopus is a search engine used for scholarly articles, and it is a part of the empire of publisher Elsevier. For most official analyses, it will be your number of publications in Scopus, your number of citations in Scopus, and the resulting h-index that will be evaluated and reported. If you plan to publish a journal paper, check if the journal you are considering is indexed in Scopus. Scopus also provides a ranking of journals, which is different from the ranking in Google Scholar and the Scimago Journal and Country Ranking. As a search engine for scholarly articles, Scopus tends to be quite powerful and commonly used. If you use the search engine while you are on your university's network, you can be redirected from the indexed abstract in Scopus to the full paper, provided that your university has a subscription for the journal in which this paper is published. For more about publications, see Chap. 12.

Self-Care

Whatever happens during your PhD, regardless of how much you are struggling, you should never forget to take care of yourself. As a bare minimum, make sure you eat properly, sleep enough, and exercise. If you don't take care of these basics, you will eventually get sick, and you will notice that you can't concentrate properly and start to make mistakes in your research. And once you notice you made a mistake, you become frustrated, feel like you have even more work now that you have to work on correcting the mistake, and spiral further and further away into the abyss of stress. Don't let this happen to you, and take proper care of yourself. If living on your own is new to you, and you struggle to take care of yourself, ask a friend or family member to check on you every now and then. Besides the basics (nutrition, sleep, exercise), you should also build a bit of pleasure into your daily routine as you need a fresh and playful mind to do research. What do you enjoy doing? How can you find time for doing at least one thing you really enjoy on a daily basis? Many activities fit into this category: drawing, coloring, playing music, listening to music, chatting with a friend, reading a book, playing with a pet, spending time outside, knitting, crafting, gaming, playing a board game, solving a puzzle, taking a hot bath… the options are endless. If it feels odd to do things simply for yourself because you've been always focused on the comfort of others, pick ten very small things that perhaps take no more than ten minutes each, and schedule one thing for each day for the next ten days. After these ten days, evaluate how this went: did anybody die because you took out some time for yourself? Do you feel more balanced and perhaps empowered because you dared to take out some time for yourself? For more about building self-care habits into your daily routines, see Chap. 2.

Self-Evaluation

Especially if your PhD program is a research-only program, your opportunities for evaluation will be scarce. There will be no exams and homeworks to tell you if you are headed for a good GPA. In fact, some PhD programs do not use any grade at all: you either graduate and get your PhD (perhaps cum laude), or you don't. If the opportunities for evaluation are limited, with perhaps only the go/no-go meeting at the end of your first year to decide if you get to stay in the program, you will have to take matters into your own hands. Learn to have an honest conversation with yourself about how you are progressing in your PhD. Reflect on your progress on a weekly or monthly basis. Take out time at the end of the week to revise what you planned to do for the week, what you really did during the week (including tasks that came up last-minute), and assess what went well and what did not go well. If you are constantly behind on the tasks you planned, evaluate why this happens: are you simply planning too many tasks? Are you not planning in sufficient buffer time during the day to deal with distractions? Do you have difficulties concentrating, during the entire day or only at certain times of the day? Write about it in your research journal. If things don't go well, don't beat yourself up, but take this opportunity to learn how you can improve the way you manage your research project and your time. For more about setting up routines to reflect on your progress, see Chap. 2.

Self-Imposed Deadlines

During your PhD, you may have only few deadlines. There is the main deadline at the end of your contract, when you need to be finished. In some cases, your funding body will request deliverables by a certain deadline. If you are traveling to conferences to present your work, you are faced with a deadline to submit your conference paper. However, nobody will give you a deadline for your journal papers (unless you are submitting your work for a special issue) or dissertation chapters. You will need to set deadlines for yourself, and respect these. If you come from an education system in which you have regular homeworks and midterm exams, the change to a schedule that you plan yourself may be overwhelming. If you have studied at a university where you need to work through the course material at your own pace and have only one exam at the end of the semester which covers everything, you may have already learned to organize your work to avoid sleepless nights of cramming. There are no cramming-like shortcuts to finishing a journal paper, so you will need to learn how to organize your work and set deadlines for yourself. The best way to start taking your self-imposed deadlines seriously is by simply trying it out for once. Say that you strive to submit a conference paper a month before the official deadline, and set that date as your self-imposed deadline. If you try this out once you may notice that working towards a self-imposed deadline is less stressful than knowing that if you don't submit today by midnight the online system will close and your paper won't go through. As you learn how to dose your work, and find time in your evenings for enjoyable activities, you won't want to go back to days of half-assing your work and then spending two or three weeks in major panic mode, barely sleeping, because you have to finish something. You'll notice that you feel more satisfied with your day's work, and that this system is simply more enjoyable. Use planning to find the route of the least effort, and remind yourself that this principle lies at the basis of your self-imposed deadlines. For more about planning the milestones of your PhD trajectory, see Chap. 3.

Self-Plagiarism

Self-plagiarism is the extensive recycling of previous work into a new publication. Nowadays, most journals use automatic tools such as Crossref's Similarity Check to check your manuscript against already published material. If the percentage of overlap is too large, the editor may decide to reject your manuscript without sending it to reviewers. In some cases, however, you may need to repeat some parts of your earlier work in a new manuscript. For example, different series of experiments that you have carried out but that fit into the same larger scope may require you to restate some information. Most of my research deals with existing bridges, so I usually need to say something about the state of existing bridges in the Netherlands in the introduction of a paper. Another reason why you may repeat some material is that you are revisiting experiments that you've done in the past, but for a different purpose. When you do so, make sure that you refer to the original publication about these experiments. For more about academic writing, revise Chap. 7.

Self-Study

During your PhD trajectory, you will need to identify which knowledge you are missing and, if your PhD program is research-only, you need to study the material on your own instead of through a formal class. Take a course book and learn the main concepts of a new subject on your own. Studying a new subject on your own with a book is a different skill from carrying out the literature review. For the literature review, you need to go deeper into a certain topic. However, while doing so, you may find that you lack the correct background, and you will need to correct this by studying a textbook on the topic you are missing. To make time to learn these new concepts, save timeslots in your weekly planning, and identify how much material you need to work through on a daily or weekly basis to be able to apply the concepts when you need them (for example, for the analysis of your test data). For more about planning, see Chap. 3.

Service

See also "Volunteering, for all the service." Service is a broad category of activities that include serving on panels and committees within your institution, service to the industry, service as an expert during court cases, service as a reviewer, service on the scientific committee of a conference, and service on technical committees for international and national organizations. Be wise in your acceptance and selection of service appointments, and make sure that when you volunteer to work on something, you will be able to deliver. Find the right balance between service appointments that can help you make contacts and move your career forward and your other duties. Keep in mind that service appointments are volunteering efforts, but that they require time and effort (and expenses related to traveling) from your side. Women tend to take on more service appointments than men that gain little recognition and that do not help them advance their career [7]. Make wise decisions – don't say "no" to every opportunity, but also don't overload yourself with work. For more about service appointments, see Chap. 13.

Setbacks

See also "Making big changes in your research" and "Friction". At some point during your PhD trajectory, or perhaps at several points, you will experience disappointment and setbacks. The reason for this setback can be as varied as the tasks you take on during your PhD: your experimental setup may not be working properly, your supervisor may not be charmed by some of your results or by a method you are proposing, or your manuscript may be rejected. Whatever the reason for the setback, you feel deeply disappointed, and you may be wondering if you are able to finish your research. Acknowledge that a PhD trajectory is not a walk in the park, and everybody struggles at some point. Your feelings are normal, and you need to give them time and space. Take some time off to reframe your mind, and once you've found your balance again, assess the situation with a clear head and see which changes you need to make. If you have a few ideas, but are not sure in which direction to proceed, don't be afraid to ask your advisor for input. If you feel more than just down, and if your mental health is suffering, seek professional help. For more about the research process, see Chap. 5. For more about dealing with rejection, refer to Chap. 11.

Shortcuts

Unfortunately, this section won't tell you the secret shortcut through a PhD program. You have to do the work if you want to graduate, and doing the work is a learning process. This section discusses keyboard shortcuts that you can use to speed up your typing. As you start to become more fluent in your academic writing, you may find that a lot of shifting from your keyboard to your mouse slows down your train of thought. You don't have to change from your keyboard to your mouse to select certain formatting or other options. Use keyboard shortcuts for this purpose. An important one to remember is "Ctrl + s" if you use a Windows machine: this shortcut saves your work. Depending on the software package(s) you are using, and the type of operating system, you will be using different shortcuts. Learn the most important shortcuts for the different software packages you use, and you will see that your work becomes more efficient. For more about academic writing, see Chap. 7.

Simplify

If you feel overwhelmed by all your tasks, simplify. If you feel that your days are too full and there is no space for you to breathe, simplify. If you feel bogged down by constraints in your life, remove them, regardless if these are people, objects, or emotions. Your small budget as a PhD candidate will probably already make you live a minimalist life. Here are some other ways in which you can simplify:

- Know your priorities, and let go of everything else. In your research, your priority will be answering your research question. In life, your priority for your evenings may be one activity, instead of a slew of different activities, which make you feel rushed and may limit the joy you feel from each.
- Do less, but higher quality. Focus on high-impact journal papers. Focus on answering your research question in a clear way. Cook less often and in larger batches, but perhaps more complex recipes. Work less hours, but more efficiently by blocking distractions. Allow yourself real down time in the evening, instead of rushing between appointments and activities.
- Reevaluate your information stream. What sources are you reading, and what can you leave out? Do you tend to merely read the headers of the online newspapers,

but are you missing in-depth analyses? Move away from online, bite-sized news, and explore in-depth magazines that allow for a deeper understanding of the problems, for example.

- Leave more space and time, in your house, your planning, and your mind. If your house starts to get too full, evaluate what you can give away to friends, donate to charity, or trash. If your planning is too full, leave more buffer time and scratch out some unimportant tasks. If your mind is too full, find time for peace and quiet in your days. Keep your mind and senses open and aware to enjoy the present moment, instead of always thinking about things that happened in the past or things that you still have to do in the near future. If you find yourself absorbed in worries and mulling over tasks that need to be done, acknowledge it, tell yourself that tomorrow is another work day when you will be moving these tasks forward, and return your attention to the present moment. If your worries keep returning, take your journal and write about them.

For more about the basic ways to plan and structure your days, see Chap. 2.

Sleep
Sleep is one of the three things you should never give up: sleep, good food (proper nutrition), and exercise. PhD students tend to work long hours and have erratic sleep schedules. Early career researchers at conferences boast to each other that they had so much work before traveling that they only slept four hours in the last seven days, or something similar. However, if you are tired, your brain won’t be functioning properly. You need your full brain capacity for doing creative research work. Work should never be an excuse for depriving yourself of sleep, because it will only lead to a vicious circle of being tired, making mistakes, having to stay longer at work to correct these mistakes, and being even more tired. Make sleep one of your priorities. Don’t be afraid to go against the tide of the culture of overworking in academia – just make sure your output is as expected. If you have a puppy or a baby, your sleep schedule may be temporarily interrupted, but for another reason than work. If that’s the case, try to find time for napping during the day or on your weekends. If you have insomnia, don’t suffer in silence, but go see a doctor. For more information about planning your day around your non-negotiable self-care, see Chap. 2.

SlideShare
If you want to make your presentation publicly available online after the event where you presented, use SlideShare. As the name says, SlideShare (currently part of the LinkedIn empire) is a place for sharing slides (or presentations). Upload your presentation, add a description, perhaps add some keywords, and your presentation will be available for everyone who is searching for information about your research topic. You can select if you want your presentation to be available for viewing and/or for downloading. You may be surprised by the number of visits your presentations receive when you analyze your stats. SlideShare is another platform that you can use for exposure of your research, and will attract a different audience than other platforms, such as ResearchGate or LinkedIn. Uploading your presentation is fast and easy, and the benefit of making your work visible is large. Just remind yourself to

upload your presentation after you've given it. A presentation on SlideShare is easy to embed in a blog post. For more about presentations, refer to Chap. 8. For more about sharing research in the twenty-first century, refer to Chap. 9.

Speedreading
If you need to read large amounts of text, it may be useful to teach yourself the skill of speedreading. Certainly, there are papers for which you need to chew on every single word because the contents are crucial to your research. However, there are many papers that you want to skim through more quickly. The crux when it comes to speedreading is learning to read without hearing the words in your mind, which is officially called subvocalization. You can practice numbing this voice by using your finger to move quickly along the text. You may hold your breath while you let your eyes roll over as much text as possible, or make grunting noises (don't do this in the office or on the train, though!) or overwrite your inner voice by repeating tralalala to yourself. To train your eyes in their reading speed, you can use online tools such as Spreeder. Start to read words as clusters of groups of words, instead of each word separately. For more about the literature review, see Chap. 4.

Social Media
Social media can be a blessing and a curse during your PhD trajectory. It can be a curse if you are constantly distracted from your work by all the memes of the internet. It can be a blessing when you use social media to get in touch with fellow researchers, or to learn from researchers in other parts of the world. You can use social media to share blog posts about your research and your recent publications. Most of us will find that we are somewhere in the middle: we may enter the internet to share our most recent publication, and suddenly we realize we just spent thirty minutes hopping from one website to another, getting sucked into the vortex of the internet. Identify for yourself what you want to get out of your use of social media, and leave out activities that do not serve you. Avoid staring at your phone and using social media when you feel bored. If necessary, block a certain amount of time on a daily basis for your social media accounts, and do not access them during other times as a way to distract yourself. For more about communicating science in the twenty-first century, see Chap. 9.

Spreadsheet Version Management
If you develop spreadsheets, document your actions. One way you can do so is by using a separate tab for notes to yourself. You can call this tab "Version management", and add the date when you created the file, the changes you made (each with date), and other observations in this tab. Similarly, if you code, add comments to yourself. Add all the information that you need to make sense of what you did in the spreadsheet in the future, and also add everything that seems trivial at the moment you are working on it – it will not seems so trivial at a point in the future when you want to write about what you did. For more information on experimental work, see Chap. 6.

Storing Data
As you gather experimental data, and as you move through your PhD trajectory, you need to be organized: if you need something, you have to be able to find it. Create a logical tree structure on your hard drive or-preferably- on a cloud drive to store all your data. Make it a habit to always store your data after carrying out an experiment, and to always back up your data to the cloud and/or an external hard drive. You may also have notes and observations on sheets of paper: develop a storage protocol for this information. You can organize everything into binders, or use a different system; as long as you can find your information back. If you use paper-based systems, scan them at regular intervals, and back up the scans to the cloud and/or an external hard drive, to avoid that humidity, insects, or fire damage your information. For more about the development of your data storage procedures, revise Chap. 2.

Storing Literature
See also "Reference management software." After reading a paper, you need to store it. First of all, you need to use specialized reference management software to develop a database of articles, reports, and books that you read during your PhD trajectory. Make sure you can find these resources back on your hard drive or cloud drive. Use a consistent method for naming your documents, so that if the link between your reference management software and the file is lost, you still are able to find your file. If you read papers by printing them out and marking them up, you will need to develop a system (perhaps in binders) to archive the papers you've read. For more about the literature review, see Chap. 4.

Stress
A bit of stress during the PhD is unavoidable, as it is in life. You may feel a surge of stress when you need to present your work for the first time, or even as you try to finish a task for the day. However, if you feel tense all the time, grind your teeth at night, walk around with a tight jaw continuously, and your stress levels start to affect your life and health, you will need to ease up a bit. A way of keeping stress at bay is by making sure you take proper care of yourself, and have sufficient time at night and during the weekends for activities that energize or relax you. If you get stressed by the amount of tasks you need to take care of, seeing a planning and convincing yourself that everything will be taken care of in due time, may be the reassurance you need. If you need professional help, don't try to brush off your stress as trivial, but go see a professional. For more about non-negotiable self-care, refer to Chap. 2.

Studying
Research and studying are different skills. As part of your research, you may need to study certain concepts on your own, but having high grades in formal courses may not necessarily mean that research will be a great fit for you. Your PhD program can include formal courses, which require you to use the set of skills you need for studying. You may know perfectly well how to prepare for an exam and pass with flying colors, but this skill will not serve you for research. Research requires you to venture outside of what is known, into the woods, and go figure out things all

by yourself. Studying formal courses follows a set path, whereas when you do research, you may sometimes wonder if there even is a path. When you study, you know what you need to study and what you need to master. When you do research, you don't know in the beginning, Research can feel more intense than studying, and you may find that you can focus for a longer time on study material than on your research. For more about the research process, see Chap. 5.

Supervising Students

You may get the chance to supervise master's students during your PhD trajectory. They may help you a hand in the lab, or they can study a problem that is related to your main research question. Of course, working with students is extra work, but it can be quite rewarding. You learn new skills that help you grow as an independent researcher, who in the future will be able to supervise his/her own PhD students. Here are some of the main skills you learn from supervising master's students:

- You'll learn to define a good topic for a master's thesis. You can look at smaller open questions that remain in your work and that are not directly required for answering your research question, but that would be nice to know. You can delegate the coding of a tool that would be interesting to develop. You can let the student apply your experimental technique to a different sample. Don't be overly ambitious, and keep in mind that a thesis topic for a master's degree is significantly smaller and with less theoretical depth than a PhD thesis topic, so make sure you can delineate a topic that will take no more than one year of research and writing time.
- You'll learn how to teach your research to others. Don't just dump all your reports on your poor minion, but talk him/her through your most important findings that are relevant for his/her master's thesis research. This skill will also serve you at conferences and when communicating with others in your field about your work and its relevance.
- Learn to see the broader picture. Your student doesn't need to understand all the nitty gritty details of your research. Instead, you need to be able to define the most important part of your research; the part that your student really needs to understand to work with you. Learn to take a step back from your work and evaluate the bigger picture: what do you really need to communicate to someone who wants to work on this topic?
- Identify the basis of your work. Again, don't throw everything you've done onto your student. Your student may still be taking essential courses in his/her program, and not master all the theories and skills you find obvious. Identify the most important references your student should read. Which assumptions should he/she be aware of? Define the fundamentals of your work, and communicate this to him/her. Avoid burying your student under all the information you have collected over your PhD trajectory.
- The joy of working with students lies in seeing them take the information you gave them, and then see them develop their own ideas. Let yourself be surprised, and keep an open mind. Give them time and space, and don't force your own ideas upon them – no researcher was ever grown on spoon-feeding. Let go of

your predetermined thoughts, don't outline for your students what they should be doing. Give them all necessary information, and then let their creativity run wild. I call this system being a gentle guide: be there to support your students (in their research, but also when they suddenly worry that they will never graduate on time), brainstorm with them, but also respect them, their creativity and their ideas. Be the type of supervisor you'd want to work with.

For more about growing into an independent scholar, revise Chap. 13.

Supervisor
See also "Promotor." Your supervisor, advisor, or promotor will be the professor that hires you, and that either has already secured funding for your research topic, or that will be applying for funding together with you. Some supervisors like to peak over the shoulder of their PhD students every day to see how they are progressing. Other supervisors prefer to let their students run free, and meet only a few times a year. When you apply to programs and consider the professors you could work with, inform with current PhD students about the working style of your possible future supervisor to check if your working styles fit together. For more about setting your collaboration up for success, refer to Chap. 2.

15.20 T

Teaching – Teaching Assistant
Depending on the type of funding you have for your PhD, you may be asked to spend a certain amount of your time as a teaching assistant for a course. As a teaching assistant, you'll be responsible for helping students with their questions related to the course, to grade homeworks and exams, and generally be the assistant for the professor of the course. If you will be working as a teaching assistant, it is possible that you will be the teaching assistant of a professor who is different from your PhD supervisor. You may end up in a field of tension, with different professors expecting different things from you. If that's the case, have a meeting at the beginning of the semester with the professor whose assistant you'll be to identify the expectations for the course, and your time commitment. If you are hired to be a teaching assistant for 12 hours per week, schedule those hours in your weekly template, and communicate the times when you'll hold office hours with the professor of your course and your PhD supervisor. If you do this, you'll show both professors when you will be available for research and teaching respectively, and what they can realistically expect from you on a weekly basis. For more about organizing your time, see Chap. 3.

Teaching – Lecturing
As you reach the end of your PhD trajectory, you may be asked as a guest lecturer in a course, or you may even be asked to teach an entire course in one of the lower years of the undergraduate program. Teaching for the first time can be time-consuming. If you take on the responsibility of lecturing a (part of a) course, be

aware of the commitment [8] you are making, and plan accordingly. Setting up a course for the first time can be challenging, as you need to figure out the right speed to work through the material, need to design your syllabus, need to figure out the examples you will use in class, and the homework and exams you will assign. Don't plainly refuse the opportunity to lecture a (part of a) course: experience in teaching may be a plus on your resume as you start to apply for faculty positions. Even if you decide to move to the industry, but may be willing to teach professional courses every now and then, this experience is beneficial. For more about balancing teaching and research, see Chap. 13.

Tech Tools
Technology is continuously advancing, and every day tools are invented (many free of charge) that can make your life easier. When you are repeating a certain process often, see if a tech tool exists to automate your process. Use tools that sync wirelessly in the cloud across all your devices for your planning and lists. There are interesting tools out there to track your time, to time your Pomodoro sessions, to count the words you've written, to manage your references, to listen to music, and every other action you may be needing on a regular work day. Some of us may be tempted to try out every possible tool whenever it is released, and get lost in trying out tools and changing systems. Find the sweet spot between the comfort of using tech tools, and limiting the amount of time you actually spend on optimizing your technological systems. Revise your systems periodically, for example once per semester, to see what you can improve, but don't be tinkering with your tools all the time. For more about tools for planning your time, see Chap. 3.

Ten Thousand Hours
Ten thousand hours is a theory, popularized and misrepresented by Malcolm Gladwell in Outliers, the Story of Success [8]. Gladwell turned research on mastery of skills (for violin players and top chess players) into a generalized rule that it takes ten thousand hours to get good at something. A quick back-of-the-envelope calculation showed me that a PhD trajectory takes about ten thousand hours, which could mean that it indeed takes about that long to gain mastery at research. But then, how much of this time during a PhD trajectory is actually spent on research, and how much time is spent in meetings, on teaching, on replying e-mails, and on possible service commitments? By all means, don't get blinded by this (random) number, and focus on finding the answer to your research question, rather than on fulfilling ten thousand hours of work (whatever it may be) during your PhD trajectory. For more about planning your time, see Chap. 3.

Theoretical Work
See also "Analytical work." A typical research thesis will consist of experimental as well as theoretical or analytical work. You will approach your research question from two sides: based on observations in the laboratory or in the field, and based on an existing theoretical framework that you will be expanding and applying to your research. And then, hopefully, you will be able to match your theoretical and empirical efforts. Theoretical work, at its very basis, can be frustrating. You may have no

idea of what to try out and which direction to select for your work. You may have had a brainstorming session with your supervisor, and have some possible paths to try out, but nothing well-defined. It may be scary. Don't spend too much time wondering what will happen if a possible approach does not lead to good results – you can spend a lot of time hypothesizing over possible outcomes, but you won't know the result until you actually sit down to do the work. As with all research, move your theoretical work forward by making calculations, evaluating assumptions, making sketches, and actively working. For more about the research process, see Chap. 5.

Thesis

See also "Dissertation." A thesis can be one of the requirements for the graduation of a PhD student. Writing a thesis can be a daunting task, and you may have no idea how to distill all your work into one document. Remember that your thesis should show the reader how you answered your research question, and associated subquestions, and not everything you did during your PhD. Depending on the requirements of your institution and the practices in your research group, you may want to keep your dissertation limited in size, and refer to the research reports you developed during your PhD trajectory for all details of experiments, calculations, and analyses you carried out. For more about writing the dissertation, see Chap. 12.

Time Tracking

If you want to know how you are spending your time, and what are your biggest time drains, measure how you are currently spending your time. If you don't measure it, you can't know it. To improve your planning and time management strategies, you should track your time periodically (once or twice per year for maintenance, more often if you are still making tweaks to your planning strategies). You can use tools such as ManicTime or RescueTime to track the amount of time you spend on certain programs. To have a more general overview of how you spend your time between work, communting, sleeping, and all other activities, you can simply log your time for one week (the 168 hours method, see Laura Vanderkam's book [9]). Once you have collected data about how you spend your time, you should reflect on your results. Do you spend an awful lot of time on social media and e-mail? Consider installing an app that limits your time on these tasks. Do you switch tasks constantly? Try to focus on one task at a time with the Pomodoro technique. Do you spend lots of hours watching TV, but are unable to motivate yourself to exercise? Try a workout DVD. For more about planning, refer to Chap. 3.

Time Management

Managing a project that has no definite outcomes, and not even definite questions at the beginning, as in your PhD trajectory, is tricky. For many students, the unpredictability of research is a reason not to plan at all – but this approach will typically mean that you are not working effectively and efficiently. Certainly, you can't plan your PhD in the same way a process in a factory gets planned. However, you can use a broad planning of the major milestones that you need to achieve to reach graduation within a reasonable amount of time, and you can refine your planning more and more for smaller increments of time: from a general overview based on milestones in your entire PhD trajectory down to your daily list of tasks and goals. Being conscious of your time, and how you spend it, can be important for making consistent progress during your PhD trajectory. The key element here is to learn how to manage yourself and your energy to optimize the way you spend your time. For more about planning and time management, refer to Chap. 3.

Tools for Planning

When you select your tools for making your planning, use something that feels right for you. Don't use a system someone else recommends you, but that seems extremely cumbersome to you. You can download special apps to all your devices for planning, or you can use a system that revolves around single notebook and lots of colored pens – whatever suits your style of working best. Whichever system you prefer, make sure you have always access to your planning; either by taking your physical planner with you wherever you go, or by using apps that sync in the cloud. Start with a system, and evaluate it frequently in the beginning to see how you can develop a system tailored to your needs and working style. You can evaluate your system at the end of every semester, when you plan your next semester, to see if you need to make small changes or tweaks to your approach, or if you can continue with your system. For more about planning, refer to Chap. 3.

To-Do Lists and Stop-Doing Lists

To know what you want to achieve on a daily basis, you can use to-do lists. Revise your planning for the next day, see if you have any reminders for smaller tasks in your planner or in your task list app, and either develop the full task list in an app that syncs across your devices, or make a list that you leave on your desk for the next day. If the internet tends to distract you, use a paper list on your desk, so that you don't need to open your browser or smartphone. Another type of list you can make is a "stop-doing" list. There may be tasks that take too much time that you can delegate, or that are simply irrelevant. When you take time for self-evaluation and self-reflection, you can make a stop-doing list as well, and have this list visible on your desk as a reminder. If you want to slowly change your working habits, focus on one stop-doing action per month,[14] to make gradual and lasting changes. For example, one month you can focus on stop checking e-mail during the first two hours of the day, which you want to keep reserved for writing. The next month, you can try to stop looking at your electronic devices an hour before you go to sleep. For more about planning and making lists, see Chap. 3.

Travel Funds

Conference travel can be very expensive. Some conferences charge hefty fees to the participants, and the airfare and your lodging may all add up to a large cost. Since traveling to conferences is work, most universities provide at least some sponsorship for their PhD students and faculty members to participate. If you have a special fellowship for your PhD studies, it may include a travel budget. Your research project may allow for some travel expenses. Your research group may set aside funding for each group member to attend one or two conferences on a yearly basis. If you don’t see any opportunities to get support from your university for presenting your work at a conference, the conference itself may have limited funding opportunities for students. To apply for these opportunities, sometimes there is a “best paper” or “essay” award competition you need to participate in. Other possible sources of funding to help you attend conferences can include funding from your home country, funding by professional associations, or funding by commercial companies, which is a great way to keep close ties to the industry. For more about traveling to conferences, see Chap. 10.

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[14] Or any other stretch of time until the habit feels natural.

Twenty Hours
To grasp the basis of a skill, some popular books have coined that it only takes 20 hours. In the book 80,000 hours [1], further research shows that this number may be on the low side. In general, 20 hours would mean roughly an hour of (deliberate) study or practice on a daily basis (workdays only) during the course of a month. In this time, you may be able to pick up the basics of a programming language, work your way through a course that can improve your writing or creative thinking, or learn to use a piece of software that you need for your research. You will only be able to learn the very basics to get started using these skills, but in general, planning 20 hours of deliberate practice should get you started in learning a new skill. For more about planning your time, see Chap. 3.

Twitter
Twitter can be a great tool for PhD candidates, or a great way to lose a lot of time – all depending on the way you use Twitter. You can use Twitter to share your insights from your PhD trajectory, get in touch with fellow researchers, participate in discussions about higher education, and get in touch with the industry in your field and professional organizations. You can share tips and tricks with fellow PhD students to improve your writing and communication skills. You can tweet the link to a paper of yours when it is published, or you can use Twitter to share the link to your blog posts. All these applications of Twitter, and many more, can make Twitter an excellent tool for scholars. On the other hand, you can also spend a lot of time on Twitter looking at pictures of food, kittens, gossip articles, and other random activities that may not be that helpful for you as a scholar. As always, when you decide to use a social media tool such as Twitter, do so consciously. If you find that you get easily carried away by the internet, define which activities you want to carry out on the website, set time limits, and be conscious of how you are using this tool. For more about the use of social media for research communication, see Chap. 9.

Twitter Chats
Twitter chats can be a great way to interact with fellow PhD candidates. You can focus on chats organized within your field, or you can join general chats on topics related to research skills. Some chats randomly develop around a certain hashtag, whereas other chats take place on a fixed time each week, with a moderator guiding

the discussion. Many of these chats are later on published through Storify[15] or other tools to archive tweets, and discussed in blog posts. Twitter chats are marked by a hashtag. Some recommended tags to check out are: #withaphd, #phdchat, #goscholargo, #scholarsunday, #ECRchat, #highered, #acwri, and #acwrimo. For more about the use of Twitter for research communication, see Chap. 9.

#Tweetprop
The hashtag #tweetprop is used by PhD candidates and recent graduates from Dutch universities, and started by @felienne. In the Netherlands, the requirement for graduation is the publication of a dissertation and list of propositions, and the defense of the dissertation and propositions. A number of recent PhD graduates have started to tweet their propositions under the hashtag project #tweetprop. Often, these tweets are accompanied by a blog post that explains the reasoning behind the proposition. In a Dutch dissertation, the propositions are published on a separate sheet of paper, typically one side in Dutch and another side in English. There is no space in the dissertation or as part of the propositions to explain why you selected a certain proposition. For the propositions that follow directly from the research, the dissertation should contain these explanations. For the other propositions, about your broader field, or general topics, the only venue where you can explain your short proposition is during your oral defense. Therefore, a number of scientists graduated in the Dutch system have used blogs and Twitter to expand upon their propositions, trying to make their explanations more accessible for the general public, as the propositions typically cover a wide range of topics. For more about using Twitter for research communication, see Chap. 9.

15.21 U

Urgent/Important Matrix
The urgent/important matrix is a tool which you can use to prioritize tasks. The matrix results from identifying whether or not a tasks is urgent, and whether or not a task is important. As a result, you have four possible combinations:

- Urgent and important: in this category you can find important deadlines that are coming up soon. The tasks in this category will obviously be on the back of your mind, and you will feel like you really need to work on these tasks.
- Not urgent and important: in this category you can find important tasks that do not have deadlines. A classic example of tasks in this category are the development of your journal papers, as these do not have deadlines (unless your self-imposed deadlines). You need to consciously spend time working on tasks in this category to move your research and your career forward.
- Urgent and not important: emergencies that are not important, but that you need to deal with: a ringing phone, a student who shows up with questions, an e-mail

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[15] Storify is going out of business mid-2018.

that pops up into your mailbox. Typically, you can handle tasks in this category more efficiently by allotting time slots to deal with these tasks, and by bunching up tasks of this category. Don't confuse the urgency of the demand with its (lack of) importance.

- Not urgent and not important: these are tasks that you should try to avoid, automatize, or make more efficient. Tasks in this category can be distractions, and are good candidates to put on your stop-doing list. Examples include sending e-mails that you can avoid sending, and wasting time on social media.

For more about prioritizing tasks, refer to Chap. 3.

Using Your Native Language for Research

While typically most of your presentations will be in English, as will be the majority of your publications, you may want to publish and/or present your work sometimes in your native language. The strange observation here may be that, even though your native language is the language you are most comfortable in, you may feel oddly uncomfortable when you need to present your work in your native language. A reason for such discomfort is that most of your material is in English, and suddenly you need to translate tables and graphs. Another reason may be that you notice that you use the English technical terms for your research more often than the terms in your native language, and that switching back to your native language slows you down. Finally, writing in your native language perhaps does not come naturally for you, and when you develop a publication in your native language, you may be going through all the familiar struggles of finding voice and authority in your writing in your native language as you had when you started writing your first articles in English. For more about presenting your work in another language, see Chap. 8. For more about writing in another language than English, see Chap. 7.

University Rankings

University rankings are often used to evaluate how "good" a certain university is. There are different institutions (such as QS, Times Higher Education, US News, Newsweek) that make university rankings, each based on slightly different categories and weighing factors. Some rankings evaluate the entire university and all its programs, whereas other rankings will be based on each career separately. Some rankings consider all levels of the programs, whereas others subdivide undergraduate programs from graduate programs. When you decide where you want to go for your PhD studies, don't let a ranking alone define your choice. Consider if the research group is a good fit for you, who would be your possible supervisor, what your funding would cover, the lab facilities, and the opportunities to travel to conferences. For more about selecting and getting started in a PhD program, see Chap. 2.

University Support Systems

Most universities offer a variety of services for support to their scientific staff. Often, however, PhD students don't find their way to these services as they simply don't know about them. Inform yourself about what is available at your university. When you arrive, check out the following: library services, software and hardware support services, additional insurance coverage for travel, administrative support systems, medical services, sports facilities, mental health facilities, science communication support, union representation, and career planning services. Your university may be offering all of these, or a number of these. When you arrive, it is good to know what is available, and what you can count on when you need help. Inform yourself, and take advantage of the support your university provides to make your PhD trajectory and future career a success. For more about exploring the options available to you in your university, see Chap. 2.

15.22 V

Viva
See also “Defense.” The “viva”, short for “viva voce” is the PhD defense as it is called in the United Kingdom. Depending on your institution, the requirements for the viva may differ from one place to another. Typically, a viva has a closed and public part in the UK: in the closed part, you get grilled by the defense committee (which includes one external reviewer), whereas in the public part, you get to enjoy a defense in the presence of your friends and family. In the UK, the defense is also typically held before the final submission of the dissertation. For more about the PhD defense, see Chap. 12.

Visibility
Visibility refers to how well other scientists and/or the general public know your research and you as a researcher. On the extreme side of the visibility spectrum, you find celebrity scientists. Whereas for most of us it is not our ambition to become a celebrity scientist or TV personality, it can be good that fellow researchers “know” you and can connect to you when needed. For this purpose, you can follow the traditional lines of communication for your research: present your work at technical conferences, and publish your work in high-impact journals. You can also write blog posts in a more accessible style to communicate your work with the general public. There’s no need to be tooting your own horn here, but there’s also no reason to keep your work to yourself. Find a level of visibility for your work and yourself that you are comfortable with. For more about communicating science in the twenty-first century, see Chap. 9. For more about making your work and career visible, revise Chap. 13.

Volunteering, Outside of Academia
In some countries, outreach of faculty members is narrowed down to volunteering work for struggling communities. While you may find it strange at first, it can be rewarding to use some of your skills for the greater good of your community and the world. If you are a scientist in a country of the developed world, this issue may sound much more remote to you. However, if you are interested in serving your community or underprivileged communities elsewhere in the world, there are numerous organizations for scientists and professionals to use your skills for the improvement of local communities. You will need to volunteer some of your time

and effort, but seeing a project move forward and improve the lives of people in underprivileged communities can be very rewarding.

Volunteering, for All the Service

See also "Service." Service positions on technical committees or for committees in your institution generally are volunteering efforts. Service is an important factor in the work of scientists, and often practitioners volunteer some of their time for service appointments too. If you are at the beginning of a research career, it can be good to volunteer for a number of committees and raise your hand when work needs to be done. By doing so, you can show fellow academics and scientists that you are willing to work, willing to serve your community, and that you can be a valuable collaborator for the future. For more about volunteering for service activities, see Chap. 13.

15.23 W

Weekly Template

When figuring out how to balance your different responsibilities, use a weekly template. A weekly template is typically developed per semester, especially if you have teaching responsibilities or if you are taking courses that run on a semester basis. When you develop your weekly template, try to limit yourself to "normal" working hours, to have a realistic idea of what you can achieve with your time. Plan also your other tasks: plan time for exercise, to cook your food and eat it, to go do your groceries, and for your social commitments. Keep in mind that when you plan time slots for work activities, you will typically only have 75% of the time in that time slot to really work on a task – leave enough air to be able to deal with distractions and disturbances as they arise, without getting stressed about running behind your schedule. Once you have your weekly template, you can fill in your specific tasks in each category on a weekly basis, and define your goals even further on a daily basis. For more about planning your work, see Chap. 3.

Word Count – As Motivation

When you need to write lots of text, for example for your PhD dissertation, it can be helpful to track how many words you've written in a day. You can use a tool, like the PhDometer of PhD2Published to keep track of the amount of words you are writing on a daily basis. For example, if you are writing your dissertation, you may aim at writing 1000 words each day. You can track your words, and when you are done for the day with writing, you can move on to the next task. Keeping track of the words you write can be very motivating, as it gives a tangible idea of how your work is progressing. You can also log your output on a daily basis. As I have different writing projects going on at the same time, I use an Excel spreadsheet with my different writing projects in different columns. I log on a daily basis how much words I produced for the different categories, and calculate how many words I write on average on a daily basis by averaging the counts per month. I find it motivating to see the word count grow and grow as time progresses, and to see bits and pieces of work move forward on a daily basis. For more about writing a dissertation, see Chap. 12.

Word Count – Sticking to It
If you are planning to write a certain number of words on a day, you may find that your plan and your reality don't align. You may get distracted all the time, and be unable to find your focus. If you have difficulties motivating yourself, there are a number of things you can do. You can use the Pomodoro technique to set aside just 25 minutes of uninterrupted writing time. If you have difficulties getting to writing or reserving time for your writing, you may want to join a local #shutupandwrite group, or start a group yourself at your university. In a #shutupandwrite group, writers of different backgrounds get together in a coffee shop, commit to writing for an hour, and then grab a coffee and have some time for chatting. For some writers, this social support can be very helpful. If you have difficulties sticking to your goal word count because the number seems large, start smaller and increase the number over time as you develop a writing habit. If you are faced with writer's block, try free-writing in your research journal first, to write without pressure and explore the blockage you are faced with. For more about motivating yourself when writing, see Chap. 12.

Workflow Processes
Your work flows best when you align the activities with the ebb and flow of your energy levels during the day. On the most abstract level, your general workflow should fit within your day, and your energy levels throughout the day. On a more detailed level, your workflow processes can entail all standard protocols you use for tasks you repeat often. For e-mail, you can use the workflow process of the Inbox Zero technique: read, react, file. For your experimental data, you can use a flow of processes that includes writing a short description of your observations in your report, selecting a few representative photographs of your test, adding the most important data to your overview tables, and storing all your data to a cloud drive. For more about workflow processes and organizing your day around your energy levels, revise Chap. 2.

Working from Home
For some, working from home means an endless string of distractions: from the laundry that you "quickly" put in the laundry machine, to your pet who wants attention, to the internet that may be more attractive when you work from home and have no "social control" by your colleagues. You may also turn to social media for connection with peers when you work from home because you feel isolated. On the other hand, working from home can be incredibly productive, as there is no work phone, students, and colleagues to walk into your office – you can be hiding away from the world and move your work forward. If you work from home, follow these few basic guidelines to ensure productivity:

- Make sure you are comfortable and equipped for your work. If you want to work from home, you need to have a good laptop or desktop computer with access to all your files and necessary software. Have a designated work space in your

house. Don't stay in your pajamas and in bed for working; it is much more challenging to be motivated to move your work forward in an environment that you associate with relaxation and sleep.
- Define your goals for the day or timeslot that you work from home. Just as with other work situations, you will be most productive when you know what you need to achieve and during which time. If you stay at home to work on your dissertation the entire day, but you haven't defined which figures you will develop, your goal word count for the day, or which sections you want to finish, you probably won't make much progress.
- Don't let work and life blend into each other when you work from home. If you work a number of days from home, your schedule may start to shift. You may be sleeping in, and then working long hours, but with lots of distractions in between. Stick to regular working hours, even when you work from home, and postpone all activities that are not work-related to after your working hours. Set boundaries between your work and your life, even though you there may be no such physical boundaries in your home.

As always, if you work from home, your planning and tasks for the days and goals to achieve are important. For more about planning, revise Chap. 3.

Work-Life Balance
Some people think you can't have a life when you are a scientist. I beg to differ, and I encourage you to join me. Certainly, there will be times when you have several projects running together, and you may need to push through for a few days. But don't let your work run your life every single day. Find what works for you and your family. You may be only available to work on your PhD in your university office or laboratory from nine to five. However, you shouldn't stare yourself blind on the number of hours that you put into your work: if you need to meet a deadline, push through for one day, and crawl back behind your computer after dinner, or for a day during the weekend. Be flexible and willing to go the extra mile when necessary, but keep your priorities straight, and never let your non-negotiable self-care activities take the backseat. Use the weekly template to make everything fit in your life, including your time for sleep, exercise, social activities, and hobbies. For more about balancing your life and work, see Chap. 2.

Work Hours
While I'm not fully convinced that you can simply limit yourself to working from nine to five in an academic career or as a PhD candidate, I do think you shouldn't let your work hours expand into all corners of your life and time. In fact, as you spend more and more time on your research, you have diminishing returns. Understand what works for you, for your life and your family situation. During my PhD, I usually worked about 55 hours a week, which is a bit more than a work week of 40 hours, but also not as excessive as the 80+ hours that some academics work constantly. What worked for me, was to spend about nine to ten hours a day on my work, sometimes including an extra hour or two after dinner, and to work one day in the weekend, on Sunday, to get ahead of the week. Find something that works for

you, and that you can commit to, without feeling that your PhD is limiting you in your life. Make sure you limit your working hours but that you work in a smart way, by defining your goals, and eliminating distractions. Use a weekly template to fit all your tasks, and to make sure you have enough time for exercise, cooking, doing the groceries, eating, cleaning your place, social events, and everything that you should never give up for your PhD studies. For more about planning your time and setting up a weekly template, see Chap. 3.

Workloads

Academic workloads can cause a lot of pressure on PhD students and early career researchers. However, these large workloads are caused because we tend to take on too many responsibilities at the same time. Whenever you commit to a new project, make sure you can deliver the promised results within the time frame that you proposed. Before you volunteer for all the service commitments, make sure you can deliver your promises. If you find the topic of your PhD research to be a beast with 1000 heads, return to your original research question and subquestions, and focus on answering these questions, and not everything that may be interesting and fun to look at. When you feel overwhelmed by everything you need to do, list down everything that is weighing on you and all your tasks and responsibilities, and then assign priority levels. You can use the urgent/important matrix to identify your high-priority tasks. For more about prioritizing tasks, see Chap. 3.

Writer's Block

Writer's block is the state of being unable to write. You feel completely blocked from developing coherent sentences. Many PhD candidates are faced with writer's block when they start writing a large document, such as their literature review or dissertation. To mitigate writer's block, it can be helpful to get your writing juices flowing by using free writing in your research journal or in an online app such as 750words.com. If you are faced with writer's block, an honest self-evaluation may be what you need. Try to figure out why you are experiencing writer's block. Is it because the task ahead of you seems too large and too difficult to tackle? Split up the task in smaller subtasks, and define on a daily basis what you want to achieve, for example a certain number of written words. Is it because you don't know how to start writing? You don't need to start with the introduction. In fact, it is often easier to start describing your methods, especially if you already have information available from your preparations. If you don't know how to start writing your literature review, then start by drawing a mind map of the different theories and approaches that you came across while reading. Is it because the white page is scaring you? Take some information from a previous report or even from your research journal and paste it into the file. Take some photographs or figures and add them. Now, start writing around the information that you already added into the document, editing as you go or editing everything after you've developed the first draft. For more about developing academic writing habits, see Chap. 7.

Writing Habits

Creating good writing habits is essential during your PhD trajectory, so that you are in good shape when you need to start writing your dissertation. Get into the habit of reporting your work while you develop it, write entries in your research journal, and get used to academic writing by developing conference and perhaps journal papers. Avoid writer's block by starting small. When you work on your literature review, write small discussions or summaries of the papers you read. When you develop your research question, write short documents outlining the gaps you found in the literature or developing small exploratory calculations. Find time for writing on a daily basis: make writing a habit, and not a task that is associated with emotional blockages if you want to avoid writer's block long-term. For more about academic writing, refer to Chap. 7.

Writing Diet

If you want to improve your writing skills, write often and practice deliberately. To make progress with a certain skill, go a bit deeper. If you want to improve your writing, get help from a writing coach or teacher, or become your own coach or teacher, and read your work very critically. Analyze the work of others in depth. Remember that if a violinist wants to increase his/her level, he/she needs to focus intensely on working through difficult passages, instead of playing tunes he/she already knows for hours on end. You will need to work on your writing with the same concentration and intensity if you want to go to the next level. If it is the habit of writing, more than the actual writing, that you need to develop, put yourself on a writing diet. To get used to writing, the best way is to practice writing a lot. To develop your voice, the best way is to be creative and explore different styles of writing. When you put yourself on a writing diet, you make a conscious effort to improve your writing habits by writing different styles on a daily/weekly basis. You can do this by writing in our research journal every day, by writing blog posts, by setting aside a fixed amount of time to write your reports and/or papers, by exploring creative writing through fiction writing, or by keeping a personal journal. For more about developing your writing skills, see Chap. 7.

Writing in English as a Non-native Speaker

Developing writing habits and constantly moving a dissertation forward can be a challenge even if your native language is English (assuming that you will write all your documents during your PhD trajectory in English). If English is not your native language, you are facing an additional challenge. Not only will you need to find your voice in writing and develop your writing habits, but you will have to do so in a language that is not your own. You may be faced with particular challenges in your writing that are typical for your native language. You may have difficulties getting your grammar skills to a level that is good enough to write papers for high-impact journals. If that's the case, do extra effort; nobody is going to be more lenient on your writing because English is not your native language. If possible, enroll in a writing course at your university for support. For more about improving your writing skills when English is not your native language, refer to Chap. 7.

15.24 Z

Zone

See also "Concentration", "Flow", and "Focus". You are "in the zone" when you are fully concentrated on your work, seem to move ahead effortlessly, and don't get disturbed by anything. You may not notice that you are hungry or need to go to the bathroom because you are so concentrated on your work. As you can imagine, being "in the zone" or in a state of flow is not something you can keep up for a long time, as it is exhausting. You can't expect to be in the flow and writing for eight hours a day. Find this state of flow during the times of the day when your energy levels are optimal. Organize tasks that require flow around your energy levels in the day, and set aside time slots that facilitate achieving this state. For more about organizing your work day around your energy levels, see Chap. 2.

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