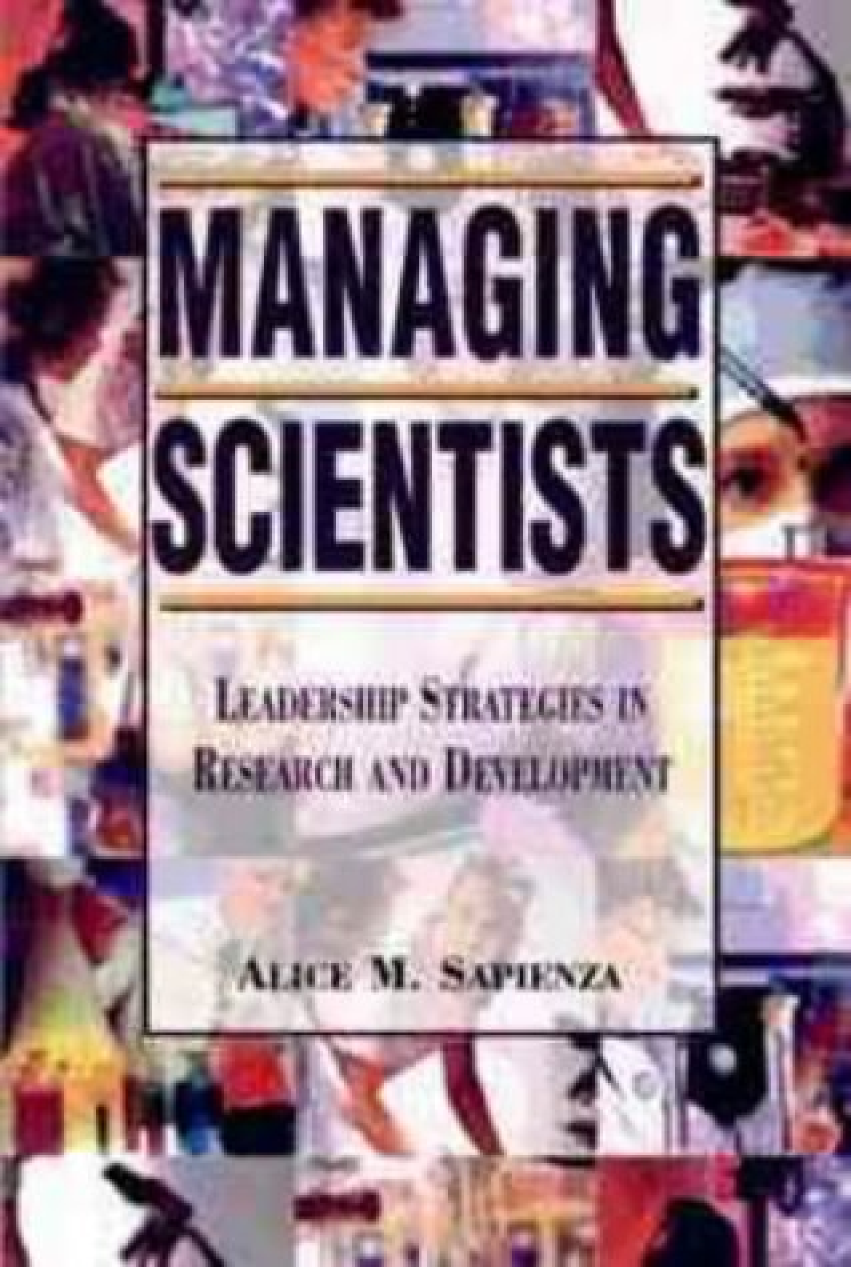

MANAGING SCIENTISTS

LEADERSHIP STRATEGIES IN RESEARCH AND DEVELOPMENT

ALICE M. SAPIENZA

MANAGING SCIENTISTS

Second Edition

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Leadership Strategies in Scientific Research

Second Edition

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Dedicated to VS

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PREFACE TO THE SECOND EDITION

BACKGROUND

A second edition benefits reader and author in several ways. Errors and/or omissions can be addressed; content can be updated and modified; arguments can be strengthened; new facts can be marshaled. Changes in the environment can be accounted for.

When I was asked by Wiley if I was interested in producing a second edition of *Managing Scientists,* I was eager to do so, for the reasons given above. A second edition provides a focused opportunity for reflecting on what the author has learned since the first edition was published. But, I was happily unaware of how long I would need to complete this edition—because I have learned so much more about the subject in the intervening years.

I have learned, for example, that the consequences of managing scientists poorly are even worse than I had considered. In Chapter 1, I present results of expert panel surveys that I and a colleague collected between 1996 and 1999, from scientists, postdocs, technicians, and physician researchers. They were asked to describe the worst example of leadership they had observed or experienced as well as the best. I am sure many readers will not be surprised by the candid depictions of laboratories in turmoil because the leader could not handle conflict, or verbally abused the staff, or simply was not present.

Postdocs, I have learned, are a particularly vulnerable population. They are sometimes asked to work under circumstances that would not be tolerated in the "real world" (i.e., companies). They are also facing the prospect of having to lead a staff of their own, either without systematic training or (as examples of the worst leaders suggest) without a good role model to observe.

I have learned how difficult it still is for women scientists in academia and in industry. Scientific institutions are not free from bias and stereotyping. Gender remains an important issue, in terms of the visibility, presumed competence, inclusion (in meaningful task forces and committees), and parity of promotion and remuneration of women scientists. In one firm to which I consulted, women scientists who tried to develop a support and mentoring network were upbraided by their managers for being seditious. Difficulties also face others not in the majority. One non-U.S. male scientist told me that his colleagues assumed he "thought with an accent" (in other words, stumblingly and haltingly) because he spoke English with an accent.

I have learned, because scientists told me about their experience, that poor leadership results almost invariably in poor productivity and a lack of creativity. I learned how few are the examples of successful institutional change and how often the fate of an organization rests on the knife-edge of personal insight, or active listening, or effective communication.

As a professor of management, I am convinced that formal management education is incredibly helpful to anyone who wants to lead effectively. Good courses in organizational behavior can, I believe, often make the difference between a satisfactorily run laboratory and a superbly creative laboratory. I am also convinced that the journey from occupying a managerial/leadership role to being an effective leader sometimes begins with a book. I began my formal management training, in part, because I happened to read Peter Drucker's 1954 classic text, *The Practice of Management* (this has been reissued in paperback by Harper Business Books). I hope that this small book can provide you with even a fraction of the inspiration his books provided me.

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Clearly, numerous general books on management and leadership are available. Simply view the choices under the keywords *management* and *leadership* in online bookstores. However, there is no book focused specifically on helping those scientists who find themselves leading other scientists and technical personnel. This book attempts to provide help as follows:

- Chapter 1 (Introduction) is a new chapter and contains the rationale for such a book: survey data on scientists' own experience of leadership. Major themes emerging from the data and verbatim comments from the surveys are interwoven throughout the rest of the text.
- Chapter 2 (Condition of Being Different) is also a new chapter. It provides a broad perspective on diversity and a narrow discussion of the challenges with which women scientists must deal. Both the heterogeneity of the current science workforce and the real gender discrimination that occurs are examined from the vantage of what leaders face.
- Chapter 3 (Understanding What Motivates You and What Motivates Others) is an expanded version of the second chapter in the first edition. I now include more material on motivation theory, new projective instruments, and new analyses of the case study from some of my clinical graduate students.
- Chapter 4 (Understanding Your Leadership Style and That of Others) is also an expanded version of what was the third chapter in the first edition, with new material on leadership theory.
- Chapter 5 (Communicating Effectively) is an enlarged and modified version of the former sixth chapter. I have included gender schemas in communication as well as new analyses of the case study (also from my best clinical graduate students).
- Chapter 6 (Dealing with Conflict) adds, to what was originally the seventh chapter, material on dealing with power differences, which emerged as important sources of conflict in asymmetric relationships such as postdoc and Principal Investigator (PI), junior and senior faculty, and so forth.
- Chapter 7 (Creativity: Influence of Structure, Size, and Formal Systems) draws on a number of additional studies of creative groups. I also include, in what was formerly the fifth chapter, a new section on the importance of tacit knowledge and how it can be captured in the laboratory.
- Chapter 8 (Project Management) benefits from work I conducted for

The National Aeronautics and Space Administration (NASA) on the roles and competencies of project scientists. This is an enlarged version of the eighth chapter in the first edition.

- Chapter 9 (Discerning and Assessing Organizational Culture) contains two additional case examples (only one was included in the former fourth chapter) of culture. These came from my consulting experience and represent, as do all the cases, real organizations and real people (disguised, of course).
- Chapter 10 (Leading Change) includes more material on theory than the former ninth chapter and an update on the case example. In the years since the first edition, one of the case examples in Chapter 8 disappeared (was acquired) and the one in Chapter 10 showed remarkable improvements.

ACKNOWLEDGMENTS

Because this is a second edition, I remain indebted to those who inspired and supported me in the first edition. In addition, I want to thank Carl Cohen (colleague and collaborator in the first rounds of expert panel surveys); Richard Corder (a graduate student who provided the major analyses of the survey data); Stacey Blake-Beard (for an illuminating review of the second chapter); Diana Stork (whose collaboration has been influential throughout many of the chapters); Joseph Lombarino (also a special supporter of the first edition); the scientists who took the time to respond to our surveys; the postdocs of the University of California (who helped me understand the particular challenges of this position); and my graduate students, whose wonderful analyses of the case studies in this book can now be shared with a larger audience. Finally, I want to give a special thanks to my editor at Wiley, Luna Han, for her support and, above all, her patience.

1
INTRODUCTION

It would be surprising if anyone reading this book had decided to embark upon a graduate degree in science with the objective of becoming a leader of scientists. My assumption is that you became gradually aware—probably during your postdoc experiences—that laboratories could be managed and people could be led effectively or ineffectively. Perhaps you reflected on the possible association between leadership and the qualities of the scientific outcomes (e.g., creative, productive, provocative). Or, you experienced or observed groups that were ineffectively led and wondered whether the outcomes might have been different under different (better) conditions.

If you set up your own laboratory in a university or research institute, you discovered that *managing* and *leading* were, inescapably, your responsibilities. If you chose to work in industry and became the leader of a group, that promotion was likely based on your scientific and technical successes. In either case, I presume that, by the time you realized your role had changed, you had little or no formal, systematic management or leadership training. Perhaps you were skeptical about such training. Did you ask: *Are the "soft" sciences just too soft to help me?*

HARD AND SOFT SCIENCES

In my early discussions with groups of scientists about leadership, almost invariably someone would tell me that he or she had witnessed or knew about a laboratory that was led ineffectively yet still produced good scientific re-

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sults. The question left hanging was: What does that mean in terms of management and leadership training?

Let me respond by disentangling the implied propositions. The first proposition is that *leadership of scientists does not matter.* As a professor of management, I am unlikely to agree. Given that you are reading this book, I assume you will concur if we do not entertain the first proposition.

The second proposition—*ineffective leadership does not negate good science*—is more interesting. Certainly, scientists have been productive and achieved good results under trying leadership conditions. When I was told about groups that had been productive although the leader was ineffective, I posed this question: Might effective leadership produce better results than ineffective leadership?

I am prone to believe the answer is "yes," but there are no science–leadership experiments that can satisfy the criteria of the scientific method.[1] After all, who would volunteer to be part of the "bad laboratory" in a study of inept versus effective leaders? (Who would agree to be the inept leader?) Even if we could find volunteers to work under these conditions, could we ever control the myriad human and other variables so as to determine with confidence that effective leaders *caused* good science?

The answers are "no one" and "no."

An effective leader of scientists is more likely to have an enthusiastic, energetic, passionately committed group working for him or her than an ineffective leader. In addition, I propose that the former group is more likely to produce better results. The simplest reason I can give is that more "brain power" can be employed in scientific endeavors under effective leadership conditions than under the opposite conditions. Consider how difficult it is for people to focus on the science if they are caught in unresolved conflicts, the crossfire of sniping and negative criticism, or the emotional wake of verbal abuse from their boss. Unfortunately, these situations are typical of some scientists' experiences of ineffective leaders, as described later in the chapter.

Despite the improbability of designing (to "hard" science standards) leadership experiments, I am confident of the relevance and utility of key lessons and concepts from the "soft" sciences that are presented in this book. However, I must state explicitly that the intrinsic limits of testing in the behavioral sciences require that answers to leadership questions be guidelines rather than rules, heuristics rather than algorithms, and suggested tactics rather than normative protocols.

In the soft sciences, such as management, hypothesis testing is challenging but not impossible. If you are in a leadership position, I exhort you to use your scientific expertise to formulate and test behavioral and organizational hypotheses and, thus, to learn and to grow in wisdom and effectiveness. Hypothesis testing begins with making your assumptions about people and organizations as explicit as your assumptions about the variables in your bench experiments. It involves observing your own and others' behavior with a "beginner's mind," seeking out disconfirming evidence for your hypothesis, and being honest about the outcomes.[2] Reflect on root causes of behavioral problems, decide on an intervention, and determine what happens as a possible result. Ask for candid feedback. This methodology was part of your training as a scientist, and it is generalizable to your development as a wise and effective leader.

So, you might ask: *Is leading people qualitatively different from conducting experiments?* I suggest that they have more in common than you may expect, but only if you approach both with openness, humility, curiosity, and appropriate reverence. Will you be equally good at both responsibilities? Not necessarily, but understanding your shortcomings and taking steps to rectify them are as necessary to leading people well as to doing good science.

MANAGING VERSUS LEADING

A good *manager* (the more common term) must also be a good *leader* (the currently popular term). When I use the word *managing* throughout this book, I refer to two types of activities: (1) leading scientists as individuals and (2) administering the research organization (e.g., overseeing laboratory budgets, preparing annual plans). When I use the word *leading,* I refer to being an exemplar and inspiration to those who work with and for you as well as directing them in a course of action, in decision making, and in problem solving. My emphasis throughout the book is on your role as leader.

I define an effective leader as a person who is capable of developing *and maintaining* an enthusiastic, energetic, and creative group of scientists and of administering the laboratory or research-and-development (R&D) organization successfully. I wrote this book, originally, because I believe that effective leadership of scientists requires surmounting several difficulties that are different from those found in "nonscience" situations. The first difficulty is that scientists are people whose primary activity occurs between their ears. Moreover, the purpose of their work is to generate new knowledge and ideas, an endeavor that, in comparison with other formally organized activities, is oblique, hard to predict, unwieldy to measure, and difficult to judge except in hindsight. Because of these characteristics, much of the conventional wisdom of administration, such as engineering-based planning and controlling, may not be directly applicable to planning, managing, and evaluating the work of scientists. This often puts the leader of science at odds with those trained to use more traditional standards and metrics.

A second difficulty is that scientific education and training result in groups of people who have conceptual frameworks, vocabularies, and discipline cultures that are very different from one another. A related difficulty, as you know, is that scientists are essentially trained to be solo contributors. (This does not rule out their directing a group of people engaged in their project or collaborating with scientists working on related projects.) Multidisciplinary teamwork, cross-functional communication, and collaboration are not easily realized.[3] Also, the matrix structure of formally organized R&D presents a special challenge because a matrix requires lateral communication and collaborative behaviors.

The final difficulty that I want to point out (although this is not an exhaustive list) is that scientists have moods, biases, quirks, and warts like the rest of humanity. When scientists come to work in the morning, they bring more than their cerebellum to the bench.

This combination of science, an oblique and unpredictable activity, and scientists, highly trained solo contributors who are also human beings, is notoriously hard to lead well. Striking the right balance between, first, the freedom, ambiguity, and challenge necessary to foster creativity and, second, the constraints necessary for producing results within time, cost, and perhaps commercial objectives is fraught with problems. Few are able to strike that balance without making painful mistakes. My hope is that this book will help you avoid as many painful mistakes as possible.

SCIENTISTS' OWN EXPERIENCES OF LEADERSHIP

I have tackled a second edition of this book because, in the years since the first edition, I observed so many negative repercussions of ineffective leadership. Now, when a scientist tells me that "X laboratory produced good science despite an inept leader," I know that the science may have been good for a time but the personal consequences were bad: Scientists gave up the bench entirely for another career, left that organization, or remained on the job but "exited" mentally from working to their capacity.

My beliefs that (1) poor leadership does not negate good science but (2) good leadership is more likely to produce better results were informed by my own experiences. They were also reinforced by an investigation conducted initially with a colleague (a senior scientist directing a research laboratory). We were interested in scientists' experiences of leadership—both being a leader and being led.[4] Between 1996 and 1999, we surveyed five expert panels that totaled 147 scientists, of whom two-thirds were PhDs, 14% were MDs, 5% were PhD–MDs, and the remainder MS technicians (and students). Most were working in the life sciences, although a number had doctorates in engineering, mathematics, and physics. A slight majority was working in academia, the rest in biotechnology and biomedical companies.

These panels were not meant to provide a representative sample of all scientists but rather a window into what it may feel like to lead and to be led in scientific endeavors. Possibly, life scientists are very different from other disciplines; or, academic leadership is completely distinct from industry leadership. (Because the panels were not representative, we did not analyze the responses by discipline, by degree, or by place of work.)

The survey consisted of three open-ended topics, based on our interests (questions were asked in reverse order):

1. Describe the worst example of scientific leadership you have encountered and explain why this person was ineffective (this generated 177 responses).
2. Describe the best example of scientific leadership you have encountered and explain why this person was effective (this generated 235 responses).

3. Of the typical problems that you encounter in your scientific position, describe the most difficult (this generated 214 responses).

Below, I discuss the panel scientists' experiences of ineffective and effective leaders. At the conclusion of this chapter, I describe their own most difficult leadership problems.

The Ineffective Leader

More than half of the responses to this question described the worst example of scientific leadership as involving a boss who:

- Publicly humiliated subordinates, was abusive, or provided only negative feedback (20% of responses)
- Could not deal with conflict (17% of responses)
- Was selfish, exploitive, dictatorial, or disrespectful (16% of responses)

Other descriptors included being disorganized, having unrealistic expectations, taking prolonged absences from the laboratory, and being dishonest.

The verbatim comments that people provided as to why the person was ineffective were sobering. Scientists had been yelled at publicly, berated, nagged continuously, and belittled. One scientist described "lab meetings [as] notorious for being forums for public denigration. [X] was abusive in meetings and often bluffed his way through things he knew little about." Numerous respondents cited leaders' inability to deal with conflict. People stated that ineffective leaders "avoided conflicts and let problems fester"; they "looked the other way"; they "hid from conflict." One scientist wrote that the director "used the technique of avoidance and, when problems were arising, simply never showed up in the lab." Another gave an example of a situation in which the principal investigator "delayed dealing with interpersonal problems until they grew out of hand—then asked a post-doc to handle the issues."

We were struck by the powerful negative climate created by an ineffective leader. The survey revealed numerous instances in which harsh criticism and negative reinforcements were heaped on scientists; in which public humiliation—not only in their graduate and postgraduate training—was typical; and in which the level of interpersonal conflict in the laboratory was so high it had to affect the work. Not one respondent noted, in all the descriptions of ineffective leadership, that scientists were nevertheless productive. In fact, in their own words, the opposite was described:

> I often find not only in my experiences but observing others that negative motivation doesn't work. It makes me much less productive. . . .
>
> There is much waste of human and financial resources in science from ineffective leadership. . . .
>
> Management can have a significant impact on the morale and productivity of a group. . . .
>
> Having had both extremes—great and horrible—as leaders, I'm aware of the productivity associated with a good leader and the lack of productivity associated with a bad leader.

Fortunately for the state of science and the work life of scientists, a different picture emerged from their descriptions of effective leaders.

The Effective Leader

We expected that scientists would rank intelligence and skill as important in their characterization of the best example of scientific leadership, and they did. However, what I will call "being a nice person" was noted most often. This attribute was followed by skills in management, such as ability to resolve conflict and to communicate and listen; being a good role model and mentor; and, then, intellectual accomplishment.

Effective leaders were described as:

- Caring, compassionate, supportive, enthusiastic, motivating (31% of responses)

- Possessing managerial skills, such as communicating effectively and listening well, resolving conflict, being organized, holding informative meetings (26% of responses)
- Being a good role model, mentor, and coach (17% of responses)
- Being technically accomplished to lead a scientific effort (15% of responses).

Other attributes included diplomacy, consistency and fairness, and having a sense of humor.

The importance of leaders' care and compassion to scientists and technicians working in the laboratory was striking. The best leaders were characterized as "scientifically very competent, and compassionate and caring deeply for collaborators and subordinates." As one respondent noted, the best leader was "caring but assertive. Good working rapport as well as friendship in the lab. Overall feeling of appreciation for the work done." Similarly, in contrast to the use of negative reinforcement by ineffective leaders, the best leader "not only criticized but also *praised.* A lot of people tell you when you've done something wrong. Very few people tell you when you've done something right" (the scientist's own emphasis).

Capturing many of the respondents' descriptions was this warm recollection of a former boss, who was

> a great scientific leader and manager. He held regular group meetings, included everyone in the discussions, took risks scientifically and in management, and was not afraid to speak up. He kept everyone focused and was a real "cheerleader" when it came to motivating us, keeping us a very focused and excited research team. He gave us a certain amount of independence and expected us to plan our work thoroughly. He also spent a lot of time in the lab, talking with us individually about the work. Our team was VERY productive [respondent's capitalization]!

These and related comments provided insight into the climate produced by an effective leader. Unlike the harsh and punitive environment in which "no one wanted to cooperate," the effective leader generated a "fun and productive atmosphere in which each person could thrive in his/her own individual way." Effective leaders, who were "highly enthusiastic and supported others' unorthodox ways of thinking," created an atmosphere in which professional growth and scientific innovation seemed to occur naturally.

One link between effective leadership and the quality of the outcomes can be found in these responses. Scientists reported that the effective leader "could get the best out of each person"; ensured that each person "felt a part of what was happening and wanted to do a good job"; and had "the ability to inspire and make everyone enthusiastic about the research." These leaders "created a stimulating environment," "encouraged ingenuity," and "appreciated innovative/novel/different ideas." Scientists and technicians working for an effective leader were enthusiastic, energetic, and committed. As I proposed earlier in the chapter, they were also far more likely to use their brain power in support of the science than those who were (in their own words) "verbally abused," "exploited," and "always criticized."

Exhibit 1 summarizes these scientists' experiences of "good " and "bad" laboratories.

MY MOST DIFFICULT PROBLEMS

There will always be scientific and technical problems and setbacks. Success in the end, however, depends not only on the solution of scientific and technical problems but also on the leadership and management skills of responsible scientists. Yet, as a number of articles in the scientific press have noted, scientists' "management skills [are learned] on the fly."[5] Even the National Academy of Arts and Sciences noted that scientists are not prepared to "work well in teams and demonstrate leadership ability."[6]

The scientists in our panels admitted that they were not ready for one of the most difficult and consequential aspects of their work—leading a group of people. In order of proportion of responses, their most difficult problems were:

- Becoming a leader, which included being authoritative, staying focused, balancing the scientific efforts with the management responsibilities, delegating (28% of responses)

- Dealing with conflict (24% of responses)
- Motivating people, generating enthusiasm (12% of responses)
- Communicating effectively, primarily providing feedback (10% of responses).

Other difficulties included “not being taken seriously as a leader,” “lack of respect and support from people in authority,” and “being undermined by colleagues, mentors, even secretaries.” Because they have informed this edition of the book, I describe each of the four major problems in more detail, below.

Becoming a Leader

What scientists encounter in their new role is quite typical of the problems encountered by every first-time supervisor. Moving from a position as colleague and friend of other group members to being a leader with some authority over those group members is hard for anyone. The scientist-supervisor now has to “determine how to allocate work among team members and, occasionally, convince people they are going in the wrong direction without their resenting that as criticism.” As leader, he or she is the person who inevitably hears and receives the complaints, who must handle “defiant and argumentative staff,” and who has to confront those “lab members who leave a mess for others.”

A number of respondents said that keeping a balance between moving the science forward and “complying with regulations,” “obtaining space and technical support,” or “raising money” was nearly impossible at first. Although they found joy in their scientific work, these scientists were sometimes overwhelmed by management responsibilities (“NON-SCIENCE activities,” in the exact words and capitalization of one respondent). These ranged from “space conflicts and limited reagents” to dealing with “recalcitrant techs,” “mediocre students,” and “subversive colleagues.” Their new role required them to “solve equipment and material problems,” “deal with parking,” and “chase after borrowed equipment that was not returned.” Suddenly, there was “too much work, too little time, and too few hands,” perhaps because (as one scientist stated) of the difficulty of “saying ‘No.’” Still another admitted that he lacked the “confidence to delegate.”

No matter how onerous the administrative duties, however, the thorniest issues involved dealing with people. One principal investigator stated that being a leader now required him to manage “difficult—arrogant and abrasive—people in other labs with which we must deal on a regular basis; I struggle with getting my point across, without causing a bigger dispute.”

Dealing with Conflict

As the respondents pointed out, resolution of the inevitable conflicts that arise when people work together was one hallmark of the effective leader. In any organization, there will be interpersonal differences, personality clashes, and cliques. Scientists reported how difficult it was to resolve disagreements that ranged from “which music is played in the lab to which experiments have higher priority.” They struggled to “keep people from sniping at each other,” and they found themselves wondering how to handle jealousy, moodiness, and “one bad apple who poisons the atmosphere.”

Conflict that is not resolved—especially when it is ignored and avoided—tends to draw in formerly disinterested parties. Whether they intend to or not, scientists and technicians take sides and further polarize the issues. And, inevitably, those who become even marginally involved in a conflict find that more and more of their energies go to the conflict situation rather than the science.

Dealing with conflict and motivating people (the next reported difficulties) are often surprising challenges to new leaders. Just because they are scientists does not mean that team members and colleagues are either “conflict proof” or highly motivated. Scientists have moods and quirks, and they bring more than their cerebellum to the bench every morning.

Motivating People

One of our respondents described the best boss as a “‘cheerleader’ when it came to motivating us.” In their new role, these scientists realize how hard it can be to generate “enthusiasm equal (or at least closer) to my own.” In some cases, they have laboratory members who “dream of being famous but lack motivation." Others report that they have to deal with "people with low energy level—mind on the golf course and not at work." And, one scientist noted that she found herself "massaging egos of scientists who require attention."

Motivating people, as implied by the earlier descriptions of effective and ineffective leaders, entails praising, supporting, cajoling, and inspiring those around you. It involves spending "a lot of time in the lab, talking with [people] individually about their work." Thus, it is not surprising that *motivating people* and *communicating effectively* emerged as closely related leadership challenges.

Communicating Effectively

When the respondents described their difficulties in communication, they were not referring to clarity of verbal or written directions. The most common illustration of communication problems was giving feedback to others in ways that would not be felt as "personal attacks." As another scientist described it, the difficulty was "being able to convince people that they are going in a (likely) wrong direction in a way that would leave no resentment behind."

The ability to provide comments and suggestions while not "sounding confrontational" or "hurting [people's] feelings" was seen as vital both to motivation and to "keeping all team players focused on the critical path." When there is "too much work and too little time," staying focused is essential. Thus, communicating effectively—although ranked fourth in the respondents' list of difficulties—is a foundation skill for dealing with conflict and motivating people.

CONCLUSIONS

Larger Context

My purpose in presenting the above results is to illustrate the impact of leadership on scientists themselves. However, we must not overlook the impact of leadership on the quality of the science—and, ultimately, the impact on society.

The U.S. National Science Foundation regularly publishes an overview of the status and role of science, engineering, and technology. Not surprisingly, global economies benefit and depend on crucial high-technology industries and services (such as health care) defined by "their high R&D spending and performance, and which produce innovations that spill over into other economic sectors."[7] Most of these industries, in turn, depend on academic research that enables advances in the private sector. Thus, the performance of crucial (to the nations) industries and services is linked to the performance of academic research.

When the output of research is high-quality innovation, those firms investing in R&D enjoy positive economic returns. At the same time, society benefits. In fact, "returns to society overall are estimated to be even higher. Society often gains more from successful scientific advancements than does the organization conducting the research."[8] It is not too much of an exaggeration, or simplification, to conclude that effectively led science contributes to social and economic welfare.

A possible impediment to that contribution, as the earlier discussions suggest, is scientists' lack of training for the interpersonal and organizational challenges they will face in becoming a leader. As one of the expert panel respondents said candidly, "Management of people is the most challenging, important, and time-consuming aspect of my job and exacts the greatest emotional toll on me. I often feel I am not getting the best from people in my group." The purpose of this book is to help meet these challenges.

FOCUS OF SECOND EDITION

The focus of this second edition of the book remains the same: to help you to improve the quality of the human interaction among scientists. Although scientists' principal activity is cognitive, the quality of the human interaction influences how creative the science and technology will be (and how much of a contribution to society the science and technology will make). Important links between cognitive and behavioral theories have inspired this book.

Let me be clear that this is not an academic text that provides an overview of relevant theories. I have chosen to discuss only a limited number of topics—those I have come to appreciate as most important for leaders to "get right." I have also been selective in drawing from "soft science" theories and constructs those that meet three criteria. First, they must be robust. There must be good empirical evidence over time that the particular theory is valid and reliable. Second, they must be parsimonious. Theories that are robust but may be cumbersome for leaders to put into practice are not considered. Third, they must have proved useful, in my direct experience, to leaders of science.

In the course of nearly 20 years, I have experimented with a number of robust and parsimonious theories while teaching scientists and consulting to R&D organizations, and I have learned what works well. Other theories or models you may come across can be useful, and I urge you to read more widely than this book. However, this book is intentionally focused and selective.

Finally, I have attempted to distill the knowledge I gained from my doctorate in organizational behavior, my general management experience, and my teaching and consulting so that my ideas can be simply put and readily applied (following the advice of a scientist who said to me: "Any fool can have a difficult idea!"). All chapters have been written for you to read, reflect upon, and read again. With each reading I hope you will bring different experiences to bear, drawing additional and deeper insights that you can apply directly to your own situation. If you approach the material with a willingness to learn in this way—that is, to read, reflect, and reread—I can state with confidence that:

- You will learn something about yourself: what motivates you and what is your preferred leadership (i.e., decision-making, problem-solving) style. I believe firmly that the beginning of wisdom and effectiveness in leadership comes from a better understanding of oneself and one's strengths and weaknesses. From this comes heightened sensitivity to and appreciation for what motivates others and, in turn, an understanding of what is important in recruiting and training people. Such insights will be helpful as you think about your career development and that of other scientists.
- You will learn techniques for communicating and confronting effec-

tively. Developing skills to deal with intragroup dynamics will help you develop collaboration when it is required, for example, in program and project teams. Simply putting qualified and capable scientists together on a task does not create a team. However, understanding motivation, leadership style, communication, and confrontation will help you to promote teamwork among individuals as well as collaboration among larger groups, such as between two laboratories or different organizational functions (e.g., R&D and marketing).

- You will learn how structure, size, and formal systems can be designed to improve the innovativeness of science. There is ample evidence that a leader who can develop an organic organization, characterized by (among other attributes) lateral relationships among scientists, can improve the creativity of science.
- You will learn how to analyze the culture of your organization, with a view to discerning how that culture encourages or discourages creativity. Any organization more than a few months old will have a distinctive culture. Aspects of that culture will either foster the type of organization you want to lead—with energetic, innovative, productive people—or discourage its development. You will learn what culture consists of, how it evolves, and how it can affect thinking and behaving. With this understanding you can assess the impact of culture on your organization's performance and begin to evaluate aspects of the culture that may be detrimental to creativity.
- Finally, because all organizations are imperfect, you will learn how to approach change efforts whose goal is to achieve an energetic, innovative, and productive organization. You will learn two fundamental change models, when and how to employ them, and what problems are likely to arise.

When you finish this book, my hope is that you will understand yourself and your colleagues better as people; that you will be able to analyze your laboratory or larger R&D organization in a more systematic and rigorous manner; and that you will be better prepared to address the problems you have identified. My hope is that you will be well on your way to becoming an effective leader.

NOTES

1. See, e.g., *The Limits of Science,* by P Medawar, Oxford: Oxford University Press, 1984. See also *Learning: Theories,* by M. H. Marx (Ed.), London: Collier-Macmillan, 1970.
2. Epstein, R. M., Mindful practice. *Journal of the American Medical Association 282,* i9,1999.
3. There was a symposium at the National Institutes of Health entitled Catalyzing team science and described by an attending postdoc (www.the-scientist.com/yr2003/sep/prof7_030908.html).
4. These management training workshops were led by Carl M. Cohen, PhD, and initially sponsored by the National Science Foundation.
5. Kreeger, K. Y., Researchers setting up labs must learn skills on the fly, *Scientist,* 1997 (www.the-scientist.com/yr1997/mar/prof_970303.html). See also Transforming scientists into managers, by P. Brickley, *Scientist,* 2001 (www.the-scientist.com/yr2001/nov/prof_0111236.html).
6. National Academy of Arts and Sciences, Reshaping the graduate education of scientists and engineers, Report from the Committee on Science, Engineering, and Public Policy, 1995.
7. National Science Foundation (NSF), *Science and Engineering Indicators,* NSF, Washington, DC, 2001, Chapter 7, p. 4.
8. Ibid.

Exhibit 1. Good Laboratories, Bad Laboratories

Good Laboratories and Effective Leaders

- Are full of energy, collaboration, curiosity, enthusiasm, FUN
- Encourage open and candid discussion among all scientists, value new ideas, balance individual scientific goals with institutional goals
- Provide freedom to explore while keeping efforts focused
- Employ first-rate scientists, demand hard work and rigor from scientists (but no harder than from the leader), clearly define expectations
- Inspire passion for the work, challenge and engage people, create an environment for learning and discovery by their compassion and support for individuals
- Always hire the most talented and avoid micromanagement
- Are organized and able to support many projects at one time
- Have a vision, communicate it to everyone, so everyone knows what is going on and how each effort at the bench fits the larger picture
- Are productive and creative

Effective leaders are compassionate and supportive, encourage interaction among staff, and " are not afraid to speak up." They are accessible and able to resolve conflicts successfully. They value each individual's contribution, praise as well as critique (but never degrade), treat people as equals, and value everyone's opinion. They have a "generous, open style" and are passionately enthusiastic and good role models (set personal example of standards, integrity, dedication, efforts). They are calm, relaxed, and informal. They have a first-rate intellect with wide interests and are able to "think outside the box."

Bad Laboratories and Ineffective Leaders

- Use negative reinforcement, blame and berate people for failure, destroy self-confidence of scientists
- Pit individuals against each other (foster internal competitiveness), encourage intragroup rivalry that inhibits flow of information

- Set unrealistic goals, deadlines, and expectations
- Are unable to resolve conflicts
- Are disorganized and inefficient
- Provide no freedom to learn on one's own or explore own ideas
- Are unable to define priorities ("everything is crucial"), change direction frequently for no apparent reason
- Put scientists on repetitive tasks with no challenge
- Stick with old techniques, make little attempt to learn new areas
- Are indifferent to the science
- Micromanage

Ineffective leaders allow conflict to fester, avoid confrontation, are poor communicators, and are unable to deal with conflict effectively. They berate people behind their backs, have personal favorites, and take sides when conflict arises. They jump to conclusions and are egocentric, manipulative, overbearing, and dominating. They have little concern for personal relationships, are unavailable, and rarely communicate directly. They are more interested in their own career than the work of the laboratory, exploit staff for their own career, and are unwilling to share credit and develop others. They are dogmatic, controlling, and unfocused and publicly criticize. They are disorganized and inefficient and unable to manage (often, they are "scientists without any management knowledge and skills"). They act like the resident "braintrust," so people "learn not to think on their own." They expect people to "read my mind" and are arrogant, emotional, and distant. They engage in sloppy thinking, are not intellectually demanding, are moody, and pay little attention to the laboratory. They appear blind to the efforts involved by their scientists and pay attention only to results.

2
CONDITION OF BEING DIFFERENT

You face the reality of leading an international, heterogeneous by education and age, scientific workforce in which potential contributors (black and Hispanic scientists) are likely to be missing and other contributors (women scientists) are likely to be overlooked. Yet, you must encourage and support increasing diversity in the laboratory to be an effective leader.

Webster's Third New International Dictionary defines *diversity* as "the condition of being different," and I have three reasons for addressing the subject explicitly in a book on leadership. First, according to National Science Foundation surveys, the science and engineering workforce is very diverse in terms of differences in national origin, educational level, and age. Second, the condition of being different has important consequences for equity (fair and impartial treatment of people) in this workforce. Third, there is a crucial link between the diversity of people working in the laboratory and the caliber of thinking that can occur in that laboratory. Each of these is discussed below.

SCIENTISTS: DIVERSE IN NATIONAL ORIGIN, EDUCATION, AND AGE[1]

National Differences

More than one-quarter of all scientists and engineers employed in the United States are born elsewhere. Foreign-born, foreign PhDs and foreign-born,

Managing Scientists: Leadership Strategies in Scientific Research, Second Edition, by Alice Sapienza
ISBN 0-471-22614-9

U.S. PhDs account for about 27% of all doctoral-prepared science and engineering workers.

By general area of origin, most (57%) come from Asia, followed by Europe (24%), Central and South America (13%), Canada and Oceania (6%), and Africa (4%). By country, India and China account for the largest percentages (8% and 7%, respectively).

Foreign-born doctorates dominate civil engineering (52%); they account for at least 40% of chemical, electrical, and mechanical specialties. They account for 27% of biologists, 30% of chemists, and 33% of physicists. In computer and mathematical sciences, they make up nearly half (46%) of the workforce. In industry alone (excluding academic employment), foreign-born scientists account for between 20 and 30% of life and physical science workers, respectively. “Multicultural” is an apt description of today’s laboratories.

Educational Differences

In the science and engineering workforce, 56% of people hold bachelor’s degrees, 29% master’s, and 14% doctorates. These proportions vary, of course, among fields. In the life sciences, 40% hold bachelor’s, 21% master’s, and 35% doctorates. Only social scientists have a similarly high proportion of doctoral degree holders.

That this workforce is highly educated can be judged from recent data on educational levels of the general population. According to the National Center for Education Statistics, in 2001 the proportion of people 25 years of age and over with a bachelor’s degree was 17%; with a master’s, 6%; with a doctorate, slightly over 1%.[2]

Age Differences

The largest age group in the overall science and engineering workforce, including all degree levels, is 35 to 44 years of age (about 33%). The next largest group is older: 45 to 54 years (26%). However, a sizable proportion (14%) are 29 years old or *younger,* and 7% are 60 years old or *older.* (Those

50 to 54 years old account for about 7%, and those 30 to 34 years old account for about 13%.)

These proportions change when we examine the age of the workforce by educational level. Scientists and engineers with bachelor's degrees account for 56% of the total; with master's degrees, 29%; with doctorate, 14%. As might be expected, at the bachelor's level, about 20% of the workforce are 29 years and younger; 5% are 60 years or older. The largest proportion is still 35 to 44 years (33%). At the master's level, the workforce is somewhat older: 40- to 49-year-olds account for the largest group (32%), followed by 50- to 59-year-olds (29%). About 9% of the total population are 29 years old or younger and about 7% are 60 years old or older. Similar proportions hold for those with doctorates (the largest groups are 40 to 49 years and 50 to 59 years), although fewer (2%) are 29 years old or younger and more (13%) are 60 years old or older. Although we do not have exact data, some very active senior scientists are still working at 85 years of age or older.[3]

Life scientists with bachelor's degrees account for 40% of the total, and most (38%) of those are between 25 and 34 years of age. Those with master's degrees account for 21% of the total, and most (36%) are between 35 and 44 years of age. Those with a doctorate account for 35%, and most (35%) are also between 35 and 44 years of age. Life scientists with a doctorate are relatively younger than the overall science and engineering workforce at that educational level (those 29 years or younger account for 12%).

SCIENTISTS: LESS DIVERSE BY RACE AND GENDER

Although multicultural according to country of origin and diverse in education and age, scientists working in the laboratory are otherwise quite homogeneous in terms of race (white) and gender (mostly male).

Racial Differences

This specialized workforce is predominantly white at all levels of education. At the bachelor's level, the overall workforce is 84% white, 4% black, 4%

Hispanic, and 8% Asian/Pacific Islander. At the master's level, the overall workforce is 78% white, 3% black, 3% Hispanic, and 15% Asian/Pacific Islander.

Of doctoral-prepared scientists (excluding engineers), 81% are white, 15% are Asian/Pacific Islander, 2% are black, and 3% are Hispanic. Life scientists are similar in racial composition: 79% white, 16% Asian/Pacific Islander, 2% black, and 3% Hispanic. Engineers with doctorates have a somewhat different racial composition: 67% white, 29% Asian/Pacific Islander, 2% black, and 2% Hispanic. In general, the proportion of black and Hispanic scientists (and engineers) decreases as one moves up the educational levels, while the proportion of Asians/Pacific Islanders increases.

Gender Differences

By gender as by race, the workforce is less diverse. Across all degrees and fields, men account for 76% of the science and engineering workforce and women for 24%. In the life sciences, men account for 63%; in engineering, men account for 90%.

The proportions of men and women differ by educational levels. Taking the life sciences as an example, men account for 57% of those with bachelor's degrees, 60% of those with master's degree, and 71% of those with a doctorate. Similar to racial composition, the proportion of women decreases as one moves up the educational levels and has done so since the National Science Foundation 1993 surveys.[4] However, at the doctoral level, gender composition differs by age. Women life scientists account for 60% of doctorates in the workforce between 25 and 29 years of age, 42% between 30 and 34 years, 38% between 35 and 39 years, and 29% between 40 and 44 years.

Some General Comparisons

A recent Bureau of Labor Statistics (BLS) report noted that the "ethnic and racial composition of the U.S. population is more diverse now than at any time since the Nation's founding."[5] How the science and engineering (S&E) workforce is similar to or different from the overall labor force, along several dimensions, is summarized below:

- Foreign-born workers account for one in eight of the general labor force and more than one in four of the S&E workforce.
- Asians account for about 26% of foreign-born workers generally and about 57% of foreign-born scientists and engineers.
- The general labor force is predominantly white (84%), like the S&E workforce (81%). In 2001, the overall workforce was 11% black and 10% Hispanic (Hispanics are included in both white and black populations in these data). As was illustrated earlier, there are fewer black and Hispanic and far more Asian scientists and engineers in the S&E workforce than in the general labor force.
- Women account for nearly half (46%) of the general labor force, 24% of the S&E workforce, 39% of life scientists, and 10% of engineers.

A "typical" (hypothetically average) laboratory with about a dozen people might be described as follows: A number of different national cultures are represented. Several of the group are foreign born, predominantly from Asia. Nearly half (44%) are between 35 and 49 years of age; one or two are younger than 29 years and perhaps one is 60 years or over. About half have a doctorate and about half have a bachelor's degree. Several are women, but the leader is most likely a man. There are no black or Hispanic scientists at the bench.

DIVERSITY AND EQUITY

My second reason for addressing diversity upfront in this book is that, as the prior discussion suggests, the condition of being different can have important consequences for equity in the workplace. The leader of science has to deal not only with a heterogeneous group of people working in the laboratory but also with what appear to be systemic inequities in the way women scientists are treated. Before I address the latter, I want to describe very briefly how inequitable (unfair and biased) treatment of classes of individuals may arise.

Pattern Recognition

What links *diversity* (the condition of being different) and *equity* (fair and impartial treatment of people) is the brain's capacity and propensity to recognize patterns from sensory data and to categorize them on the bases of those patterns. Consider this example provided by the Nobel Laureate Gerald Edleman (and Giulio Tononi):

> The signals entering the eye of an animal in the jungle—patches of green and overlapping browns and of movements in the wind—can be combined in countless ways. An animal must nevertheless categorize these signals for its own adaptive purposes, whether in perception or memory, and somehow it must associate this categorization with previous experiences of the same kinds of signals. In the case of humans, we would most likely report seeing "trees."[6]

The ability to recognize patterns and categorize them is adaptive from both the perspective of consciousness (mind) and the perspective of the psyche (self-consciousness and identity).[7] The ability to learn language illustrates pattern recognition that is adaptive from the perspective of consciousness. Simplistically, sound patterns become recognizable phoneme patterns, which become invested with shared meaning (i.e., language). Conscious experience in humans is articulable and communicable because of language. Thinking, especially reflection, is most usually accomplished by means of language.

What young children exhibit as stranger anxiety illustrates pattern recognition that is adaptive from the perspective of the psyche: "[Aversion] to strangers occurs at an age when children first become effectively mobile (are less likely to be carried) and thus this anxiety insures that they will stay close to their parents when they are moving around other people."[8] Stranger anxiety essentially supports family identity and self-identity.

The adaptive capacity to recognize patterns also makes us prone to stereotyping. *To stereotype* comes from the verb meaning the process of repeating or reproducing something without variation. When we stereotype, we ascribe characteristics of one or a few individuals to an entire class, without variation.

For instance, if we ascribe prodigious facility in stringed instrument playing to Asian children, we are stereotyping. If we ascribe limited facility in learning physics to girls, we are stereotyping. Stereotyping derives from pattern recognition—but, it is an attribution of characteristics without allowing for variation. Stereotyping can be stated positively ("Asian children play the violin well") as well as negatively ("girls have trouble with physics"). In both cases, however, it presumes no or few exceptions to the rule (pattern). Where there is stereotyping, there is no acknowledgment of diversity.

Stereotypes arise because there is believed to be evidence of a pattern or support for a potential pattern. If there were any way to devise a study of violin-playing capacity in all children in the world, we might then have evidence of a real pattern. What we probably have, on the other hand, is very visible evidence of very few instances, such as an Asian prodigy who appears with a national symphony orchestra. (Tversky and Kahneman have addressed some of the fallibilities of human reasoning.[9])

Stereotypes and Schemas

Stereotypes of either sort, positive or negative, would be only intellectually interesting if they stayed intellectual. Stereotypes belong to the category of cognitive constructs—specifically, a belief system—or what Valian called schemas: "implicit, or nonconscious, hypotheses."[10] Schemas are the foundations of attitudes, and attitudes are predispositions to behave in a way that supports or confirms our hypotheses.

If we held a gender schema that could be described as "girls have problems with physics," then we are likely to have an attitude or predisposition to behave in a way that supports our hypothesis. Put another way, the danger of an unrecognized schema is that (in this instance) we may be predisposed to discount the performance of girls who do not have problems with physics, to encourage girls not to take physics, to provide limited or no support to girls who have problems with physics, and so on.

Schemas and Labor Market Segregation

Schemas that incorporate stereotypes may be the basis for the pronounced lack of equity in labor markets. Labor markets are segregated—different classes of people are treated differentially—both horizontally and vertically.

Horizontal segregation means that certain industries are characterized by the overrepresentation of classes of individuals (e.g., by gender or race) and by underrepresentation of other classes. If women account for a little less than half (46%) of the overall working population, then we should find that women make up a little less than half of any industry workforce. However, many industries employ more men than would be expected on a population basis (i.e., they "underemploy" women). As the National Science Foundation data showed, women account for 24% of the total S&E workforce (and only 10% of the engineering workforce). Some industries "overemploy" women, such as service industries (e.g., education and health care). Bureau of Labor Statistics data show that two-thirds of those employed in services are women.[11]

Vertical segregation means that, within an industry, certain occupations or positions are overrepresented by a class of individuals. Bureau of Labor Statistics data also show that, within health care (one industry), women are overrepresented in health aide positions: Women account for 77% of all aides. On the other hand, men are overrepresented in the profession of medicine, accounting for two-thirds of all physicians. Vertical segregation is also evident by race. According to the BLS, in 2001, black men accounted for less than 1% of "executive, administrative, and managerial positions."

Horizontally segregated industries in which women predominate, such as health care and education, have lower median weekly earnings than industries in which men predominate. The median weekly earning of therapists (health care) is $788; of engineers (manufacturing), $1142. The median weekly earning of secondary school teachers (education) is $774; of marketing managers (professional services), $1095 (www.bls.gov).

Within all industries, however, women earn less than men: "In 2001, median weekly earnings for women who were full-time wage and salary workers were $511, or 76 percent of the $672 median for their male counterparts."[12] In health care, women therapists earned $782 versus men at $810; in education, women secondary school teachers earned $759 versus men at $826. In professional services, women marketing managers earned $853 versus men at $1219. These pay inequities prompted a U.S. Government Accounting Office (GAO) investigation of women in management, which concluded:

> Controlling for education, age, marital status, and race, we found that in 1995 and 2000, full-time female managers in each of the 10 industries [we analyzed] earned less than male full-time managers.[13]

In fact, the relative disparity in salary for women managers was worse in the year 2000. Instead of declining, the gap in pay had increased. (An important but unmeasured variable was the difference in experience between men and women because of the correlation between experience and pay.)

GENDER DISCRIMINATION

> The National Academy of Sciences (NAS) announced 72 new members . . . , nearly 25 percent of them female, representing the largest proportion of women ever elected. . . . The new members boost the total number of women in the Academy to about 160, or approximately 8% of the 1,922 active members.[14]
>
> A record nine women are among the 42 new fellows elected by the U.K.'s Royal Society this year. Women now make up 4.4% of the Royal Society's total fellowship of 1290.[15]

As the prior data reveal, the diversity of the scientific workforce in terms of national origin, education, and age is offset by the underrepresentation of certain racial minorities (black and Hispanic) and of women. Because a number of analyses over the past decade have revealed serious and systematic failures in science organizations (in both academia and industry) to treat the genders fairly and impartially, I want to focus in this section on gender disparities. This in no way diminishes the importance for the leader of treating all differences (cultural, racial, ethnic, etc.) equitably.

Studies of Pay and Advancement

A 1993 study of salaries in the science and engineering workforce by the National Science Foundation found that the average income of women was 78% that of men. As described by Valian:

> Even among the newest Ph.D.s—those with degrees earned in 1991–1992—women fared worse than men. . . . The lack of parity for new graduates, however, is due to nonacademic employment sectors. . . . But academia does not provide salary parity for even slightly more experienced women. . . . Overall, women scientists in universities and four-year colleges earned about 80% of men's salaries.[16]

The Sonnert and Holton study of the academic career outcomes of men and women postdocs (Project Access) confirmed the existence of pay and advancement inequities in academia.[17] Of scientists who received their PhD before 1978, women were only half as likely as men to become full professors. Men published more articles, although articles published by women were cited more frequently. Career obstacles for women were "small in themselves in effect, but large in numbers . . . [so that] a small set of misfortunes or disadvantages throughout the career accumulated in the same direction, so as to deflect the women in one direction." The data from their study "documented clear indication of a glass ceiling for women in science."

Valian expanded on the notion of accumulation of advantage or disadvantage, which she attributed to gender schemas that result in certain professions (such as science) being perceived as more suitable for men:

> [The schemas'] most important consequence for professional life is that men are consistently overrated, while women are underrated. . . . [Women] and men are equal or nearly equal very early in their careers,

> but . . . men's advantage increases over time . . . [because] men accumulate advantage more easily than women do.[18]

One of the clearest examples of overrating male scientists and their accumulation of advantage was a 1997 study reported in *Nature* of the Swedish peer review system for postdoctoral fellowship applications. Although the reviews were supposedly impartial—that is, judging only the competence of the applicants—the authors found that "peer reviewers cannot judge scientific merit independent of gender." They reached that conclusion because regression analyses of factors influencing the judgment of competence showed that:

> [Female] applicants started from a basic competence level of 2.09 competence points . . . and were given an extra 0.0033 competence point by the reviewers for every impact point they had accumulated. Independent of scientific productivity, however, male applicants received an extra 0.21 points for competence. So, for a female scientist to be awarded the same competence scores as a male colleague, she needed to exceed his scientific productivity by 64 impact points.[19]

Another article published that year, entitled "Female Leaders of Science Report Cracks in the Glass Ceiling," noted that the male culture of science was self-perpetuating in the sense that women were overlooked as suitable for positions of honor or status.[20]

Lack of fair and impartial treatment of women scientists in academia was the topic of a 1999 article in *Science.* Nancy Hopkins (who worked on the mutagenesis of zebrafish) observed that in a "long series of unpleasant incidences that had dogged her 26 years at [MIT] . . . the common thread was gender." Women scientists at MIT and Harvard were described as not "confronting open opposition from institutions [but rather] struggling with subtle inequalities stemming from unconscious attitudes [i.e., gender schemas] of individuals." Despite gains, women academic scientists made up less than 13% of senior faculty (associate and full professors) and left the scientific track more frequently than men.[21]

Women scientists in industry apparently have faced similar barriers to advancement, as described in a 1999 study by Catalyst. Two of the major barriers were "male stereotyping and preconceptions" of women and "exclusion from informal networks of communication," both of which could be attributed to gender schemas:

> The competencies and personal traits associated with successful careers in science—quantitative skills, objectivity, and a singular commitment to work—are generally viewed as male attributes. Traditional assumptions about women are just the opposite—it is said that they lack quantitative skills, are emotional, and place family obligations above work.[22]

Experiences of Expert Panel Respondents

Respondents to the survey discussed in Chapter 1 were not asked to give their names, and none of the questions included reference to gender. However, a number of scientists both identified themselves and described experiences that ranged from blatant gender discrimination to more subtle inequalities resulting in probable accumulation of disadvantages.

For example, one scientist wrote that her most difficult problem was "overcoming the 'old-boy' network. . . . There is favoritism—males vs. females—in terms of salaries and job prospects, and I have had no introduction to more senior scientists in the field." An associate professor said, "I find male grad students often do not listen to me. I also sometimes find myself undermined by [male] colleagues and mentors—even female secretaries." Another woman associate professor noted the "reluctance of support personnel to provide me with the same level of services that are provided to males in the same position as myself."

The disadvantages that could accumulate over women scientists' careers included instances of being ignored and/or overlooked by men in high positions. One postdoc reported, "My advisor ignores me when experiments don't work; refuses to have productive discussions; takes experiments away from me if I don't succeed; and is generally not supportive." A junior faculty said, "when I had a serious problem with a male lab instructor for a course of 500 freshmen students, my chairman chose to look the other way and let me fend for myself." Another faculty member wrote that her most difficult problem was “exclusion from the committees that contribute to the way the department is run.” As one woman noted, “I feel invisible to certain higher ranking faculty.”

Other comments by expert panel respondents revealed the discomfort of women dealing with gender schemas, “male stereotyping and preconceptions,” in their workplace. One industrial scientist observed, “If I am too soft or quiet, then I am not taken seriously as a leader. I need to learn how to assert myself in a leadership position.” An associate professor echoed this experience: “Often, gender issues seem to confuse the situation, making it difficult for me to direct others in ways that are acceptable to them.” Struggling with preconceptions, a young woman scientist just beginning to lead a laboratory said, “I have had a fast career [MD, PhD], and I feel a bit uneasy in my position because the staff appears to see me as a ‘little girl.’”

As the author of a study of women scientists from both academia and industry more recently observed, “Even today, those of us who have made it in science feel the sting of prejudice.”[23]

DIVERSITY AND COGNITION

My final reason for addressing diversity—and the most crucial from the perspective of science—is the link between the diversity of those working in the laboratory and the caliber of thinking (cognition) that occurs in that laboratory. Insight into this relationship comes from cognitive science as well as management science research. One early study of the conditions associated with optimal problem solving of groups showed that, among other qualities, there must be sufficient difference in (or diversity of) approaches, views, perspectives, and so on. With too little diversity, the scope of information search and the quality of the “processing” of the information by the group are degraded.[24] In short, the caliber of thinking is compromised.[25]

Management studies of innovation also reveal that structural characteristics such as complexity (analogous to diversity but at the group or organizational level of analysis) are more strongly related to innovation than environmental and individual characteristics: “This does not negate the role of the individual but suggests that factors such as complexity are crucial in understanding how and why processes such as innovation occur." In these studies, *complexity* was defined as the degree of differentiation or differences in specialization and training of workers. The larger the degree of differentiation, the more complex the structure of the organization.[26]

Studies of creative groups bear out the link between what we might call social conditions (encouragement and promotion of diversity as well as the complexity of the organizational context in which work is carried out) and innovation or caliber of thinking associated with the output of such groups. Many cite the need for contributions that are eccentric to the traditional ways of thinking, for challenge to established notions, and for the friction that occurs when eccentricity and challenge are permitted. For instance:

> Knowledge can be amplified or crystallized at the group level through dialogue, discussion, experience sharing, and observation. . . . [and it is the team that provides] shared context in which individuals can interact with each other. . . . This dialogue can involve considerable conflict and disagreement, but it is precisely such conflict that pushes employees to question existing premises and to make sense of their experience in a new way.[27]

Put another way, "science is fundamentally a way of thinking, and people from other countries think differently," as do people of different races and gender.[28] To an appreciable degree, given the relevant intellectual competencies of those involved, the caliber of science in a laboratory is dependent on the inclusion of people from different countries, from different racial and ethnic groups, and from the minority gender. Tilghman, president of Princeton, noted that "by excluding women either consciously or unconsciously, we are reducing the pool of the most talented scholars."[29] The same can be said about the exclusion of black and Hispanic scientists.

At the same time, of course, mere representation of diverse individuals does not assure inclusion of their contributions. Leaders have to be aware of how "male stereotyping and preconceptions" can even influence scientific communication:

> The commonplace presence of women in the laboratory, and the occasional inclusion of women in management positions, masks one resid-

> ual problem: scientific competence is still judged by male communication styles. Objective, unemotional, assertive. This stereotypic male style seems to be the very essence of research.[30]

Responses from the expert panels cited earlier reflect the reality of women scientists being excluded from important committees, being ignored in the laboratory, feeling invisible to senior staff, and not being taken seriously. These are the issues that leaders must acknowledge and address.

Our expert panel responses, however, also illuminated how leaders can foster and encourage what might be called inclusive diversity. The most effective leader was described as a person who:

- Really listens to everyone
- Includes everyone in the discussions
- Treats all postdocs as colleagues
- Treats laboratory workers as equals
- Creates an atmosphere of mutual scientific exchange in which everyone's opinion is valued, from technician to laboratory head
- Takes in multiple points of view and tries to involve everyone and get them to see the other person's point of view
- Appreciates innovative/novel/different ideas
- Supports unorthodox ways and thinking

CONCLUSION

There are three, crucial, "take-home" ("take-into-the-laboratory") points that I want to emphasize, based on this very brief overview of a complicated subject. First and most apparent to everyone with experience, leaders face the reality of managing an international, heterogeneous (by education and age), scientific workforce. Leaders of such groups have to become knowledgeable about the cultures, customs, expectations, values, and assumptions brought to the scientific effort by those who work in the laboratory:

> Cultural differences in style, expectations, and work attitudes can create misunderstandings that impede the flow of information and the

> development of science. . . . Yet, [most respondents to the survey] say ideas flourish in an international setting and work styles from other countries help keep US scientists on their toes.[31]

Second, leaders have to face the concomitant reality that some potential scholars are now missing from the laboratory (e.g., black and Hispanic scientists). Other potential scholars may be in the laboratory physically but be overlooked because of prevailing gender schemas. If women are present but excluded and/or ignored, then so are their contributions to the "way of thinking" that should characterize the scientific effort. Leaders, both male and female, must become knowledgeable about the assumptions, values, and expectations regarding gender that *they* bring to the workplace as well as what may be the operative assumptions, values, and expectations in that workplace:

> Although most people want to judge fairly, genuine fairness demands that we understand that our reactions to individuals are, inevitably, affected by the group the person belongs to. Our implicit ideas about men and women as a whole condition our reactions to men and women as individuals. Only by recognizing how our perceptions are skewed by nonconscious beliefs can we learn to see others, and ourselves, accurately.[32]

The third point I want to emphasize is that effective leaders use simple tactics to encourage and support diversity in their laboratories. Such tactics include listening, ensuring that each person contributes and is heard by others, and treating everyone as equals. In this way, leaders create that atmosphere of "mutual scientific exchange in which everyone's opinion is valued." The result of these and related tactics, such as appreciating novel ideas and supporting heterodoxy in thinking, should be an improvement in the caliber of cognition and, finally, better science.

NOTES

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3

UNDERSTANDING WHAT MOTIVATES YOU AND WHAT MOTIVATES OTHERS

Imagine this. You wake up before the alarm goes off with a feeling of joyful anticipation about the day ahead. Taking your coffee with you in the car, you arrive at the laboratory and greet your co-workers, who are also arriving early. At some point in the afternoon, you and your colleagues go to the cafeteria for a sandwich, continuing an intense discussion about the experiment that is being planned. Back at your desk, the time goes by so quickly that, when someone asks when you're leaving, you notice with regret that it is already 6:20 PM.

This chapter picks up one of the major themes from the expert panel responses described in Chapter 1: *motivation.* Scientists working for ineffective leaders described themselves and their colleagues as "demoralized." They reported that "morale collapsed in the laboratory" or that their ineffective leader "left people depressed and guilt ridden." Positive motivation was lacking. On the other hand, scientists working for effective leaders described their laboratories as a "stimulating environment" in which everyone "wanted to do a good job." Effective leaders were able to motivate positively those who worked for them. How did they do that?

As the chapter title implies, my approach to answering the question of how to motivate begins by helping you first understand some of what moti-

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vates you and, by extension, what motivates others. The beginning of wisdom and effectiveness as a leader is self-awareness. In addition to a brief overview of relevant theories of motivation, this chapter contains what one scientist called an "eye-opening personal exercise." It is from this exercise that greater comprehension and understanding of yourself may be derived. And it is from these building blocks (i.e., insights) that you will be better prepared to motivate those you lead.

WHAT IS MOTIVATION?

The word *motivation* comes from the Latin movere, meaning "to move"—not in the sense of picking up a beaker and moving it to the sink, but in the sense of being moved to action. This is also the root of the word *motive.* Motives are defined as "relatively stable dispositions to strive for [in other words, be moved to action toward] certain classes of goals."[1]

When the term *motivated* is used in this book, it means that people are moved to the enthusiastic and energetic action illustrated by the above scenario. When people are motivated, there is little they cannot accomplish. Resource constraints? They will find other means. Seemingly intractable problem? They will keep turning the problem on its head and persist until they find a solution.

Being motivated implies that you love your job, literally. Certainly, some days will be closer to the ideal than others. However, in a motivated science organization, you, your colleagues, your boss, and your subordinates should feel pleasurable anticipation about what you are doing, and the time at work should pass quickly and with joy.

Behavioral science research has found that the foundation for developing a motivated group includes the following:

- *Reasonable working conditions.* Safety in the laboratory must be ensured, space must be at least adequate and decently appointed, the required equipment must be available to do the job, and so forth.
- *Competent people trained appropriately for their job.*
- *Assurance of the link between effort and outcomes.* People must believe that their effort will lead to the desired job performance (e.g., discover-

ing the genetic component of a disease), they must believe that this performance will lead to certain outcomes (e.g., project success and personal recognition by their scientific peers), and they must value those outcomes.

- *Equity and fairness.* People must be treated and paid fairly in the organization, as compared with similar organizations.
- *Appropriate challenge.* People should not be asked to perform the impossible, but they should be encouraged to go beyond what they initially see as their limits.[2]

Given the description of conditions (and feelings) of groups working for an ineffective leader, it should be obvious that people will not be motivated if:

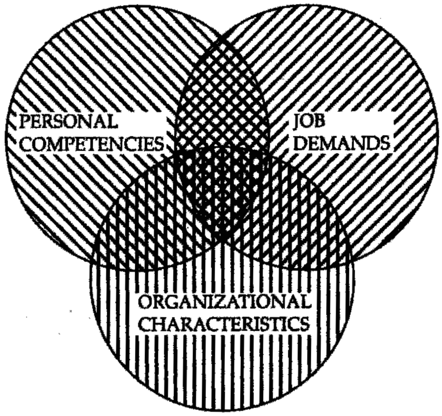
- The situation in which they work is hazardous or fundamentally problematic.
- They are not competent or not trained properly for the job.
- They do not believe their effort will lead to performance or performance will lead to an outcome or they do not value the outcome.
- Their treatment (including pay and benefits) is not fair.
- They are not challenged to excel.

These are commonsense propositions, and I will assume that they are not an issue in your organization. If they are, you must rectify the problems as far as you are able. Pay and benefits may not be under your control, but visibly working to improve them—and any other shortcomings—goes far to improve morale and motivation.

In addition to these basic conditions, behavioral research also indicates that motivation requires a fit among (1) personal competencies, (2) job demands, and (3) organizational characteristics, as shown in Figure 3-1.[3]

I have subdivided the three spheres in the Venn diagram above into *technical* and *human* aspects. The technical aspects of personal competencies, for example, include education, training, and skills. The human aspects include (for example) willingness to take risks, tolerance of ambiguity, work motivation needs, and leadership style. The technical aspects of job demands include those usually listed in the job description, such as specific responsibilities, discipline knowledge, required skills, and experience. The human aspects are

Motivation: The Required Fit



Personal Competencies

Technical Aspects—Education, skills, training, etc.
Human Aspects—Work-motivation needs, leadership style, etc.

Job Demands

Technical Aspects—Responsibilities, experience, etc.
Human Aspects—Patience, diplomacy, good listener, etc.

Organizational Characteristics

Technical Aspects—Structure, systems, etc.
Human Aspects—Culture, etc.

Figure 3-1

usually not listed, but they might include patience, diplomacy, good listening skills, and sense of humor. Technical aspects of organizational characteristics include size, structure, and formal systems. The human aspect is culture. (Organizational characteristics are discussed in Chapters 7 and 9.)

If the basic conditions described earlier are met *and* there is a good fit between technical and human aspects among these three spheres of influence, then visitors should feel the motivation when they enter your laboratory. When people are working enthusiastically and energetically, loving their jobs, the laboratory or science organization will emit an almost audible *hum.*

From experience, I emphasize the necessity of fit between the human aspects of personal competencies and job demands in this and the following chapters. I have found that most of us are sufficiently adept at matching the technical aspects of person and job. Job descriptions and systematic organizational processes can adequately match people to jobs on the basis of education, training, skills, and experience. However, I have observed numerous times that we are generally less adept at recognizing (let alone ensuring) what it means to match human aspects of person and job.

Consider the job of leader of scientists. If I were to write a description of some of the required human aspects (based on the expert panel responses in Chapter 1, Exhibit 1), I might say:

> *Required:* Able to inspire and enliven. Caring and compassionate—recognizes that scientists and technicians are individuals. Listens and communicates well. Patient, tactful, enthusiastic. Sense of humor and sense of fairness. Skilled in resolving conflicts. Well organized and energetic. Able to make tough decisions and stick to them. Content with working behind the scenes in successful times and willing to take the blame upfront in difficult times. Calm, supportive, relaxed, informal. . . .

Or for the job of project leader (discussed again in Chapter 8):

> *Required:* Collegial and collaborative at all times. Able to balance the apparently irreconcilable demands made by the functional managers involved in the project. Adept at living within a matrix structure. Able to handle difficult team members with grace and good humor. Appreciates and deals effectively with the emotionally charged termination of successful as well as unsuccessful projects. . . .

Or for the job of lead scientist:

> *Required:* Able to focus single-mindedly on the problem, no matter what the distractions. Passionate about the science and able to generate

> similar enthusiasm in others. Can sustain hope under conditions of failure and inspire co-workers to persist. Never lets the organization get him or her down. . . .

Helping you better understand how to match the human aspects of the job to those of the person, beginning with yourself, is the objective of this chapter.

UNDERSTANDING WHAT MOTIVATES YOU

Being an effective leader starts with a better understanding of oneself and one's own strengths and weaknesses. We gain wisdom when we learn from mistakes made on the job. We also gain wisdom by being mindful, that is, by means of reflective self-analysis.[4]

Note: Construct validity requires that the exercise that follows be completed and interpreted before reading the subsequent explanation and discussion. Ensure that you have an uninterrupted 60 minutes (at least) to complete the instrument.

Work-Related Needs

There are a number of exercises by which people gain insight into their personality. The one I use in this chapter is based on the work of a number of psychologists, particularly David McClelland. McClelland and colleagues proposed that each individual has a unique ordering of three work-related needs.[5] Each of us has a need for power, defined as a desire to have an impact on people, to influence or to affect the behavior or feelings of others.[6] Each of us has a need for achievement, defined as a concern for doing things better, for surpassing standards of excellence.[7] And each of us has a need for affiliation, defined as a concern for establishing, maintaining, or restoring positive affective relationships with another person or group of persons.[8]

Before you read further, take a piece of paper and graphically portray (using whatever image comes to mind) what you believe is your unique ordering of these needs. Save this illustration.

Look at each of the pictures below and think about the following questions:[9]

1. What is happening? Who are the people?
2. What has led up to this situation? What has happened in the past?
3. What is being thought? What is being wanted? By whom?
4. What will happen? What will be done?

Then, for each picture, write a story that is *continuous and imaginative*—do not attempt to answer each question. Try to write the stories in a relaxed and informal setting, spending about 5 to 10 minutes on each story. There are no right or wrong "answers."

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Figure 3-2

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Figure 3-6

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Figure 3-7

Thematic Apperceptive Measures

The six pictures provided are examples of thematic apperceptive measures of work motivation needs. They provide story-based measures of motives that have demonstrated "greater validity for predicting long-term trends in behavior than have self-reported desires as recorded in questionnaires" (in case you wonder why I did not include a questionnaire).[10]

Thematic apperceptive measures are projective instruments—you project in your writing, or imagine as if objective (e.g., your story), that which actually reflects your internal psychological content. Formal administration of projective instruments probably originated with Hermann Rorschach. In use since the 1920s, the now-famous inkblot Rorschach series has also influenced developments of thematic apperceptive measures such as the Thematic Apperception Test (TAT).

The TAT was developed by Henry Murray and Christiana Morgan. Consisting of a series of black-and-white pictures, the TAT provided the subject with images about which to write a story. A contemporary of Murray, David McClelland is perhaps best known for elaborating Murray's framework and developing a testable theory of work motivation needs described (in Murray's terms) as the need for power (nPOW), achievement (nACH), and affiliation (nAFF). Some of the same black-and-white pictures that Murray used were revised and others have been added to the corpus of techniques to elicit stories of work motivation needs as well as other dynamics.

Although definitely in the category of soft science, work motivation need theory and the thematic apperceptive measures are quite robust and parsimonious. There has been an enormous amount of research dating from the 1940s, when Murray first began using the TAT and including the longitudinal studies of McClelland and colleagues. From this research, we can be assured of "satisfactory test-retest reliability."[11] In addition, comparison studies of subjects who completed thematic apperceptive measures (stories) and questionnaires showed greater validity of the stories for predicting long-term behavior.[12] The general theory of work motivation needs proposes that "a person will engage repeatedly in motive-relevant behavior . . . over the long term" because motives "affect the kinds of situations (activities, careers) people choose to be in."[13] The theory and technique also meet the third criterion described in Chapter 1: They have proved tremendously helpful to leaders of scientists. In my 15 years of using these tools, they have consistently worked well, and I am confident they will benefit your development as a leader.

Interpreting the Stories

To interpret the thematic apperceptive measures, first read through each story and then examine it in light of the guidelines provided, which are derived from the empirical scoring system. The purpose of the scoring system is to indicate which, if any, of the three work motives is present in a story. Actual stories written by scientists to whom I have administered the TAT are provided as illustration. You may discover that your story contains more than one of these motives or none at all.

Power.[14] One or more characters in the story are concerned with attaining, maintaining, or restoring their impact, control, or influence over another person (or group or the world at large). There are three ways in which power can be expressed:

1. A character's actions in themselves express power (such as providing unsolicited advice, affecting another's life by firing or transferring them, or trying to influence or persuade another to change his or her opinion).
2. A character does something that arouses strong positive or negative emotions in others, even if the emotion was not intended by the character (such as a student listening intently to an instructor or a person feeling crushed by a supervisor's feedback).
3. A character is described as having a concern for her or his reputation or position (such as concerned about being perceived as slow and awkward in laboratory techniques or keeping one's title and status in the organization). To "score" as power, a character must be concerned about position or prestige, rather than showing positive or negative emotions about successful or unsuccessful striving.

The following story (of the man at a drafting table in the picture above) reflects the theme of power:

> Mr. Foley is an engineer in an architectural design firm. He was recently promoted to be partner in the firm and, with this new responsi-

> bility, he is working extra hard. He puts in a lot of additional hours, and sometimes he is still busy working late at night. When that happens he misses his family.

The need for power is expressed in this story as *concern for position.* The writer describes the character's action, working extra hard, as prompted by the new responsibility of being promoted to a partner in the firm. Mr. Foley misses his family "sometimes," when he is "still busy working late at night." In other words, the character is not described as feeling positive or negative about what has been successful striving for that new position of partner.

Another story (of the man sitting with glasses/paper in his lap in the picture above) also reflects nPOW:

> Paul is sitting on a return flight, exhausted after his business meeting in another state. He is happily reminiscing about how he confidently pitched his ideas in front of more than a dozen of his peers and won his company a $15 million contract. He can't wait to get home to his family to celebrate his finest accomplishment thus far.

The second sentence, describing Paul's confident pitch (a strong nPOW image) and win (another strong image), is key. Note that the accomplishment, the $15 million contract, is in support of his company. Paul's success will have an impact on the firm.

Achievement.[15] One or more characters in the story are concerned with accomplishing a goal, excelling, or striving toward a long-term feat. Stories that reflect achievement motivation contain explicit or implicit descriptions of a need for mastery as well as affect (positive or negative) related to the possibility of personal success or failure. There may be obstacles to be overcome or something that blocks achievement, and another character may support or encourage the person striving for achievement. Ways in which achievement can be expressed are as follows[16]:

1. A character is concerned about a standard of excellence, such as wanting to do well in competition. Standards are self-imposed, or the per-

son is emotionally invested in attaining the goal. The character states a desire (or a determination or want) for achievement.

2. A character is involved in an activity that is unique, such as an invention or artistic creation. The description indicates an actual striving relevant to that invention or creation.
3. A character is determined to accomplish a long-term goal, such as attaining high scores on medical school admissions tests and receiving a medical degree. One or more characters perform an activity that is instrumental in attaining the goal (or think about what action will be instrumental).

This story of the man at the drafting table reflects the theme of achievement:

> Jim is a brilliant architect who works in a very elegant studio on a high floor. He is still young—35–40. Today, Jim is working a difficult project. He has to get his own ideas to fit under the constraints of the client. The project is dicey, because they are on opposite sides. This is also a very important project with deadlines. Yesterday there was a demanding project as well, for which it was difficult to find a solution. And tomorrow?

In this story, the character of Jim is concerned with accomplishing a goal: a design project with constraints and deadlines. There is an obstacle to be overcome, which is the opposing view of the client. Each of his design projects is unique, demanding, and difficult. Note that there is no mention, in this scientist's story, of the photo of the family (implied, above, by Mr. Foley's missing his family).

Affiliation.[17] One or more of the characters express concern over establishing, maintaining, or restoring a positive affective relationship with another person. There is a warm, companionate quality to the relationship described in the story. The story may also contain a description of one character being separated from another, but the character wants the relationship restored. Ways in which affiliation can be expressed are as follows:

1. A character describes the relationship as *friendship.* Or, the interpersonal relationship is described as warm and companionable, one of mutual interest and sympathetic understanding.
2. A character describes grief or sorrow because of a broken relationship, and the story provides evidence that the character wants that relationship to be restored (or to be forgiven).
3. The story describes parties, visits, reunions, or relaxed times with colleagues.
4. One character consoles, helps, and is concerned about the happiness or well-being of another. Loving, nurturing acts of one character suggest the desire for reciprocation.

The following story of the man sitting with papers and glasses in his lap reflects the theme of affiliation:

> Joe is on his way home from a meeting. He takes off his glasses and leans back in his chair. The clouds look like giant puffballs. It's time to reflect about home and family, friends, pets, the warm welcome awaiting him at the airport. Work is important, but so is relaxation.

In this story, the character of Joe is looking forward to friends, a warm welcome, and relaxation (which he describes as important). There is a "warm, companionate quality" to Joe's interpersonal relationships that reflects a need for affiliation beyond the relationship between him and his family. If the story did not include the word *friends* and the positive emotion derived from thinking about those who awaited him at the airport, it would not be "scored" for affiliation.

As I noted earlier, stories may contain evidence of more than one need. Both stories that follow (describing the picture of two women in a laboratory) provide an illustration of nPOW as well as nACH:

> *The Mentor.* A young chemistry student and her teacher are in the lab performing an experiment. This student is here on her own accord. It is the afternoon, and classes are done for the day. The student truly enjoys chemistry and actually stays late after school every day to observe and assist the teacher in numerous experiments. However, at this mo-

> ment the student is not concentrating on the experiment per se, but the teacher especially. The young girl admires the teacher and has taken an interest in the subject because of this. She watches the teacher's enthusiasm for the subject and her enjoyment working the lab. The teacher has fostered this interest by allowing the girl to partake and teaching her. The girl looks at the teacher and knows that this is the career she wants to follow.

In the above story, both the title and the first sentence reveal nPOW (the desire to influence, or to have an impact). A mentor is an *experienced counselor or guide,* and is by definition a person desirous of influencing the protégé. The story combines the roles of mentor and teacher in one character and states explicitly that the teacher has fostered this interest in her student—in other words, has influenced the student so that she *truly enjoys chemistry.*

The description of the student reveals nACH. This student has set her own standard of excellence and desire for mastery ("here on her own accord . . . stays late after school every day"). Moreover, the last sentence implies this will be a long-term involvement.

The same combination of needs is illustrated by the following story:

> Annette is an accomplished geneticist, working on the human genome project. She is well known in the scientific community for her prolific writing. Su-Kyeong, who originally thought that she had landed the internship of a lifetime, has found it difficult to work for and learn from Annette. Annette makes her nervous. She is demanding and can be demeaning. Su-Kyeong, who has always been an outstanding student, has never felt so inept. While working on her most recent project, several issues have come up. Although fearful of the response, Su-Kyeong feels she must ask Annette several questions.

In this story, the relationship between teacher and student is not so benevolent (Annette appears, according to the criteria of Chapter 1, to be an ineffective leader). The actions of the character of Annette, however, express power (in the story, she is described as being demanding and demeaning). She is also a person of power, insofar as she is well known, accomplished, and prolific.

Clearly, negative emotions are aroused in Su-Kyeong, also consistent with the scoring guidelines (the character does something that arouses strong positive or negative emotions in others even if that was not intended).

Su-Kyeong's actions, especially the assumed *competition with a standard* that resulted in this "internship of a lifetime," reveal nACH. We are told that she is an outstanding student but, under Annette, has never felt so inept. Despite the negative affect, Su-Kyeong apparently will master her fears and ask Annette several questions in order to accomplish her goals on her most recent project. Su-Kyeong is clearly striving towards a long-term feat, and there are obstacles to be overcome (her fear of the senior scientist).

When you read your own stories again, underline key words and phrases and then transcribe them to another sheet of paper under the heading that best fits the work-related need (power, achievement, affiliation). Some key words and phrases to look for include:

- *Power* (titles, instrumental activity to influence or inspire, concern with organizational action or success, career position and prestige, strategy)
- *Achievement* (numbers, means–end statements, winning, doing as well as or better than another, concern with how well a task is being performed)
- *Affiliation* (friends, statements describing emotions about relationships, helping, need for positive response from another)

If you find more than one need expressed in a story, try to approximate the proportion of the story that reflects each need. For example, the story of Annette and Su-Kyeong contains eight sentences. The first two describe Annette—the figure illustrating nPOW. The next six sentences are written from the perspective of Su-Kyeong, but two of the six deal solely with Annette and one describes Su-Kyeong's negative affect (feeling "so inept") in response to Annette. Thus, I would estimate the story to be two-thirds nPOW (five sentences, including the first two, referring to the need for power) and one-third nACH (the remaining sentences about Su-Kyeong's need for achievement).

If it is difficult for you to find any reference to work motivation needs in a story, focus instead on what the other stories reveal. What is important is that you gauge from the stories taken as a whole what your unique ordering of needs might be.

When you have read and reread your stories, written the key words and themes on a worksheet, and compared the stories with the examples, again graphically portray what they illustrate as your unique ordering of motivation needs. Compare this with what you initially deduced. Are the illustrations different? (They usually are.) After you interpret the material, you might ask at least two people to read the stories and then reflect on your own and their interpretations. Getting an outside perspective is very useful.

SOME IMPLICATIONS OF THE THEORY

Our ordering of work-related needs, in particular our dominant need, constitutes a major human aspect of our particular personal competencies. McClelland and colleagues have made a number of observations based on longitudinal studies of people on the job. With regard to power, people with a high nPOW[18]:

- Were less willing to compromise in a two-person situation
- Acted from a basis of legitimate interpersonal power
- Seized opportunities to make decisions and influence others
- Had greater managerial success

The researchers found no evidence of gender differences.

With regard to achievement, people with high nACH[19]:

- Wanted to feel personally responsible and have a high degree of self-determination in their work
- Persisted in their task
- Preferred individual problem solving and tended to surround themselves with other experts
- Had greater entrepreneurial success

The researchers again found no evidence of gender differences. They found that monetary rewards did not appear to be strong incentives for people with high nACH. Rather, such individuals valued money instead for the information it provided on how well they were doing in their work.

With regard to affiliation, people with high nAFF[20]:

- Quickly learned social networks
- Spent more of their time interacting with others
- Communicated more intensively
- Preferred affiliation-oriented rather than company-oriented feedback
- Believed that goodwill was more important than reason in solving problems

In one study, when subjects were randomly beeped during the day, those with high nAFF were more likely to be found interacting with others. In another study, people with high nAFF were observed to select working with friends over working with experts. Again, no gender differences were found. Interestingly, however, there was "some evidence that the level of affiliative motivation decreases across the adult life-span for women, whereas it remains stable for men."[21]

Of course, these three motives or needs (as well as others, which are outside the scope of our discussion) exist in some unique "mixture" in every person. Thus, the dominance of one motive and the interrelationships among them in terms of strength are also variables of interest. Research that took into account the mixture of work motivation needs showed that[22]:

- People with high nACH and high nAFF were observed to be more conscientious and socially responsible.
- People with high nACH and low nAFF were found to perform better when they were given feedback on how well they were doing.
- People with high nAFF and low nACH, on the other hand, did better when they were told how cooperative they were.
- The nPOW and nAFF motives are generally negatively correlated.

Based on the decades of research that have examined work motivation needs and actual behavior on the job, we can draw a number of general conclusions. Perhaps most importantly, the ordering of needs is a stable part of your personality. It does not change over time or with different types of work experience (i.e., one cannot "grow" one's need for power by moving into general management). Your ordering of needs is a very good predictor of long-term patterns of behavior, although not necessarily of a single action or of behavior over the short term.

As stated above, McClelland and his colleagues found no gender differences in the ordering of work motivation needs. Thus, if we were to ascribe a greater likelihood of a dominant need for affiliation in women versus men, we would be using a gender schema (compare Chapter 2) that was false. If we were to ascribe a lesser likelihood of a dominant need for power in women versus men, we would be using a false gender schema, and so on. The hypotheses on which we based our treatment of women and men would not stand scientific scrutiny in this regard, and the attitudes deriving from these hypotheses might predispose us to behave in unfair and biased ways.

The research also shows that people with a high need for achievement are critical to the scientific and technologic progress of organizations. They do well as individual contributors but are generally not interested in managing others. People with a dominant need for achievement are primarily interested in how well they are doing, not how well the organization is doing. In contrast, people with a high need for power are associated with making dramatic organizational innovations and with bringing about radical change. They are likely to seek positions of leadership and to be impatient with positions that do not give them scope for influencing others. People with a dominant need for power coupled with a low need for affiliation may be able to make difficult organizational decisions without worrying about being liked or disliked because of their decisions. People with a high need for affiliation perform best when the demands of their job enable them to satisfy their need for establishing and maintaining positive working relationships (e.g., middle and project management). However, they may be anxious about how well they are liked, and they may violate larger group norms (e.g., the division) in favor of the small group that they manage (e.g., a project team). What do these findings mean for you?

If you have a high need for power, you are likely to enjoy leading a science organization and unlikely to be happy (motivated) in a job that does not provide you with opportunities to be influential. If you have a high need for affiliation, you are also likely to enjoy leading others, particularly in positions requiring a high level of interaction, and unlikely to be happy (motivated) in a job in which you work essentially alone. If you have a high need for achievement, you are likely to enjoy conducting your own research, working primarily as an individual contributor, and unlikely to be happy (motivated) in a job in which your primary task is leading others in non-science activities (Chapter 1). These are just guidelines, because we have a combination of many needs, but they are important guidelines that are referred to throughout this book.

Consider again the Venn diagram presented earlier and the two top spheres of personal competencies and job demands. Assuming that the basic conditions listed earlier are met (e.g., safety, equity, goal challenge), your own motivation—loving your job—depends a good deal on the proper matching of both the technical aspects of your job with your technical competencies *and* the human aspects of your job with your work-related needs.

Are you in the right job? Perhaps you have been struggling with the job and wondering about your career. If the fit of the human aspects is not quite right, you may be able to restructure your job and improve the match. For example, if you have a high need for power and a low need for affiliation, you may want an assistant with a high need for affiliation to focus on the human relationships within your organization. Or, you might ask to take on responsibilities beyond the job description that allow you scope to do what you love to do and not detract from your current task. Or, you might begin a discussion with your boss to plan a career path that will put you in a position for which you are better suited. Or, you might change organizations or change jobs.

RECOGNIZING WHAT MOTIVATES OTHERS

Short of becoming an expert in administering and interpreting thematic apperception measures, what can you do to understand better what motivates other people, such as your boss, your colleagues, or your subordinates? You can observe their behavior over time and listen to them. The insights you have gained from a better understanding of yourself will also help, as will analyzing the following case study of three scientists and the careers they chose.[23] As you read the case study (based on real but disguised individuals and using their modestly disguised verbatim conversation), ask yourself what each person's order of work motivation needs might be and consider the "evidence" for your conclusion.

Three Scientific Careers

In early 1990, Shelly and Geoff, two PhD biochemists from the same university, went to work in the R&D division of a large multinational corporation. Shelly came directly from a postdoc position and was immediately impressed with the corporate research facilities:

> The university laboratory in which I'd been running my experiments had only the "bare bones," so I was constantly scrounging equipment from other departments or buying it myself. When I first went to work in the corporate R&D facility I thought: "Here is everything I could possibly want. It was like a science fiction movie with all this fantastic equipment!"

Her colleague, Geoff, recalled something quite different:

> I think there were about 200 people in R&D and we all got to know one another very quickly. I also recall that there were no formal distribution lists for information—you got it over coffee in the morning or at lunchtime when everyone sat together, managers as well as technicians. We all knew each other, from the most junior person to the most senior manager.

About 4 years later, the director of R&D who had hired Shelly and Geoff decided to move to a smaller, more entrepreneurial firm. Shelly had made a major scientific discovery, resulting in a compound (prescription drug) expected to earn enormous profits. However, she was kept on a project looking for successors and was becoming bored. The director was readily able to persuade both Shelly and Geoff to join him at the smaller company, where he had the opportunity to build a world-class technology capability.

At the new company, Shelly applied her earlier strategy and logic to another medical problem, and Geoff worked in a related department. All went smoothly until about 2 years later, when the director accepted a position in Asia and chose Geoff to succeed him as manager. For Geoff, the result of that promotion was initially traumatic:

> I don't mind admitting that this was one of the most difficult periods of my entire working career. Not only was I suddenly moved from a bench position to management but also the relationship Shelly and I had became very tense because of my promotion. Although we didn't talk about it, I could see that she was hurt and furious at being "passed over."
>
> When I think about what my boss did, and I truly believe he made the right decision, I wonder if I could have done the same at that time. Shelly is undoubtedly a better scientist than I. But I was the better choice for manager, because I soon discovered how much I enjoyed it and how well I accomplished it.
>
> That is, I enjoyed it after Shelly and I began speaking to one another again. I'm still not sure, if it had been up to me, that I would have been able to make this decision. Shelly and I both suffered. Although we eventually resolved our problems, it took three difficult months for us to sort it out.

It was obvious to Geoff that Shelly was on the verge of another breakthrough discovery, but their firm was struggling. Earnings had been flat, and there were no new drugs likely to be ready for several years. As a result, corporate management began to put pressure on Geoff to stop the project, but he demurred. Shelly was only partly aware of these company pressures:

> Well, I knew something was going on when corporate management showed up in the laboratory. They didn't say anything; just walked around with Geoff in tow.
>
> Geoff let us continue to work on the project. In fact, I don't re-

> member any decisions one way or the other. The truth is, I just went on working for several more years. Perhaps Geoff or someone went to headquarters to support us, but I was happily unaware of this. As long as our salaries were being paid, as long as I had all the technicians I needed and the right equipment, I just kept on with the experiments.

In 2000, Shelly and her team delivered a paper that made it clear how important their achievement was in the field. Even though the actual product would not be on the market for several years, Shelly decided to leave the company and go back to a university:

> Yes, I enjoyed the work at the two companies, but I left because, once I have solved the problems in principle, I need to move on. I did not want to find myself typecast as expert in only one particular field and being bored by having to find successor products.

When Geoff described his tenure as director, he was quite honest about the conflicting emotions he felt:

> During this period I had terrible indigestion, all the time, from stress. When Shelly left for the university I was very upset to lose our most creative researcher. But she said to me, "Look on the bright side. You'll feel so much better when I leave." She was right. But of course I would work with Shelly tomorrow, even if it meant a return of that stress and gastric misery.
>
> I discovered as a new manager that my staff could be divided into two groups. When I heard that anyone from the first group had an appointment with me, I would look forward to a nice, friendly discussion. But I also discovered that, when they walked out of my office, I was usually no wiser than before they came in.
>
> The second group of scientists was very small in number, for which I was grateful. When I heard they had an appointment, I would fantasize about disappearing before they came in because I knew they were going to be blunt—quite outspoken about what I had or had not done—and they were going to be demanding. But I soon learned that

when they left my office, I was definitely a wiser manager. They were the people I and the company needed, even if I did not want to admit it then, and Shelly most certainly fell into that category.

Towards the end of 2000, Geoff hired Ichiro Naiti, a PhD working in a government defense laboratory, as replacement for Shelly. When Ichiro described his impressions of the company, the attraction was clear:

> For the first time in my experience I saw an organization in which chemists and biologists worked together, really collaborated. And, they had come up with a tremendous breakthrough.
>
> I was brought in initially as Shelly's replacement, but I had an agreement with Geoff that, if all went well, he would promote me to assistant director. In fact, six months later he made me his assistant.

Today, Shelly is running a large academic laboratory, Geoff is working as head of global R&D for another large multinational, and Ichiro moved to New York to run a small venture capital firm. When asked about their respective careers, each responded as follows:

> *Geoff:*
>
> I still envy people like Shelly who have made important discoveries. I ask myself, "What have you achieved?" And, all I can answer is that I am a manager. Now I have to get my technical pleasures vicariously: talking to my staff, hearing what they're up to, reading their work.
>
> I discovered that I like making decisions, influencing the direction of large groups of people. I like contributing to the success of the organization in the broadest sense. I like being a manager. Although I'm envious sometimes when I read about what people in research laboratories are doing, I've long since come to terms with being a manager.

> *Shelly:*
>
> What I want to find in my research activities, whether I'm in industry or academia, is not to do whatever I please. I look for specific goals. I also look for constraints and restrictions because I think that is how I

succeed. I have noticed that, whenever people decide that no constraint is going to stand in their way, nothing does.

When I was in industry I had no idea what would be profitable, but I could say if the problem was only wishful thinking. I still cannot predict if anything coming out of my experiments will be profitable, but I can say with certainty that this is the way to tackle the problems.

Ichiro:

I had no career plan that involved industry, but I was becoming bored with my government job. I know that I'm a capable scientist but I'm not a very creative one. So when I moved to [the small entrepreneurial firm] I did not regard my career as going from science to management; I regarded it as a move to science management. What I was glad to do was move out of the laboratory.

I discovered in that first industry job that what really fascinates me is having an idea about strategy and then bringing all the bits and pieces together to attain the strategy. That is what is so interesting about this venture capital organization. When you're in a job in which you can integrate and manipulate the bits and pieces and use a lot of input to make strategy happen—that's what I love.

Analysis of Work-Related Needs

Although Shelly, Geoff, and Ichiro are about the same age with similar backgrounds and work experience in the same company, each has a different dominant work-related need and, therefore, exhibits a different human aspect within his or her personal competencies. They also followed quite different career paths that were consistent with their dominant needs.

Shelly exemplifies the scientist with a dominant need for achievement. As you have inferred from the case, such a person sets her own goals, persists as long as it takes to reach them, and is not easily distracted ("I was happily unaware . . . I just went on working"). However, such a scientist must be kept challenged or she will leave. Both companies failed to keep Shelly motivated because management tried to typecast her after her success (i.e., keep her working on the development of second- and third-generation compounds).

Shelly loves to be the solo contributor and does not enjoy leading people other than those who work on her projects. She is quite uninterested in spending time dealing with "people problems."

My graduate students said this about Shelly:

> Shelly is very focused on her work and achieving goals that she sets. She designs and carries out her own experiments. While at the university, instead of trying to influence the faculty or administrators to increase funding for better equipment, Shelly scrounged up equipment or bought it herself. Once at the R&D facility, where there was an abundance of impressive equipment, instead of thinking, "What an amazing organization!" she thought, "Here is everything *I* could possibly want." At the smaller company, Shelly continued in the same vein, focused on a medical problem. She admits that she was happily oblivious to management issues. She didn't even care to find out what was going on when she saw Geoff in the lab with members of the corporate management. She showed no interest in the financial health of the company, as long as she received her salary and she had the staff and equipment she needed to complete her work. She was obviously very focused on achieving her goal with no interest in how the company was doing. Once she did present her results, and it was clear that they were significant, it was not important to her to stay until the product was developed. She had attained her own personal goal. It was time to move on. Shelly's decision to work in the academic setting was not surprising. In this setting, she could continue to pursue very specific goals, without thought of profitability or how her work was affecting or influencing the financial status of a company.

Geoff exemplifies the scientist with a dominant need for affiliation, as evidenced by his focus on work relationships and his distress when Shelly was upset over the decision to name him manager. He was also distressed whenever he had to deal with people from that "second group" who, he knew, would be "blunt" and "outspoken." He does have a secondary need for power, but it is likely to be relatively small (based on the research showing a negative correlation of nPOW and nAFF). Geoff's need for power is reflected in his statements about liking to influence large groups of people and in his ability to manage his bosses (persuading corporate management not to discontinue Shelly's project) and to shield his scientists from what he felt were inappropriate corporate pressures (so that Shelly was unaware of any decisions about her project).

These same students, above, said about Geoff:

> Geoff's focus, upon arriving at the corporation, was people and the manner in which these people communicated. He immediately made connections with everyone, from technicians to managers, from most junior to most senior positions. He quickly learned the social network—that information was shared through informal gatherings, while drinking coffee and schmoozing in the morning or during lunch. All of these actions have an affiliative quality to them.
>
> When Geoff was promoted to manager in the smaller company, he was most concerned about how this affected his relationship with Shelly, once again showing nAFF. He admits that this was one of the most difficult periods of his working career, because he was concerned about restoring his positive relationship with Shelly. He recognized that her feelings had been hurt and that she was furious, but he notes that they BOTH suffered. He evidently was committed to restoring the relationship, because after some months the issues were resolved (and, assuming Shelly's low nAFF, we can infer that the reconciliation was a result of Geoff's efforts).
>
> Geoff, believing in the importance of Shelly's work, and probably not wanting to disappoint her, placed the importance of his relationship with Shelly above the welfare of the company, showing again his nAFF. Geoff was getting pressured by upper management to stop Shelly's project. Even though it was promising, it would not produce any financial benefits to the company for years. It probably would have been better for the company to stop the project, but Geoff followed his nAFF tendencies instead and kept the project alive.
>
> Geoff mentions how difficult it was to meet with various staff members. He was intelligent enough to know that those staff who challenged him, with whom it was difficult to meet because of conflict, offered him invaluable insight. However, he hated the process because he disliked the conflict so much. He was so stressed by the diffi-

culty of maintaining positive relationships with everyone that he had terrible indigestion. He admits, however, that he would choose the discomfort over losing someone like Shelly.

Geoff looks upon his career with some regret. He obviously has great respect for such individuals as Shelly. He feels that his position as manager is less important than what she is able to accomplish. He doesn't seem to think that his position is one of prestige. He certainly is not reveling in any visions of grandeur. Instead, for pleasure, he resorts to turning to his staff to hear about their achievements and accomplishments. Geoff has a secondary need for power. He states that he enjoys making decisions and influencing the direction of large groups of people. He says he likes contributing to the success of the organization. One must assume that he is effective in what he does, since he is the head of a large, multinational R&D company. However, his dominant work motivation need is affiliation. Making decisions and influencing others has come at a personal cost (stress, indigestion, difficulties with conflict). He probably does well making decisions, if he doesn't know the people who are affected by his decisions (e.g., Shelly).

Ichiro exemplifies the scientist with a dominant need for power. He is not happy working in a laboratory as solo contributor; he prefers to think about strategy. He is most attracted to jobs that allow him to bring "all the bits and pieces together," so that his current position as head of a venture capital firm is very exciting for him.

The dominant work-related need of each of these scientists was clear from their description of their first job in industry. Shelly recalled the equipment and the facility in which she could run her experiments. Geoff recalled the people—knowing one another no matter what was one's place in the organizational hierarchy. Ichiro recalled the organizational structure and then commented on his own career expectations.

Imagine that you are recruiting and you interview these scientists. To understand what motivates people, listen carefully to how they describe their experiences. What do they talk about? What do they like? What don't they like? What did they do well?

Consider Shelly. Her means–end focus is apparent (the equipment at the first corporation, the resources and technicians at the second). What is she looking for? Goals, constraints, restrictions, commitment. Why did she leave the two companies? Because she did not want to be typecast. A scientist like this will be motivated as a solo contributor if kept challenged. If you can keep the high-achievement-need scientists challenged, you can almost guarantee the technical progress of the science organization.

Consider Geoff. His focus on people is as apparent as Shelly's focus on things. Geoff described his first job in terms of people as well as his current job (getting his technical pleasures from talking to people). He also handled the difficult situation with Shelly (when he was first promoted to management) so competently that she not only did not leave immediately but also went on to make a second important discovery. Of course, the stress of dealing with these difficult situations can take its toll physically. A scientist like this will be motivated in a position that allows him or her to focus on interpersonal relationships.

Finally, consider Ichiro. His focus on organization and strategy is apparent in his description of his first job in industry. He took over a large department very early in his industry career and was so successful that he was soon promoted to senior management. A scientist like this will be motivated in a position that puts him or her in the "big picture" and allows scope for working on change and strategy.

Is there a personality "type" that is recognizable? There is indeed a type, but it comes packaged in a variety of ways. There is no easy surface indicator of this aspect of personality. You cannot discern work motivation needs by examining only external aspects like dress and social behavior. You can discern work motivation needs by listening carefully to people and observing the patterns of their work behaviors over time.

SOME MANAGEMENT IMPLICATIONS

We will be motivated when the basic conditions of work are met and the human aspects of our job fit the human aspects of our personality. Some of us stumble into the right job; others correctly choose the position; still others are in the right job but choose or are moved to one that does not suit them. When there is no longer a fit between personal competencies and job demands, the joy goes out of our work. We may delude ourselves for a time with title, prestige, or money, but fundamentally we will not be happy (motivated).

One common mistake made in science organizations is promoting a person to a management position on the basis of scientific or technical performance without taking into account the fit (or lack of fit) between the human aspects of the job and the individual's work-related needs. If the organization is lucky, the individual discovers that managing is what he or she really loves to do. In other cases, however, the scientist is first pleased and then increasingly frustrated at being away from the science. Some try to maintain their bench experiments, but then both the science and the management suffer.

Scientific or technical "ladders"—titles and positions and rewards for scientists that parallel the management track but do not carry management responsibilities—may be appropriate. Of course, the parallel ladder must be just that—parallel. If the organization really does not value scientific and technical achievement as much as business accomplishments, then the accoutrements of the ladder are a sham. If your organization is fortunate to employ a "Shelly" and you want to keep her, then you must keep her challenged and rewarded with meaningful acknowledgments (including pay and benefits) that are visible to the entire organization.

If you are managing and believe you have unmotivated scientists, consider moving them around to tasks that better fit their personal competencies. If there is no possibility, then a serious discussion of other career moves is in order, before the person becomes truly demoralized and erodes the morale of the whole organization.

If you are thinking about promoting a scientist to management and after reflection believe that the person has a dominant need for affiliation and would enjoy the position, then consider the type of training you should provide. What will be difficult for this person at first are the decisions that hurt some people, as exemplified by Geoff's realization that he might not have been able to promote someone like himself rather than Shelly to management.

If you are in the right job, is your boss? A crucial management task is managing up as well as across and down. Perhaps your boss was inappropriately promoted from the bench to management. Your job, then, requires that you "interpret" the person for your staff and perhaps for others in upper management. You might have to "think for two"; that is, take care of your own responsibilities and consider what your boss should be doing and attempt, diplomatically, to coach and suggest. In the case of a high achiever promoted to management, you might recommend an assistant with a dominant need for affiliation and think about how strategic leadership might be provided by a team or task force that includes your boss plus someone with both the desire and the work-related need for power.

SUMMARY

How do you motivate others? At this point in the book, we will present some guidelines you might follow. First, ensure that the basic conditions of work are met (safety, equity, training, and so on). Second, understand yourself better and what is important to you about the human aspects of your job (e.g., influencing others). Third, work hard to ensure that the human aspects of those who work for you are matched as well as possible to the human aspects of their jobs. As leader, you appreciate the necessity to meet people's deeper needs—for power, achievement, and affiliation—as well as to provide the vision, focus, and challenge for them to complete the scientific and technological tasks.

NOTES

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19. McClelland and Koestner, op. cit.
20. Koestner and McClelland, op. cit.
21. Koestner and McClelland, op. cit., p. 206.
22. McClelland, op. cit.
23. All stories used in this book are written by me as composites of actual people and events and are not meant to resemble particular persons or organizations.

4

UNDERSTANDING YOUR LEADERSHIP STYLE AND THAT OF OTHERS

Leading, as emerged from the expert panel responses presented in Chapter 1, involves directing others in a course of action, in decision making, and in problem solving (among others). For example, as described by a postdoc, the most effective leader was “a great . . . manager. He held regular group meetings . . . kept everyone focused . . . [and] spent a lot of time in the lab talking with us individually about the work.”

Leading also involves being a role model, mentor, and inspiration to others. The most effective leaders were often described as “highly enthusiastic and motivating through enthusiasm,” as “affable and calm—supportive and a constant presence,” and as “able to inspire and see the best in everyone.”

In short, leading involves both *doing* and *being.*

Chapter 3 focused on leadership from the perspective of being, insofar as it dealt with those attributes of personality defined as work motivation needs. This chapter focuses on leadership from the perspective of doing. More specifically, the chapter is concerned with your style of directing people, your style of making decisions, your style of solving problems—in fact, your style in just about all the activities required of a leader, including com-

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municating and resolving conflict. How you naturally—that is, without much prior thought—go about these activities of leadership (the doing) can be defined as a style that is particular to you. Of course, being cannot be removed from doing, and I will illustrate the relationship between work motivation needs and leadership style later in the discussion. Below, I want to provide a brief introduction to behavioral science theories of leadership and the research on which this chapter is based.

THEORIES OF LEADERSHIP

Not surprisingly, interest in leadership stemmed from military concerns, particularly around World Wars I and II. Could potential military leaders be identified by psychological testing? In other words, were there key personality traits that could be discerned in recruits? Or, could training develop skillful leadership behaviors in individuals?

The expert panel responses in Chapter 1 reflect the natural bifurcation of perspectives on leadership into what I called being and doing. Social scientists also examined both perspectives over the decades, prompted by the rising interests of industry rather than solely the military.[1] Much early research (until the late 1940s) examined being, or the *traits* of a good leader. Studies attempted to identify attributes of personality (including those that could be measured by psychological instruments) that were reliably associated with good leadership—as defined by some measure of group performance and/or satisfaction—but to little avail. Another tack, from about the 1940s through the 1960s, examined specific *behaviors* that might be reliably associated with good leadership. What these studies found, however, was that behaviors associated with success in one instance were not necessarily associated with success in a different situation.

A more promising approach to leadership was the proposition that neither trait nor behavior alone determined effectiveness. Rather, the situation in which the leader acted was also an important variable. As suggested by the results of the behavior school of leadership, above, effectiveness appeared to be contingent on particular aspects of the leadership situation. Hence, this later school of thought was defined as the contingency school.

Both traits and behaviors are important to examine. As the work of Murray, McClelland, and others addressed in Chapter 3 illustrates, people who are effective leaders have a personality trait defined as a need for power (either dominant or secondary). Trait is necessary, but it is not sufficient. What the behavior school of research highlighted was that effective leaders were also skilled in two broad classes of behavior: initiating structure and consideration. The latter behaviors were described as two types of *leadership style.*

The first class of behaviors involves "planning, clarifying jobs to be done, and emphasizing the need to get work out."[2] This style (also called *job centered* or *task focused*) was reliably associated with higher productivity, of individuals and groups, than when there was no initiation of structure. The second class of behaviors involved actions taken "to perceive the human needs of subordinates and to support subordinates in their own attempts to satisfy their needs."[3] This style (*employee centered* or *relationship focused*) was reliably associated with higher satisfaction of employees. But, the relationship between satisfied people and productive people was not clear. Research conducted by proponents of the contingency school did reveal that neither style was more effective under all conditions; rather, each style was more effective under particular conditions.

Scholarly controversy and ambiguity of results hampered the ability of social science scholars, management educators, and consultants to be "safely" prescriptive. It was safe (i.e., backed by reliable data) to prescribe that leaders must initiate structure rather than leave people to flounder in their work. It was also safe to prescribe that leaders must be considerate rather than completely ignore the needs of workers—safe but not especially helpful.

Responses from the expert panel (Chapter 1) clearly reveal that effective leaders must initiate structure—by organizing work, supporting people's efforts to plan their projects thoroughly, holding informative meetings in which various approaches to the problem can be examined, and so on. The responses also clearly reveal that effective leaders must be considerate—by ensuring good rapport among staff, caring for individuals, praising jobs well done, and so on. The vital question is: When is each style appropriate? An equally vital question is: Why?

Leadership Style and Task Structure

A 1997 study noted that the "Contingency Model of Leadership Effectiveness (Fiedler, 1967) is widely recognized as being one of the most fully developed theories of leadership."[4] Fred Fiedler, on the faculty of the University of Illinois, had proposed that the effectiveness of a leader depended on the right match between leadership style (task or relationship focused) and three characteristics of the situation: (1) leader–member relations, (2) task structure, and (3) power position. The first characteristic "refers to the degree of confidence, trust, and respect that followers have in the leader."[5]

The second characteristic refers to[6]:

- The degree to which the job's tasks and duties are clearly stated and known to the people performing the job.
- The degree to which problems encountered in the job can be solved by a variety of procedures. . . .
- The degree to which the "correctness" of the solutions or decisions typically encountered in a job can be demonstrated by appeal to authority, by logical procedures, or by feedback. . . .
- The degree to which there is generally more than one correct solution. . . .

Tasks based on these criteria can be generally divided into those with high structure ("tasks and duties . . . clearly . . . known," a small number of possible solutions, demonstrable correctness of solution) and those with low structure (tasks and duties vaguely known, many possible solutions, and correctness not readily demonstrable).

The third characteristic, position power, refers to the formal authority of the leader "to make decisions and to exact obedience from subordinates."[7] Fiedler defined eight possible combinations (termed *octants*) related to situational favorableness. They were composed of position power (strong or weak), task structure (high or low), and leader–member relations (good or poor). He and later researchers examined hundreds of groups in military, educational, and industrial settings to determine whether one leadership style (task or relationship) was more effective and under what conditions.

Despite the numerous studies and despite its popularity, the results obtained from Fiedler's model remained controversial. However, a meta-analysis of those streams of research involving more than 4000 subjects across numerous studies reached a more positive conclusion. The authors of this study found that "there is more than sufficient evidence to conclude that the contingency model warrants further investigation . . . and the findings presented here . . . should be viewed as providing cautious support for the contingency model overall."[8]

My reason for discussing this model, particularly leadership style and task structure, is that the meta-analysis revealed the following: A task-focused style is much more effective than a relationship-focused style *when task structure is high,* and a relationship-focused style is much more effective *when task structure is low.* (Taking into account leader–member relations and position power, the results are more ambiguous and thus are not discussed here.)

I can now begin to answer the earlier questions (when is each style appropriate and why) by providing general examples of *high-structure* and *low-structure* tasks faced by scientists.

Consider initiating a research project in an area new to your laboratory, although published work has indicated such a project is feasible. Although the work is new to the scientists in your group, you can (by examining the published literature) generally specify the required steps and are confident that your group can undertake them. In other words, the "tasks and duties are clearly stated and known to the people performing the job." There exists a framework to solve problems because there are data on methodology and approaches ("problems encountered in the job can be solved by a variety of procedures"). Finally, your group's success can be demonstrated by comparison of the results with the published work ("the 'correctness' of the solutions . . . can be demonstrated by appeal to authority"). Under these conditions (high task structure), leadership research supports an approach that is job centered, or task focused. As leader, you should begin by planning, clarifying the jobs to be done, and emphasizing the need to get work out.[9]

Now consider starting work in an entirely novel area of research in which there is little or no published work on methodology, approaches, and outcome. Because this is a novel area of science, the tasks will be only vaguely known and understood by the researchers; it is likely that there will be many ways to go about solving the problems that will arise, and the correctness of the solution cannot be demonstrated by comparison with existing work. Under this condition of low task structure, leadership research supports an approach that is employee centered, or relationship focused. As leader, you should begin by understanding the *human needs* of your group and supporting "their own attempts to satisfy their needs."[10]

Why? To many people, the opposite appears to be intuitive—when task structure is low (they believe), the leader *should* plan, clarify, and emphasize getting the work done. The explanation for the difference in effectiveness of leadership styles is based on research on cognition and communication (information processing).[11] A task-focused style imposes structure (procedures, methods, algorithms) on a situation—hence, the earlier term *initiating structure* to describe the first class of leader behaviors. When the level of task structure is high, there is little ambiguity about how to proceed. There may be disagreement, and there may be uncertainty, but there will be little equivocality or ambiguity. (These latter attributes will be discussed again in Chapter 5.) When the "how to" is straightforward from a cognitive perspective, a task-focused style improves efficiency. People will get the job done better and faster when the leader plans, clarifies, and moves the work along.

When the level of task structure is low, these are the characteristics by definition: steps are not clear, there are many potential (but as-yet-unknown) solutions, and correctness of the approach cannot be judged ahead of time. There will be a high level of ambiguity about how to proceed. Differently trained scientists will have different (and perhaps conflicting or at least competing) recommendations for approaching the work. Under this condition, imposing structure will actually curtail the wide information-seeking and communicating activities needed to come to shared agreement before scientists can move forward. Work cannot be planned until there is concurrence on a starting approach (or, more likely, on a desired outcome of the work). Steps cannot be clarified too far in advance because of the *variety of solutions.* And, it would be foolhardy to move work along given that the direction of this work is unlikely to be clearly visible. When the how to is not straightforward from a cognitive perspective, a focus on relationships to ensure candid and challenging discussion will be more effective.

Of course, scientific work is not that simple. A project may begin as a highly structured task, but discoveries along the way may reveal ambiguities (and vice versa). The effective leader thus has to be capable of behaving in a style that is task focused or relationship focused depending on the conditions. In short, he or she must be capable of both sets of behaviors and appreciate when each set may be required.

Understanding Your Leadership Style

Fiedler and Chemers proposed that one's preferred leadership style (task, or relationship)

> is an index of a motivational hierarchy, or of behavioral preferences, implying that some goals are more important to the individual than others.[12]

Such a central tendency toward a style of behaving is a stable part of our personalities. Unlike needs, however, style can (and must) be modified. Wisdom in leadership necessitates understanding your preferred style, in other words, what goals are more important to you, so that you can adjust it to suit the work circumstances.

Fiedler and his colleagues created a useful test to measure whether a person can be classified as a task-focused or relationship-focused leader.

Note: The exercise that follows, like that for thematic apperceptive measures, must be completed and scored *before* reading the subsequent explanation and discussion. Ensure that you have an uninterrupted 15 minutes to complete the questionnaire.

Here are the instructions for completing the instrument (least preferred co-worker scale): Think of a person with whom you work or have worked least well. You may have liked or disliked the person; what is important for the purpose of the questionnaire is that the two of you did not work well together. [That is why it is called the least preferred co-worker (LPC) questionnaire.] Describe the person using the following scale (e.g., if you think of this person as "pleasant," check 8 on the first item). Go through the material carefully; the scales reverse throughout the questionnaire.

Least Preferred Co-Worker Scale

									Scoring*
Pleasant	8	7	6	5	4	3	2	1	Unpleasant ___
Friendly	8	7	6	5	4	3	2	1	Unfriendly ___
Rejecting	1	2	3	4	5	6	7	8	Accepting ___
Tense	1	2	3	4	5	6	7	8	Relaxed ___
Distant	1	2	3	4	5	6	7	8	Close ___
Cold	1	2	3	4	5	6	7	8	Warm ___
Supportive	8	7	6	5	4	3	2	1	Hostile ___
Boring	1	2	3	4	5	6	7	8	Interesting ___
Quarrelsome	1	2	3	4	5	6	7	8	Harmonious ___
Gloomy	1	2	3	4	5	6	7	8	Cheerful ___
Open	8	7	6	5	4	3	2	1	Guarded ___
Backbiting	1	2	3	4	5	6	7	8	Loyal ___
Untrustworthy	1	2	3	4	5	6	7	8	Trustworthy ___
Considerate	8	7	6	5	4	3	2	1	Unconsiderate ___
Nasty	1	2	3	4	5	6	7	8	Nice ___
Agreeable	8	7	6	5	4	3	2	1	Disagreeable ___
Insincere	1	2	3	4	5	6	7	8	Sincere ___
Kind	8	7	6	5	4	3	2	1	Unkind ___
									Total ___

*Transfer your scale position number to the scoring column.

When you have finished, sum your answers for your total score (which will be between 18 and 144). If your total score is between 18 and 57, you have a central tendency to be task focused. If your score is between 64 and 144, you have a central tendency to be relationship focused. If you score between 58 and 63, pick the endpoint to which you are closer.

Note that the high scores on the questionnaire reflect a positive assessment of your least preferred co-worker. If you describe this person in positive terms, your preferred style is relationship focused. If you describe this person in negative terms (with low scores), your preferred style is task focused. Fiedler and Chemers noted that

> the high LPC person, who perceives his [sic] least preferred coworker in a more favorable, more differentiated manner, has as his basic goal the desire to be "related." . . . The low LPC person has a different hierarchy of goals. His basic goal is to accomplish the task. His self-esteem is derived from [task] achievement.[13]

RECOGNIZING STYLE DIFFERENCES

As in Chapter 3, a short case study follows that will allow you to reflect on the characters' behaviors and to "listen" to how they speak in order to develop your skill in discerning your and others' preferred styles of leading. The case will also help to illustrate the proposed association between traits (work motivation needs) and behaviors (leadership style), thus integrating the two perspectives of leadership—being and doing.

Two Leadership Styles

Lee and Stefan are physicists who direct nationally renowned research facilities. Each described making the transition to R&D management:

> *Lee:*
>
> The big transition for me was moving from chief of particle physics to director of this institute. As chief, I ran a relatively small facility of

about $0.5 million per year. Then the director of the institute became ill, and I was asked to apply for the job. I took a month to decide. While I bicycled back and forth to work I would ask myself why I wanted to take on a budget of nearly $200 million and a lot more management responsibilities.

My family became tired of listening to my arguments!

Stefan:

My transition to management was more gradual. I started out as a postdoc in another university, gradually became responsible for a group of doctoral students and technicians, and then became assistant professor and chief of the laser laboratory. This involved a certain amount of managerial responsibility—if nothing else, worrying about the performance of my staff. I gradually took on more responsibilities, ultimately becoming director of the entire department.

When asked what advice they might offer other scientists facing similar career choices, they responded:

Lee:

First of all, you should move into management sooner rather than later. I think that when you are new to management you have all kinds of ideas you'll try out, because you're not embedded in the bureaucracy. The older you get, the more entangled you become in "the system" and you start to accept it at face value. That's why my first point is "do it now."

My second point is, if you want to have influence over the way an organization is run and over where it is going, take a management job. When I was offered the job of director of this institute, there were a lot of things I thought could be improved. It seemed to me to be a good opportunity to make changes I believed were important.

Stefan:

Of course, those are good points, but there are other considerations. You should reflect on the issue of whether you will grieve at being away from the bench. I spend a lot of time with people in my department who are thinking about this, telling them that if they are not absolutely sure they can leave research without a terrible sense of loss, they should not go into management.

Moreover, too often people decide to take a management position because work is not going well in the laboratory, or they disagree with their department chair, or they didn't get tenure. Something of that sort. But, moving into management should be a positive step. If you're a manager only by default, you will never be effective.

Both Lee and Stefan are very successful managers who gave these reasons for their success:

Lee:

I believe very strongly that, to be good at a job like this, you have to stay very close to the science. I hold a weekly session that is required attendance for our institute's management committee. We invite a very select group of physicists who are on the leading edge or who are controversial. This allows us to judge where we should invest our money.

I also believe it's crucial to the success of the institute that I hire the brightest person I can possibly find. I've watched a number of my colleagues hire people they feel they can get along with. And, we have to admit, we sometimes feel most comfortable with people who have to look up to us. I've always tried to hire the smartest possible person, even though I have had some problems and my hires have not always worked out.

Stefan:

I agree about hiring the best and the smartest because people are, as far as I'm concerned, the most precious resource I have. I try to choose staff carefully, to nurture them, to be in communication with them. I think this is the most important aspect of managing scientists.

Whom I hire, how I mentor them, and where I place them are crucial. If my staff is incapable of doing something, or doesn't trust me, or doesn't care enough to do it well, then the work of this department is not going to be accomplished satisfactorily. Anything that is done well is done because there are good scientists to do it.

When asked about their management styles, Lee and Stefan gave these examples:

Lee:

Two years ago a very highly regarded scientist needed a larger space and more responsibility or he would leave the institute. At the time, there was a department in another building that really didn't belong in that building. In a very swift maneuver, I decided to move this entire corridor, and we created a laboratory for the scientist in its place. That person now is one of my division directors.

The other scientist, the one whose department I moved, barely spoke to me for months because he was very angry. But when his laboratory began to flourish in its new location, because it was surrounded by others engaged in very complementary research, he came to me and said he thought I did the right thing.

Stefan:

I have scientists working for me who are very eccentric and yet very brilliant. When I am asked where I draw the line when they cause trouble, I say that I draw the line very far away. I try to keep these eccentric scientists from getting into trouble in the first place. But I understand what they're like and I understand that, if I don't have people like that, I will have a very mediocre institution.

One of our scientists has required a lot of my understanding over the years. He has made people very angry because of his arrogance, but I stood between them and him. Now I take particular satisfaction in his enormous scientific achievements.

How do they feel about managing a scientific enterprise?

Stefan:

You have to be willing to give up the satisfactions of your own research and to get that satisfaction by helping with someone else's. You become a facilitator, and then you can begin to discern some progress in the field of physics. But you have to be able to take satisfaction from the facilitation instead of the experimental work itself.

Managing R&D is much less visible and less easily viewed as success than managing an organization that produces some tangible output. I have had to look for the many small ways in which I can find satisfaction, such as my day-to-day working with people, not just in the spectacular accomplishments they sometimes achieve.

Lee:

Often, the manager of R&D is simply not recognized. That's hard, because I have an ego like everybody else. The hardest part of this job for me was realizing that, by the time the world recognized my influence, I would be old and gray!

Analysis of Leadership Styles

Just as you should be able to recognize work-related needs for power, achievement, and affiliation from what people say and how they view their work, you should also be able to recognize that Lee has a task-focused and Stefan a relationship-focused leadership style. Consider how each viewed their transition to management. Lee talked about the difference in budget and size between the respective organizations (structure); Stefan spoke about increasing responsibilities for people (relationships).

In advising other scientists about management, each responded to the issue in a manner consistent with her or his style. Lee put structure around the decision: Do it sooner rather than later and do it if you want to make changes. Stefan recommended that the person first reflect about "grieving" for the lack of bench involvement and said he spent "a lot of time with people," counseling them about this career move. In other words, he focused on relationships.

When both were asked why they were successful, Lee first mentioned staying close to the science, then hiring the brightest people. Stefan immediately said that people were the most important resource for the organization and that management must "nurture them and be in close communication with them."

Finally, when asked to give an example of their management style, Lee described her imposition of structure on the situation regarding her "very highly regarded scientist" (moving a corridor of people to another building). In contrast, Stefan described those scientists whom he strives to "understand" and to protect from others who might have less patience with their eccentricity.

Do you think your style is closer to Lee's or to Stefan's?

As you read the case study, you may have noted that the career paths of the scientists differed, although each was apparently motivated by a desire to influence (i.e., by a need for power in McClelland's terms). Lee was explicit about this ("if you want to have influence over the way an organization is run . . . "), while Stefan was implicit ("moving into management should be a positive step"). Lee's secondary need is probably achievement. Her conversation suggests a desire to be challenged by (for example) the size of the new institute and the many aspects she believed "could be improved."

Stefan, on the other hand, probably has a strong secondary need for affiliation. He took on increasing leadership roles (from overseeing doctoral students to chief of a laser laboratory to "director of the entire department"). Unlike Lee, Stefan described the evolving responsibilities as including "worrying about the performance of my staff," as opposed to Lee's worrying about "a budget of nearly $200 million." Moreover, Stefan's conversation reveals that he spends a lot of his time in activities that define the need for affiliation: One character consoles, helps, and is concerned about the happiness or well-being of another. Loving, nurturing acts of one character suggest the desire for reciprocation.[14]

As I stated in the beginning of this chapter, both traits and behaviors of leaders are important. There is an association between our ordering of work-related needs (McClelland's theory) and our preferred leadership style (Fiedler's theory). Both aspects of personality have to do with motive (the LPC score was defined as an index of a motivational hierarchy), so a correlation between them is expected. If you have a high need for affiliation—either dominant or secondary—your LPC score is likely to be between 64 and 144 (probably in the 80s or 90s). If you have a high (dominant or secondary) need for achievement, your LPC score is likely to be between 18 and 57.

The association between work-related needs and leadership style illuminates as well the “distance” between your primary or dominant and secondary needs. For example, if your ordering of motivation needs is POW/AFF/ACH and your LPC score is high (e.g., 100 or more), it is probable that your need for affiliation is very “close” to your dominant need of power. If your LPC score is low (e.g., 48), then the distance between power and affiliation may be large but the distance between affiliation and achievement would be small (your need for achievement is close to your need for affiliation). If your ordering of motivation needs is AFF/ACH/POW and your LPC score is low, then achievement would be close to your dominant need, and so forth.

On that basis, you might want go back to your earlier graphic depiction of work motivation needs (Chapter Three) and adjust it using your leadership style score.

SOME MANAGEMENT IMPLICATIONS

If your preferred leadership style is task focused, it will be more effective when you face a highly structured task (clearly known, few possible solutions, demonstrable correctness). However, you must exercise caution when the circumstances are different. If, as in the examples noted earlier, your group were beginning research in a novel area (a task of low structure), you would have to be careful not to impose structure too soon. Rather, you should ensure wide and challenging communication among those involved by ensuring good interpersonal relationships. When you and your group agree on a definition of the task and on a desired outcome, a task-focused style would be more effective. When the how to is finally straightforward, at least for a short period of time, a task-focused style improves efficiency.

If your preferred leadership style is relationship focused, it will be more effective when you face a task with low structure (vaguely known, many potential solutions, no demonstrably correct result). Your preferred style will serve you well in the above example of beginning research in a novel area.

However, you must exercise caution and not persevere in emphasizing relationships when the level of task structure has increased. At that point, you must modify your behavior and style to be task focused and impose structure, so the job can be completed efficiently.

Of course, you will have to reflect on the level of task structure at many points in time, and adjust your style to the situation. In the beginning, you will probably "lapse" into your preferred style and only later reflect on its effectiveness. Soon, you will not respond until you have first thought about task structure. Finally, you will develop, through practice and reflection and learning from your mistakes, a facility for matching your style to the requirements of the situation that is almost automatic.

You also have to identify the preferred leadership style of your boss and manage situations in which your boss's style is not effective. Similarly, if you are considering one of your scientists for a management position and have concluded that this would be a good fit in terms of that person's work-related needs, you must also identify that person's leadership style. How does this scientist prefer to approach a situation: by imposing structure or by emphasizing relationships? Once you have recognized that central tendency in the other's behavior, your mentoring should include providing guidance about when and why each leadership style is effective as well as a clear and persuasive example by your actions.

SUMMARY

I want to conclude by clarifying a number of terms often discussed under the subject of leadership. For example, you may have heard someone described as an "autocratic leader" (or "democratic" or "consensus" or "participative"). These terms have little to do with leadership style, as it used in this chapter. Rather, they refer to how a leader includes or does not include input from others. Autocratic implies that little or no input from others is sought or used; democratic that the wishes of the majority are decisive; consensus that the relevant parties must agree before an action is taken; and participative that wide input is sought, although the choice of action may be decided solely by the leader.

How and to what extent you include input from others should be governed by common sense. If there is a crisis, you may have no choice but to be autocratic. No one disputes the autocracy of a physician at an accident scene. If you are selecting the color of the walls in the cafeteria, then the wishes of the majority of workers should be respected. If you are not the expert in the subject at hand, you should ensure that those who are agree on the steps to be taken. And, if your co-workers and subordinates will be greatly affected by the outcome, you should seek their wide participation in the process as much as possible. (The norms in your organization also affect how and to what extent you include input from others.)

One hallmark of effective leadership is the ability to adjust one's preferred leadership style to the requirements of the situation. Although Lee and Stefan have distinctive leadership styles, their long-term success in their respective organizations suggests that each has learned to modify that style when necessary. Understanding your preferred style, its strengths and limitations, is an important step in becoming an effective leader.

NOTES

1. This overview is drawn from texts on organizational behavior; specifically, *Organizational Behavior and the Practice of Management,* 3rd ed., by D. R. Hampton, C. E. Summer, and R. A. Webber, Glenview, IL: Scott, Foresman and Company. Another useful text is *Organizations: Behavior, Structure, Processes,* 10th ed., by J. L. Gibson, J. M. Ivancevich, and J. H. Donnelly, Jr., Boston, MA: Irwin McGraw-Hill, 2000.
2. Hampton, et al., op. cit., p 600.
3. Ibid., p. 599.
4. Vecchio, R. P., An empirical examination of the validity of Fiedler's model of leadership effectiveness, *Organizational Behavior and Human Performance 19,* 180, 1997.
5. Gibson, et al., op. cit., p. 282.
6. Ibid.
7. Ibid.
8. Schriesheim, C. A., Tepper, B. J., and Tetrault, L. A., Least preferred co-worker score, situational control, and leadership effectiveness: A meta-analysis of contingency model performance predictions, *Journal of Applied Psychology 79*(4), 572, 1994.

9. Hampton, et al., op. cit.
10. Ibid., p. 599.
11. For example, see Schroder, H. M., Driver, M., and Streufert, S., *Human Information Processing,* New York: Holt, Rinehart & Winston, 1967. See also Edelman, G. M., and Tononi, G., *A Universe of Consciousness,* New York: Basic Books, 2000.
12. Fiedler, F. E., and Chemers, M., Leadership and effective management, reprinted in Hampton et al., op. cit., p. 624.
13. Ibid., pp. 624–625.
14. From the definition of nAFF in Chapter 3.

5
COMMUNICATING EFFECTIVELY

> *Wanted:* ". . . Scientists who communicate well, work well with a team, and can manage people. . . .
>
> You can never do enough training around your overall communication skills."[1]

It should be so simple: You speak to another person, or write a memorandum, or send email, and you expect that person to understand and act accordingly. After all, you have communicated. But have you? Communication, which comes from the Latin *communicare,* meaning "to share or impart," is a more complicated process than it may appear.

Communicating effectively and listening well were the second most frequently described attributes of the best leaders by our expert panel respondents (Chapter 1). Scientists working for such leaders understood their ideas and expectations because the leaders were articulate and direct in their communication. Scientists also grasped their vision and "caught" their enthusiasm because the leaders could communicate (i.e., share) ideals and passion for the research.

Effective leaders also listened well, which (in the words of the respondents) meant they:

- "put aside bad moods when interacting with others"
- "took *time* to listen"

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- "looked at me directly when speaking and listening"
- "were never too busy to discuss results"

The most-repeated adjective associated with "listening well" was *open minded.* Effective leaders were open to others, open to ideas, open to different views, open to alternatives.

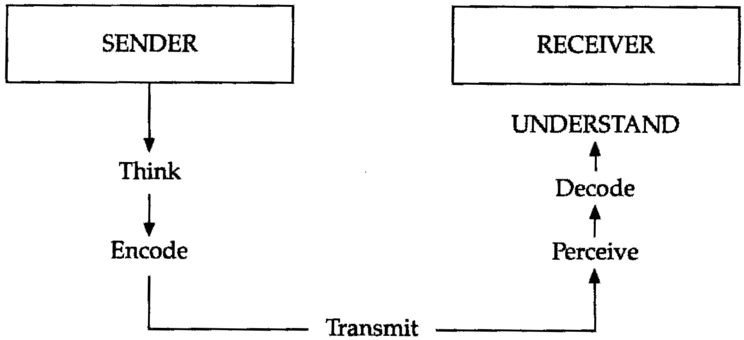
Communicating effectively, and the corresponding skill of listening well, was also one of the respondents' most difficult problems. One scientist described the struggle of "getting my point across, without causing a bigger dispute." Another wondered how to give feedback to others in ways that would not be felt as "personal attacks." How does a leader "convince people they are going in a likely wrong direction, in a way that leaves no resentment behind?"

In this chapter I first review the mathematicians' model of the process of communication (described by C. E. Shannon and W. Weaver in the 1940s) and then address a number of issues that make this activity so complex.[2] In doing so, I also provide some approaches (if not answers) to the questions raised by the expert panel respondents and some techniques that effective leaders use to communicate effectively. Communicating effectively, after all, is of paramount importance to leading effectively.

MODEL OF COMMUNICATION

Let us assume that you want to communicate to your staff that there will be a hot-water shutdown on Sunday from midnight to 4 AM because of routine maintenance. This task consists of six steps:

1. You, the *sender,* first *think* about the audience to whom the message will be sent and (in this case) the information you want to impart.
2. You *encode* the information by putting your thoughts into the communicable form of words, phrases, numbers, and so on.
3. You *transmit* the encoded message via some medium (airwaves if you speak directly, paper or electronic media otherwise) to the scientists and technicians who will be affected.



4. The *receivers,* the people to whom you sent the message, must *perceive* it. They must hear or read the message.
5. They must *decode* your message by translating the sounds or words into their thoughts.
6. Finally, the hope is that they *understand* the message as you intended.

PROBLEMS IN COMMUNICATION

To illustrate how complicated the process of communication really is, let me describe some of the problems that could arise at each of the six steps in the model.

Thinking. You did not think carefully about your intended audience and did not realize the extent of the information that you needed to impart. Not only will the hot water be off for 4 hours, but also the heating units in a small-animal room will be shut down. There are backup units on a generator, but maintenance personnel need at least 24 hours notice for a nonemergency switch of heating power to the generator during weekdays. They require 72 hours notice for a switch over the weekend to avoid unnecessary overtime. You forgot about this advance notice when you sent the message on Friday afternoon.

Encoding. You sit at your PC and type out the following memo:

TO	All Personnel in Building C
FROM	Pat, Director of R&D
DATE	Friday noon
RE:	Heating System Maintenance

During routine maintenance of the heating system this weekend, there will be no hot water in the building for 4 hours on Sunday evening. Please contact the maintenance supervisor if this will present any difficulty.

In your haste to send the message, you left out the actual times of the shutdown.

Transmitting. You send the above memo via email to all people in building C. However, your network software does not tell you that one node, the chemistry laboratory on the second floor, is offline. Their system crashed in a local power failure earlier that morning.

Perceiving. All people in building C, with the exception of those in the chemistry laboratory, have your message in their incoming mail file. Several scientists, however, neglect to check their computer for mail that afternoon.

Decoding. Some of the people who do check their email read your message and wonder exactly what time the system will be down. A few decode "evening" as from 6 to 10 PM on Sunday and decide there will not be a problem. Others decode it as sometime after midnight and decide there will be a problem.

Understanding. The technicians responsible for the small-animal room read the message and immediately worry about the switch to generator-powered heating. They ask the head of the laboratory about the shutdown, but she is one of the scientists who has not checked her messages. By the time she reads it, they are all worried that you have forgotten the advance notice required. Or has the system been changed so that the notice is no longer needed? If the system will be off between 6 and 10 PM, then the room may cool down too much. However, if the system will be off between midnight and 4 AM, they might not even need to switch to alternative power. Should they ask you or the maintenance supervisor?

ADDITIONAL PROBLEMS IN COMMUNICATION

Do not assume that most of the difficulties in the above example occurred because you were forgetful or because you used an electronic medium. Consider this scenario: You are holding your weekly staff meeting with 12 people who report to you directly. After reviewing some administrative details (vacation approvals), you announce: "We're expecting a few visitors from the corporate board on Tuesday to see the high-throughput screening facility. To make sure your people are prepared for them, I suggest. . . ." While you are speaking, there are several "breakdowns" in communication.

Distorted Perceptions. Two of your staff are not paying attention. When they "tune in," they believe they hear you say something about *regulatory authorities.* They begin to wonder what has gone wrong to bring in the regulatory authorities.

Another member of the staff, the director of the high-throughput screening facility, hears your statement but takes it a step further. He envisions that the corporate visitors will be so impressed they will insist the capabilities be expanded, and he begins to plan what equipment they might purchase. He ceases to hear the rest of your statement about the visit.

Distrusted Source. One person does not believe that you, until comparatively recently an academic (as opposed to industrial) scientist, can understand the implications of a visit from the corporate board. She assumes that the board is concerned about company finances, of which you must be ignorant, and that these representatives are hunting for areas in which to make cuts. She begins to plan how to make her own area a "sacred cow" in terms of budget cuts and ceases to hear the rest of your statement about the visit.

Distortions from the Past. The assistant to the director of the high-throughput screening facility had a painful experience at his last place of employment. Board members came to visit his facility and, the next week, the entire group was laid off. He begins to panic, assuming the same thing will happen here, and starts mentally reviewing his curriculum vitae.

Defensive Behavior. One of your staff, the head of chemical synthesis, has been feeling very undervalued since completion of the high-throughput screening facility. When he hears your announcement, he believes that the visit is yet another insult to his production department. He interrupts and begins to argue with you about the budget.

Lack of Congruence. When the head of chemical synthesis interrupts, you ask him to hold off until you finish with the details of the corporate visit. You assume he does not care about the high-throughput screening technology because he appears so argumentative. As a result, you are fairly brusque in asking him to wait. He assumes that you *really* undervalue his department and begins to consider updating his curriculum vitae.

What is the intended message? Actually, the visitors from the board are three new members who worked at a corporation on the West Coast that used the same high-throughput screening technology. You know that they are very interested, and only interested, in one piece of equipment that your facility employs. But out of 12 staff members around your table, only 6 understood your message as you intended. In other words, you have communicated to only half your staff.

LANGUAGE BARRIERS IN COMMUNICATION

In addition to the above-named problems, potential communication difficulties occur in every scientific organization as a result of language barriers. As described in Chapter 2, a sizable number of scientists and technicians in the modern laboratory are likely to have been trained in languages other than English. Because of the large proportion of foreign-born PhDs, there are likely to be linguistic misunderstandings. In addition, though, "cultural differences in style, expectations, and work attitudes can create misunderstandings that impeded the flow of information and the development of science."[3]

Language barriers also arise between disciplines and can cause problems in the encoding/decoding stages of communication that preclude mutual understanding. The reason is that each discipline represents a group of people who share a common meaning for their language, a meaning likely to be different from that shared by people trained in another discipline. For example, when used by a biologist (with implications for deviation-amplifying feedback), the word *system* may be interpreted as *order* by a mathematician (with no feedback problems at all). In communication theory terms, what occurs then is *erroneous translation.* The sender may encode "system," but the receiver decodes "order." That is why communication among scientists of different disciplines is so difficult to get right. People may talk to each other, but they do not communicate—they do not reach the same understanding of the message.

One scientist described to me his experience of communication between chemist and biologist in this way:

> Chemists are people who have a high level of expectation that tomorrow will be like today. But you can only take up biology if you have a great tolerance for ambiguity. So, when chemist and biologist first meet, collaboration is very difficult and it can take 2 to 3 years of intense collaboration to produce mutual trust.
>
> There are differences in language, differences in temperament, differences in perspectives, and differences in what chemists and biologists do with the same information. A number is "7.6" to a chemist, but to a biologist it is "7.6 ± 0.5," and that makes a . . . a lot of difference!
>
> The chemist has to learn that high variability does not mean low significance. It takes a lot of mutual learning by the chemist and biologist who are trying to collaborate.

At a large research facility employing laser physicists, engineers, and physicians among other disciplines, the director told me that, during interviews with new scientists, he asks, "Do you speak physics or biology?" He noted that he spent much of his time dealing with language barriers:

> To manage a multidisciplinary group like this, you have to identify the language barriers and get people to admit they exist. I do a lot of "interpreting" for my scientists.

Another set of language barriers arises between functions (e.g., research, development, design, manufacturing, sales). These barriers result from the fact that each function consists of people who specialize in certain activities and share similar experience and training. Like different countries and different disciplines, different organizational functions represent groups of people who share the same meaning for their language and who may have difficulty understand the meaning of people outside their groups.

Language barriers between functions are sometimes even more confounding than language barriers between countries and scientific disciplines because the terminology is nontechnical. People in research, for instance, may share a very different meaning of time from people in sales. A duration that is "soon" to a researcher may be protracted to a salesperson. People in development may share a very different meaning of *customer needs* from people in marketing. What constitutes an *important innovation* to a marketer may be quite different from what *innovation* means to a physician in development, and vice versa.

Whenever people live, train, or work together, whether in lengthy doctoral programs or by dint of experience in the field, they develop a shared meaning for their language that may not be shared by others with different training and experience. So, the encoding, decoding, and understanding steps in the communication process may be fraught with difficulty.

GENDER SCHEMAS IN COMMUNICATION

A final issue that can complicate communication derives from schemas or implicit hypotheses about gender (as well as about race and ethnicity). Unrecognized gender schemas can distort the receiver's perceptions. For example, some observers note that "scientific competence is still judged by male communication styles. Objective, unemotional, assertive."[4] Thus, if a female scientist were to speak passionately about her research, her results might be discounted by a male listener because she was not unemotional. His perceptions of the information she transmitted might be distorted by his expectations regarding appropriate scientific (male) communication style.

A woman's competence in supervising other scientists' work may be suspect if gender schemas regarding appropriate tone of voice are held by the staff. For example, if staff expect a "male" communication style, their perceptions of the directions given by a soft-spoken woman may be distorted. As one industry scientist in our expert panels reported, "If I am too soft or quiet, then I am not taken seriously as a leader." To some degree, she was saying, "I am not perceived."

An early study of factors affecting what is perceived showed, among others, that "one's own characteristics affect the characteristics that one is likely to see [and hear] in others."[5] In other words, male scientists may be more likely to perceive (see and hear) other male scientists—and less likely to perceive (see and hear) female scientists. To avoid distortions, we have to acknowledge the existence of such mental constructs: "Only by recognizing how our perceptions are skewed by nonconscious beliefs [like gender schemas] can we learn to see [and hear] others, and ourselves, accurately."[6]

COMMUNICATING MORE EFFECTIVELY: ENSURING FEEDBACK

Learning to communicate effectively requires that you first appreciate the complexity of the process and how and why problems in each of the various steps may arise. Then, you must ensure that feedback occurs throughout the process. (Remember: The person giving feedback to you becomes a *sender* and you become a *receiver.*)

Consider the feedback that might be appropriate for each of the earlier examples: water shutoff, board visitors, language barriers, and gender schemas.

Feedback: The Water Shutoff

Thinking. The first feedback loop in the communication process should always be to yourself. Before you encode a message, ensure that you have thought carefully about the intended audience and the information you want to convey. In this example, you might have (1) remembered to put in the exact time of the shutoff and (2) anticipated the problem for the small-animal room technicians.

Encoding. The next feedback loop should also be to yourself, by reviewing what you have encoded and comparing it with what you intended to say. In the case of written and electronic communication, you might ask someone to review and comment on the text before it is sent. If you had omitted the hours of the water shutoff, perhaps another person's query would prompt you to insert the time.

Transmitting. After a message is transmitted, you should seek feedback by strategically placed checks to ascertain that distribution actually took place. In this example, you should upgrade your network software to provide error messages if any node is offline. In the case of a written memorandum, telephone calls along the distribution route are advisable.

Perceiving. There is little you can do to ensure that all your staff read their email or written memoranda, other than ensuring that you are selective in how much information is distributed in these ways. Information overload is one cause of problems at this stage.

Decoding. If you had neglected to put in the times of the shutoff, you would discover this omission when you asked key staff if they had any difficulty with the upcoming maintenance.

Understanding. Direct solicitation of feedback from your staff should also clarify the misunderstandings about the small-animal facility.

Feedback: Board Visitors

Sorting out difficulties in communication while you are speaking also requires sensitivity to nuances of expression (voice, facial) and other body language. On the basis of these cues, you might solicit feedback in the following ways.

Distorted Perceptions. At your meeting, it is probably obvious to you that two of your staff are not paying close attention. They may be talking to each other, catching up on their mail, or reviewing their calendar. To ensure that they understand your message, ask them if they have any special concerns about the visit. That will give them an opening to say, "What went wrong that the regulators are coming in?" Thus, you can clarify the intended message.

Although it is impossible to anticipate that the head of the high-throughput screening facility will devise an elaborate plan for expansion after you mention that corporate board members will be visiting, a direct question might uncover the distortion: "Can you have this piece of equipment ready for a demonstration?" The head of the screening facility was thinking about purchasing equipment, not demonstrating it, so you have provided an opportunity for clarification. He may also have had a particularly intense look on his face.

Distrusted Source. In the example, you are the distrusted source because of your apparent unfamiliarity with industry. If this is not your first meeting with the staff, then you probably note either an eagerness on the part of this scientist to bring you "up to speed" or cynicism when you describe your vision for the group. A useful direct question to her at the meeting is: "Do you have suggestions for us in planning for this visit?" Let her elaborate on how she views the visit, and you can clarify the actual purpose.

Distortions from the Past. As with distorted perceptions, you may not be able to anticipate how people perceive your message based on their own past experience. But, if you seek feedback at the meeting, then either you will discover that this assistant is concerned about the visit (and you can reassure him) or the head of the facility will solicit his feedback and she can reassure him. At some point, distortions from the past will surface if feedback is truly encouraged in the organization.

Defensive Behavior. The head of chemical synthesis, who has been feeling undervalued, gives an obvious clue that something is wrong, when he interrupts to argue about the budget. You can clarify his misunderstanding of the purpose of the visit during your meeting, but you may need to confront him about the larger issue at another time (confrontation is discussed in Chapter 6).

Lack of Congruence. If you respond to the tone of this staff member instead of to his intended message, you will escalate the miscommunication. There are two examples of lack of congruence in the example. First, he appears argumentative about the budget, but he is really worried that his chemical synthesis department is valued less than the high-throughput screening facility. Second, you appear to be dismissive about his group, but you are annoyed only at the interruption and apparent change of subject. You should inform him that you will meet about the budget, but the purpose of this discussion is to inform everyone about the board's interest in a particular piece of equipment.

Feedback: Language Barriers

If you have different nationalities, different functions, and different disciplines within your laboratory, there is a high potential for the communication problem of erroneous translation. Many language barriers will be reduced or even disappear over time as people work together and develop shared meaning as the result of shared experience. Until then, you must ensure that people give and receive feedback and, as the director mentioned earlier, you must "interpret" as often as necessary. Otherwise, misunderstandings (or worse) will persist:

> Differences in language skills result in miscommunication more often than expected. People tire of having to ask for clarification more than once, so they just give up and go with what they understood, even if it is wrong.[7]

For example, if you were holding a laboratory meeting, you might ask the person who speaks English more haltingly to review in his own words what he understands of the results or other issues being discussed. If you were at a meeting involving biologists and mathematicians, you might ask the mathematician what concerns she might have about the system under discussion, providing an opportunity for the biologist to explain about deviation-amplifying feedback. Similarly, when researchers and sales people and developers and marketers communicate, you should take the lead in asking simple questions about time, needs, novelty, and so forth. Never assume, unless they have spent considerable time working together, that people from different countries, disciplines, or functions understand what others mean. Asking direct questions, even at the risk of sounding foolish, provides the opportunity for clarification. In this way the receiver has a better chance of understanding the message as the sender intended.

Feedback: Gender Schemas

If perceptions are distorted by gender schemas, the tactic of seeking feedback will depend on the genders of the sender and receiver. For example, if you (a woman) are holding a meeting about the progress of an experiment and you believe gender issues are "confusing the situation," you might say. "There seems to be a problem with how each of us is interpreting the results." Then, you could ask each individual to articulate what he or she has heard. If you (a woman) are giving directions but a (male) staff member does not appear to hear you, you might ask the person to repeat in his own words what he will do.

If you (a woman) are attending a meeting on the progress of an experiment and the leader of the laboratory (a man) does not appear to listen to your recommendation, you might find an appropriate space in the discussion and ask, "Can we go back to [your earlier comment] and clarify some of the points?" In all cases in which gender schemas may be distorting communication, a firm, yet collegial request for feedback should help to clarify the message. (As Valian asserted, "a friendly manner and respect for others also takes some of the sting out of being competent and effective."[8])

Effective leaders realize that schemas exist, that they can distort our perceptions of what is encoded and transmitted, and that they can constitute a source of systematic error in our understanding. Especially in scientific endeavors, such errors are important to identify and correct.

MEDIUM BY WHICH THE MESSAGE IS COMMUNICATED[9]

The transmission step of the Shannon and Weaver model is a much-underappreciated locus of possible problems—not just whether your email was lost or your post went astray. Specifically, the rationale by which leaders choose a *medium* to transmit their message must be more than convenience or custom. In fact, modern communication theory has shown that the medium must match a certain attribute of the message—its level of equivocality. Below, I discuss this attribute and lean and rich media choices for transmitting messages.

Equivocality

First, it is important to distinguish between two attributes that affect communication: uncertainty and equivocality. If everything were perfectly known about a subject (e.g., the experiments being conducted in the laboratory), there would be no uncertainty. *Uncertainty* means that some knowledge is lacking, that the information at hand is imperfect. For example, surprising results are obtained in an experiment or a problem with an assay arises unexpectedly. Scientists must seek information to reduce the uncertainty implied by questions such as "Why were those results achieved?" and "What might have caused that problem?" Then, they must get together to discuss the information in what communication theory terms *information processing.*

Communication theorists propose that there is a direct relationship between the level of uncertainty of the work and the amount of information that must be processed.[10] Thus, if the problem that arises in the assay is relatively minor—the level of uncertainty is small—then a "small" amount of information will be needed to resolve it. If the results from the experiment are surprising in major ways, then the level of uncertainty and the amount of information needed will be correspondingly large. One important objective of organizational communication in general and scientific communication more specifically is to reduce uncertainty by gathering, distributing, and sharing the appropriate amount of information.

Equivocality, on the other hand, refers to the existence of multiple and, sometimes, competing interpretations about something. For example, the surprising results described above may be minor, but they may be interpreted very differently by scientists working on the experiment. Equivocality (ambiguity) exists when:

- Issues are unclear, as opposed to unknown.
- It is difficult even to articulate the right questions.
- There is confusion because different people interpret the same information in different ways.
- The "language" being used is not understood and/or is interpreted differently by people in different disciplines, functions, and so on.

The equivocality or ambiguity of the message also influences communication. When uncertainty is high, more information must be sought. However, when equivocality is high, it is not clear what kinds of information are needed, what questions should be asked, or what sources of data would help to reduce the ambiguity. When scientists disagree about the interpretations of the surprising experimental results, the level of equivocality must first be reduced before the group can move forward and reduce the uncertainty (i.e., gathering, distributing, and sharing information).

If you think about some of the examples of messages used earlier in this chapter, the one concerning the water shutoff would not be characterized by high ambiguity. If you left out the time of the shutoff and forgot about the advance notice to maintenance, you unwittingly raised the uncertainty of the task of dealing with the shutoff but not the equivocality. It is quite clear what information is needed (the time of the shutoff), what questions should be asked (What is the impact on the small-animal facility?), and what sources of data would help (you and the maintenance staff). The message about the corporate visit to the prototype facility, on the other hand, was ambiguous, as evidenced by the problems that arose during the meeting. As will become apparent (below), had that message been conveyed by a memorandum to all staff, the misunderstandings might have worsened.

Uncertainty and equivocality are social constructs rather than characteristics of a particular situation or message. Thus, different members of a group working on an experiment may experience different levels of uncertainty and equivocality, even though they are trying to accomplish the same task or are working with the same technology.

Lean and Rich Media

In analyzing communication under conditions of high equivocality, communication researchers have found that certain media are more helpful in ensuring mutual understanding.[11] Media that facilitate the process of developing shared meaning and perspectives have been defined as *rich.* Such media allow immediate feedback among individuals, use natural language to convey nuance, provide multiple cues about meaning, and permit the message to have a personal focus. Face-to-face communication "transmits" by words as well as by facial expression, gestures, tone of voice, and body language and allows the quickest feedback of all media. This is thus the richest medium and the medium of choice when the objective is reducing equivocality. In descending order of "media richness" are interactive videoconferences, telephone conversations, and synchronous electronic written communication. Note that the latter, although allowing rapid feedback, does not convey nuance or carry many cues about the individuals.

Media that do not readily enhance shared meaning are referred to as *lean*. Lean media include (from less to more lean) asynchronous electronic written communication, one-way videos, voice and electronic messages to a group, bulletin board postings, PowerPoint presentations, graphics, tables of data, and so on. Lean media transmit few if any subtleties of meaning or emotion and do not allow for rapid feedback, explanation, or recognition of misunderstanding.

Very lean media, such as written or electronically distributed memoranda to an entire group, are essentially one-way means of transmitting messages.

They are useful for straightforward—unambiguous—messages. However, when the message is capable of more than one interpretation, such as the board visit, they should not be used as the sole medium of communication. Using the terms of communication theory, when equivocality is high, lean media cannot capture complexity, do not provide opportunities to give and receive feedback immediately, and cannot readily support the achievement of shared meaning.

In the modern work environment, rich media are not always available at the time they are needed. Even in the same institution, people may work in geographically dispersed facilities. Large-scale collaborations may include scientists in different nations who rarely meet. Teams may be *virtual* rather than real during most of a research project. How, then, can the leader ensure effective communication under conditions of equivocality?

Building good relationships is critical to both communication effectiveness and successful scientific collaboration. If members of a group will not be able to work face to face, the leader must bring everyone together at least initially. As one executive from a biotechnology company engaged in a virtual collaboration told me:

> There has to be enough face time with your collaborators up front, that you can keep the virtual team going. One of our scientists is a whiz at spotting body language and, once he knows the people, he is able to interpret the voice tones over the telephone. You have to be able to figure out each individual that way and understand what each wants out of the effort and, over the course of time, what are their concerns and their upsides . . .
>
> The single most important thing—no big surprise, of course—that makes collaboration work is the human chemistry.

When people have met like this and spent some informal time together, they are better able to "hear" tones of voice in electronic communication and to "see" gestures from syntax. Such cues can enable collaborators to keep the virtual team going through the processes of reducing equivocality and coming to shared agreement over scientific issues, even using leaner media. Still, it may be necessary to bring everyone together if competing interpretations persist.

MANIFEST AND LATENT CONTENT

To this point, I have been addressing communication from the perspective of a sender who wishes to impart information and share feelings in a clear and direct manner. Of course, this constitutes an ideal. There are numerous occasions in which senders do not wish to be clear or intend to be direct but discover they are being almost violently misunderstood. Messages—shorthand for what are to be shared/imparted and understood—often contain both manifest (obvious) and latent (hidden) content. Or, they contain latent content for the perceiver despite the sender's best efforts to impart only manifest content (and vice versa). An effective communicator has developed an appreciation for this dual nature of content, so to speak, and utilizes techniques such as active listening (described later) to ensure mutual understanding.

In this section, a case study of the acquisition of a high-technology startup company provides an illustration of manifest and latent content. It also underscores the importance of quickly addressing misunderstandings; otherwise (as in this case), the consequences can be professionally damaging and monetarily expensive. As you read the following discussion among the three scientists, be alert for occasions when there might be a difference between what the scientists say and what they might mean and consider the implications of what they do say.

Messages Communicated

Critical Care is a multinational medical device company with a growing business in hand-held blood chemistry and blood gas monitors for inpatient and outpatient use. The company's philosophy has been to grow by acquisition. Thus, when it became clear that biosensors represented the next frontier of technology for these devices, management began a systematic search for a startup company that might fit their firm's core competencies.

Founded around 1990, Gene-Chip was a biosensor startup that had its origin in an academic institution. Between 1993 and 1996, the company raised almost $30 million in venture capital; it also entered a joint venture (Pro-gene) with a chemical company whose management was interested in diversifying into medical devices. After the formation of the joint venture, a licensing scout from Critical Care decided that this startup was worth watching. Shortly thereafter, Critical Care worked out an agreement to acquire Gene-Chip.

In 1998, the founder of Gene-Chip, Jonathan Albright, and two managers from the central research division of Critical Care, Warren Farrell and Howard Bond, met to discuss how the two organizations might work together. Warren was then vice president of blood chemistry and blood gas R&D, and Howard was the director of clinical research. Their first subject was organization structure:

Warren: At Critical Care, we look at the hospital and outpatient environment in terms of human anatomy, in particular major organ systems, and then organize along these lines. In each area we have preclinical and clinical directors.

What we call a "project" is the developmental phase of device production. What we call a "program" is the discovery phase. There's a director of each department, and the preclinical director coordinates all the programs. Currently, there are 10 research programs in the blood chemistry and blood gas area.

As soon as one proposed device stands out, top managers meet to decide if we should move from program to project status. Then we have a project manager to oversee the next stage of chemistry and clinical activities.

Howard: In Critical Care's R&D organization, I think it is discovery that holds the most possibility for scientists to have rewarding and satisfying experiences. Once we get to projects, so much is developmental and structured.

Warren: I think Critical Care's structure is a real advantage, because it breaks up the large mass of our central R&D into smaller components. The project managers report to the major organ area directors in typical matrix fashion. On each project team is a representative from the planning function, who reports to the director of project management.

Jonathan: We have an entirely different approach to structure at Gene-Chip. First, we have a very independent, open attitude. All our laboratories are open. I've noticed that Critical Care's new facilities are small rooms, divided up. That promotes territoriality. We opened up Gene-Chip's space, with no territoriality. In fact, we don't have walls around the laboratory—you walk right up through the center of the laboratory instead of around a corridor.

Second, Gene-Chip is a young and very energetic company. We don't have corporate staff. Senior people with line responsibility report directly to the president. What we try to do is build a series of teams that looks at one basic problem. We give the scientists the opportunity to discover, but we also build critical mass around them so that whatever comes out can be moved forward rapidly.

Warren: Well, I think that biosensors is clearly the next era for Critical Care and the entire medical device industry. Products will come from the marriage of biology and electronics, and that's where Gene-Chip fits.

Jonathan: My goal is to bring Gene-Chip's new technology into Critical Care, to work with your resources and bring technology forward, to bring your biology groups new bioelectronics principles. Critical Care has traditionally been a development company—you license products, develop them, and bring them to market. I think you're entering a very interesting phase in the corporate lifecycle, and the critical task will be to build a real research capacity.

I believe that Gene-Chip provides a very formidable research capability, and I think this acquisition will propel Critical Care into the next generation of technology and improve its position in developing advanced technology products.

Howard: We have to be careful and find ways in which there is good complementation between Gene-Chip and Critical Care. We have to let our people in Critical Care do complementary and innovative work in the discovery process as well. The worst possible scenario would be for Gene-Chip to do the basic research and our group of scientists to be more and more developmental.

Jonathan: But I think the medical device industry in general is an industry based on traditional science, and a major portion of Critical Care's work consists of careful testing and preparation of the documents required by the FDA [U.S. Food and Drug Administration], which oversees medical devices—a librarianship type of activity. Of course, it has to be done with tremendous care and in a particular manner. The major factor is getting to clinical trials, getting over the regulatory hurdles. I believe Critical Care will help Gene-Chip by teaching us the aspects of bringing devices to the market.

Warren: The scientists who are affected most adversely by Critical Care's licensing, and that was the origin of this acquisition, are the biologists. They will be competing directly. For the others, it doesn't matter where the idea comes from.

However, I think the competition will be positive. I think we are all aware we are in a competitive business. And that competitive approach carries over to your work, whether you're dealing with another company that has a device like yours, a licensing agent, or this acquisition. I think our biologists are always saying: "What can we do to overcome this new challenge?" From Gene-Chip, for example.

Jonathan: I think the marriage of Gene-Chip and Critical Care will play itself out like all marriages: rocky. Territorial disputes will be the first major ones. Whose responsibility is what? And there will have to be some give and take in the management of money. But the principal assets of these two companies really fit. Critical Care's major market is in medical devices, but you had not built any bioelectronics capability in-house. And we at Gene-Chip have not yet brought any device to clinical trials.

Howard: I think there are fabulous scientists at Gene-Chip. My only concern is will they fit in at Critical Care, culturally? That's complex. I think they will help Critical Care's culture evolve. In the end they will fit in, but it will be a different culture.

Jonathan: I agree it will be a different culture. Even though you are acquiring Gene-Chip as a company, it brings an enormous quantity of new technology. It's got to bring Critical Care a different research culture as well.

ANALYSIS—MESSAGES SENT, MESSAGES RECEIVED

The conversations in this brief case study provide insight into what might happen during the implementation of the merger between Critical Care and Gene-Chip. After reading the case study, do you believe the merger will succeed or fail?

When I have used this case study with scientists in executive programs and graduate students in clinical programs, most believe, based on the conversations, that the implementation will fail. Below I have used some of the rich insights students have brought to their analyses to illustrate the major points of dissonance between the companies and among the case scientists.

Dissonance: Companies and Culture

The strategic fit between the two companies appears good (complementary skills and relevant technologies in health care), but it is very different along a number of dimensions:

> Critical Care is an established, conservative company whose senior managers hold advanced management degrees and have significant corporate experience. Their structure is highly compartmentalized, so that there are systems within a system to increase efficiency and productivity in both program and project phases of development. Gene-Chip operates under a more laid-back, liberal system. There is a positive "air" surrounding the laboratories at Gene-Chip, right down to the open physical structure of the buildings. Their strengths lie in their idealism, youth, and variety of thought.

Perhaps most importantly, the cultures of the two firms are very dissimilar, stemming from their different origins and geographic locations, among other factors:

> Successful mergers thrive due to the development of *one* organization, and *one* framework. There are many reasons for a failed merger; however, poor cultural fit between the merging organizations seems to be

> the most influential.[12] To create a merger between two distinct and opposing cultures, as has transpired between Critical Care and Gene-Chip, there must be congruity between the leadership styles and personalities of the top managers. Furthermore, leadership must blend together the two distinct frameworks that have existed independently, to reframe the dominant organization.

To many of those who read the case:

> The conversation between Critical Care and Gene-Chip appears to be a power struggle between the two companies rather than a discussion about organization of the companies. Although Critical Care seems to have more power in the conversation, as they are acquiring Gene-Chip, the tables are quickly turned and Gene-Chip takes over the powerful position in the discussion.

Thus, most concluded:

> This *merger* is headed for a downfall, based on the communication between the representatives of the two companies. The company managers are aware of, but not willing to change, their different styles of managing the companies and are choosing to ignore these differences in hopes that "the ends will justify the means." Unfortunately, it appears that the managers from both companies are looking solely at the benefits the merger will reap in terms of greater economic success, power and growth. In so doing, they ignore the tenet that, in order for a positive merger to work, each party must be willing to negotiate organizational structure and feel confident that pertinent issues revolving around their extreme differences are worked out.

Dissonance: Critical Care and Gene-Chip Scientists

The conversation begins with Warren's description of Critical Care's (CC) organizing structure, but the latent message is more complicated as my students discovered:

> This is a small sample of how the hierarchy functions at CC. Through Warren's meticulous description, the underlying message is that CC is going to be in charge of Gene-Chip (GC), and he expects GC to conform to this hierarchy. He is also implying that GC will be at the lower portion of this chain of command, responsible for discovery work following the merger.

Howard speaks next, but he moves the subject from the "big picture" of Critical Care's structure to a very important focus—what *really* interests Critical Care scientists. This is an important clue that Howard and Warren may have different perspectives about their own firm and, thus, even more divergent perspectives about Gene Chip: not a good sign for future integration of the two firms. If you examine the two-way interaction between Warren and Howard in the opening statements, they do not appear to listen to each other. Howard does not pick up on the theme of Warren (an overview of structure); rather, he voices what might be an underlying worry and, perhaps, source of tension between the two men. Although Critical Care's competence is in development, the discovery scientists (Howard's responsibility) are less interested at that stage. Warren does not respond to Howard; instead, he provides more detail about the development structure. My students noted:

> Warren next re-emphasizes how important the structuring and management of CC is to making the company as powerful as it is. By restating this, the latent message is that he is focused on power and success, he has no intention of changing how CC is organized, nor is he able to relate to any subject below the level of management. GC must find a way to fit into this arrangement, or the merger will not succeed.
>
> When Jonathan responds to Warren, he is very defensive:
>
> As soon as Jonathan started speaking, it was obvious that he was going to be the more dominant force during the meeting. Jonathan presents numerous examples of how the technology that Gene-Chip is bringing to the merger will make Critical Care a stronger company, implying

> that Jonathan is trying to establish a dominant position for *his* company in the merger.

Jonathan is really more than defensive in this first utterance; he is amazingly critical:

> It is surprising how blatantly Jonathan compares the two cultures. Throughout the conversation, Jonathan challenges the culture of Critical Care, by citing many differences between the two companies. For example, he remarks: "First, we have an independent attitude and, second, Gene-Chip is a young and very energetic company." Jonathan states that his company is young, energetic and willing to work together for the company success. On the other hand, Jonathan is condemning the culture of Critical Care, suggesting that the company is old and stagnant.

It is important to reflect on why Jonathan might be so negative. After all, Critical Care has just paid $350 million for the firm, and he (Jonathan) stands to be in a senior position at Critical Care. One reason for his defensive retort could be Warren's original description of the size and structure of the acquiring company:

> From Warren's statements it appears that Critical Care has no intention of altering their structure but rather intends to simply add Gene-Chip to their existing organizational body. Critical Care top managers will remain the decision makers, eliminating the autonomy to which Gene-Chip is accustomed. Critical Care fully intends to maintain its current structure. The organization of the newly formed entity appears non-negotiable.

Warren's response implies that he has "heard" Jonathan's defensiveness—he begins with "Well. . . ." However, he then focuses on what he may hope is a topic on which all can agree: the marriage of biology and electronics.

There is a very interesting theme throughout this short excerpt: *fitting in.* The first time the theme appears is in Warren's sentence that this is where "Gene-Chip fits."

> Warren blatantly ignores the critical conflict between the philosophies of the two companies and changes the subject to the bigger picture of the acquisition. It may well be that this small paragraph foreshadows the ultimate failure of the merger.

Jonathan's continued defensiveness could be a result of his sensitivity to where Gene-Chip fits in the large, structured organization of Critical Care. A number of students noted:

> When Jonathan comments that Gene-Chip will "bring technology forward," this suggests that Critical Care is behind the times in terms of technology. Jonathan defines their role as a development company, stating ". . . you license products, develop them, and bring them to the market." In doing so, Jonathan is trying to assert Gene-Chip's superior research capabilities and create a boundary between research and development in an effort to maintain Gene-Chip's autonomy in the research phase.
>
> Jonathan's analogy of a "corporate life cycle" suggests that, with the addition of Gene-Chip, Critical Care will be re-born. By using the phrase "real research capacity," Jonathan suggests that Critical Care is not currently as adept at research as they would like to think. This puts Critical Care back in their place and serves to remind them that their strength lies in development. Jonathan makes it very clear that Gene-Chip is an asset to Critical Care and that they need Gene-Chip in order to achieve their goals.

Interestingly, and significantly for the future of the two companies, Jonathan begins his statement by saying "my goal." This reinforces the dominance of both Jonathan and Gene Chip, at least in this conversation. Jonathan also describes Gene Chip's competence as formidable and contends that the tiny company will propel Critical Care into the future:

> Jonathan continues on as the harbinger of all that is new and innovative, and ruthlessly challenges their capabilities when he says, "the critical task [of CC] will be to build a *real* research capacity."

The introduction to the case describes the two companies, but superficially. Jonathan, however, appears to have conducted due diligence and is quite familiar with the acquiring company:

> Most of the information we glean about both companies is through Jonathan's statements. "I've noticed that the Critical Care's new facilities are divided up." Warren and Howard do not challenge Jonathan, but allow him to continue the conversation. We can see at this point that Jonathan knows specific facts about the company, and Warren and Howard cannot challenge the truth.

Again, Howard responds to the implied subordination of Critical Care's scientists to the researchers at Gene-Chip:

> His reference to the "worst case scenario" for the merger has a larger meaning. Howard is trying to envision the merger as an integration of the two companies, while at the same time keeping them separate—yet, his worst case scenario is just that. He is unsure of the role of the scientists following the merger. Furthermore, he is worried about Gene-Chip's scientists taking over research.
>
> Howard's statement contradicts what Warren voiced in his first comment, where Warren implied that the GC scientists will be at the bottom of the hierarchy after the merger. Because Howard and Warren are consistently offering conflicting arguments, one can hypothesize that they have differing ideas for what roles the GC scientists will hold during and after the merger, or that one is sugar coating the deal.

In some respects, Jonathan begins his next response in an accommodating manner, apparently praising the careful testing and other work required to file a device with the FDA:

> Jonathan's statement that the medical device industry is "based on traditional science" serves to give Gene-Chip the upper hand in comparison to Critical Care. Jonathan's reference to the ""librarianship type of

> activity" that Critical Care performs further suggests that their desire to be a part of the research/technology end is unrealistic.
>
> His choice of phrasing alone implies that Critical Care should stick to what they are most useful for, which is handling the paperwork and "getting to clinical trials, getting over the regulatory hurdles." Jonathan's statement, "I believe Critical Care will help Gene-Chip by teaching us the aspects of bringing devices to market," reveals that Gene-Chip views Critical Care as an asset to strictly further *their* knowledge of development.

Warren clearly hears the insults ("librarianship") and now throws down a gauntlet to Jonathan in terms of competition. Warren focuses on the biologists at Critical Care (the ones "affected most adversely" by Gene-Chip) and states outright that they will be competing directly with the comparable researchers at Gene-Chip. He emphasizes that this competition will be positive and that Gene-Chip's researchers are simply another new challenge to be overcome.

Jonathan backs off and uses the analogy of marriage to describe how Critical Care and Gene-chip will implement the merger. In their discussions about the case study, my students agreed:

> At this point in the conversation, Jonathan introduces the term marriage to describe the relationship between Critical Care and Gene-Chip, suggesting that the partners will be equal. Jonathan reminds Critical Care that the road will be "rocky" in an effort to prepare Critical Care for the changes they will inevitably have to accept in order for these two companies to compromise and meet in the middle. The bottom line for Jonathan, however, is that this acquisition went through for a reason, and that's because these two companies will ultimately complement each other. These comments serve as a wake up call of sorts, saying to Warren and Howard: "The deal is done. Let's make the best of it."

Howard acknowledges the scientific competence of the acquired company but repeats the theme of "fitting in" with respect to how they will accommodate to Critical Care's culture:

Howard begins by complimenting Gene-Chip's scientists, in order to ease into his concerns regarding the merging of these two cultures. By questioning whether or not Gene-Chip's scientists will "*fit in* at Critical Care," Howard is implying that their cultural model should be the foundation for the new culture that will evolve. Howard then goes on to say, "I think they will help Critical Care's culture evolve," in order to end on a positive and recognize the potential contributions that Gene-Chip's scientists have to offer. At this point in the conversation, Howard appears resigned to the fact that cultural change is inevitable.

True to form, Jonathan has the last word:

Jonathan finishes the conversation by agreeing that the culture will be different and emphasizes that the sheer amount of new technology that will be incorporated into CC, by combining forces with GC, will bring about cultural revolution out of necessity. There will be a change in culture and a difficult period of adjustment. Since the new technology will be coming from GC, the new cultural climate will also come from GC.

What Really Happened

The integration of the two firms failed several years after this conversation was recorded. Jonathan was brought to the New York City offices of Critical Care, where he soon became frustrated at being far from the action of research. Warren was sent to the West Coast to manage Gene-Chip research. Many of the scientists left, however, so that Critical Care ended up with a shell of the acquired company. (Howard stayed in the East Coast research facility.)

If the Shannon and Weaver model of communication is held up as a template against the conversations in this case, then problems in both the encoding and decoding steps become clear. These may have arisen, according to some students' analyses, because of:

- Different frames of reference (e.g., highly corporate representatives vs. startups, establishment vs. antiestablishment, youth vs. experience, cynical vs. idealistic)

- Selective listening, especially if it conflicts with established beliefs (the corporate culture is old-fashioned, slow, resistant to new ideas while the startup culture is young and inexperienced)
- Value judgments—assigning a worth to the message prior to receiving the communication
- Source credibility—the trust and faith the receiver has in the words of the communicator based on previous experiences
- Filtering—the manipulation of information so that the receiver perceives it as positive

If you witnessed this meeting (or saw it on a videotape), you would find additional clues about messages sent and messages received. You could observe the body language of Warren and Howard from Critical Care and Jonathan from Gene-Chip and draw some inferences from that as well as their verbal language. Consider the following possible scenario: Jonathan has just completed an hour's formal presentation on Gene-Chip's science in the large and well-appointed board room at Critical Care. When they start their discussion, the Critical Care managers, Warren and Howard, are comfortably leaning back in their chairs while Jonathan sits forward. Warren is at the head of the table leading the discussion, but Jonathan soon takes the lead by raising his voice somewhat and speaking more quickly and emphatically than Warren.

When Jonathan describes Critical Care as "traditionally a development company," Warren and Howard look at each other with alarm. Howard sits up and begins to fidget with his pencil, then leans forward and urges Jonathan to "be careful." Soon, Warren is sitting forward, with Howard and Jonathan sitting back. When the meeting ends, it is Jonathan who is sitting back and smiling at Warren and Howard, assured that they are in agreement with the importance and role of Gene-Chip in the evolution of Critical Care.

ACTIVE LISTENING

The above case study is an excellent example of *inactive* listening—the opposite of what our expert panels described as *listening well.* Because active listening/listening well is such an important skill of leaders, I want to reemphasize that an effective communicator:

- Puts aside bad moods when interacting with others
- Takes *time* to listen
- Looks directly at the other person when speaking and listening
- Is never too busy to discuss results

Active listening is a term used to encompass both a mental stance (i.e., deliberate emotional state) and a set of skills for reducing many of the distortions that prevent mutual understanding.[13] The mental stance required for active listening/listening well is *being nonevaluative* and is based on Carl Rogers'[14] finding that defensive communication can be reduced by the listener's neutrality. If we judge what we hear, then we are not listening well. We need to be open (also a hallmark of effective leaders in our study) and accept the other person and what he or she has to say.

Being nonevaluative is a necessary but not sufficient part of active listening. Skills required to listen well include:

- Paraphrasing manifest content
- Reflecting the implications
- Reflecting underlying feelings
- Inviting further contributions
- Using nonverbal listening responses (e.g., nodding, consistent eye contact).

Consider the conversation among Warren, Howard, and Jonathan and let us construct a very short scenario in which active listening takes place. If we were to "wind the tape" back to the first response by Jonathan ("we have an entirely different approach to structure at Gene-Chip . . .") and assume skill in active listening by Warren, the new dialogue might go as follows:

Jonathan (finishes): . . . so that whatever comes out of discovery can be moved forward rapidly.

Warren (paraphrasing manifest content): If I understand you correctly, your structure at Gene-Chip is in marked contrast to that at Critical Care?

Note that Warren has listened intently to Jonathan's description of how different the structure and attitude are at Gene-Chip, and he has heard Jonathan's emphasis on certain attributes of Gene-Chip ("young and very energetic").

Jonathan (Repeats): Yes. We don't have small rooms but open space; and, we have no corporate staff or hierarchy.

Warren has established that he has listened nonevaluatively—however he may feel about Jonathan's own mental stance!—and Jonathan has agreed with Warren, a positive start to more effective communication. Next, Warren reflects the implications of Jonathan's emphatic distinctiveness, which suggests there may be difficulty integrating the two companies.

Warren (reflecting the implications): So, these marked contrasts in facilities and in administration might affect how the two firms work together?

Warren states this as a question, allowing Jonathan to remain in charge of the conversation as opposed to feeling maneuvered.

Jonathan: I think we are *so* different that it won't be easy to integrate Gene-Chip's discovery scientists into Critical Care's development-oriented structure.

With this admission, Warren can now begin to elicit the values and attitudes that Jonathan brings to the acquisition by reflecting back to Jonathan the likely underlying feelings. It is important that Warren remain nonevaluative; otherwise, Jonathan will be put on the defensive.

Warren (reflecting the underlying feelings): If I were in your place, I would be worried about my scientists and their role in Critical Care's strategy. I would also feel that what I worked so hard to achieve might be lost in Critical's large organization.

Jonathan: Your company is so big that it's not clear if Gene-Chip scientists will be more than a West Coast appendage! How can I reassure them that they will be valued for their competence in a discipline totally new to Critical Care?

We are now at a point in the dialogue that real communication can take place. Warren, who has been using nonverbal responses (leaning toward Jonathan when he speaks, nodding at the statement above), now invites the further contributions that will influence whether the acquisition succeeds or fails.

Warren (inviting further contributions): Help me understand what Gene-Chip scientists expect will happen in this acquisition. And, what role do you believe they should play in terms of our strategy of succeeding in this next era for Critical Care?

In this ideal situation, Warren's active listening skills begin to uncover the issues that, in the case study, may have accounted for Jonathan's strong defensive reactions. This is not to say that the integration of the companies would proceed smoothly, but at least the process would get off to a better start than actually happened.

As was illustrated by Warren's responses in this scenario, some general responses for active listening can include[15]:

1. Paraphrasing manifest content: "*As I understand it, you are saying. . . . Do you mean . . . ? If I try to summarize what you said. . .*"
2. Reflecting the implications: "*If you did that, you would be in a position to. . . . So that, might lead to a situation in which. . . . Are you suggesting . . . ?*"
3. Reflecting underlying feelings: "*Does this make you anxious? If that happened to me, I would be upset. How are you? That sounds very gratifying. . . .*"
4. Inviting further contributions: "*Tell me more about that. . . . Help me understand about. . . . What happened then . . . ?*"

This brief review of a new dialogue between Warren and Jonathan is not meant to diminish the work required to ensure successful integration of two such disparate organizations. Rather, it is meant to illustrate how listening well (actively) can ensure more effective communication. By the end of such a scenario, Warren and Jonathan might actually understand each other's messages as they were intended, and they might begin to share a similar concern that scientific competence be appreciated and preserved. (I continue to believe that active listening might even have ensured the success of the integration.)

GIVING CONSTRUCTIVE FEEDBACK IN LABORATORY

I want to conclude this chapter on communication with a summary of tactics that address one of the most common communication problems experienced by scientists in our expert panels: giving feedback to others in ways that would not be felt as personal attacks and would leave no resentment behind. First, although I do not believe in giving negative examples, in giving feedback, the leader *must never*:

- Publicly humiliate
- Be abusive
- Provide only negative feedback
- Nag continuously
- Belittle
- Berate
- Denigrate

Readers will recognize this list from Chapter 1, in the description of the ineffective leader. These are behaviors that must never characterize a leader's feedback or those who receive it will certainly feel attacked and resentful.

Instead, in giving feedback, you must praise, tell people when they have done something right, and convey appreciation for work accomplished in the laboratory. Giving feedback effectively requires you to be on the watch for misunderstandings in the communication process and to ensure that you ask for feedback as well as give it. You must understand your own biases; all of us are subject to perceptual distortions, not only those to whom we "send the message."

Effective leaders give feedback by also listening well/ listening actively. They (and these are important enough to be repeated often):

- Put aside bad moods when interacting with others
- Take *time* to listen
- Look directly at the other person when speaking and listening

Effective leaders are nonevaluative and use nonverbal listening responses (look at the other person directly). They are able to reflect on the underlying feelings of those whose work is assessed or whose direction has to be altered. They invite further contributions in an interchange about the course of an experiment.

In short, effective leaders communicate and listen effectively. Scientists and technicians will understand their ideas and expectations because they are articulate and direct. Those in the laboratory will share their vision and enthusiasm because effective leaders can share the ideals and passion for research.

NOTES

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6. Valian, V., *Why So Slow? The Advancement of Women,* Cambridge, MA: MIT Press, 1999, p. 3.
7. Park, op. cit.
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9. This discussion benefits from my collaboration with Diana Stork (and Joseph

Lombardino) on the book *Leading Biotechnology Alliances: Right From the Start,* New York: Wiley-Liss, 2001.

10. This section owes a debt to Jay Galbraith, whose book on complex organizations, *Designing Complex Organizaitons,* (Reading, MA: Addison-Wesley, 1973) described uncertainty and its impact on the design of work.
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6
DEALING WITH CONFLICT

Every lab gets into conflict every now and then . . .

To paraphrase the expert panel respondent cited above, no organization is without conflict at some time or another. However, not every disagreement is indicative of conflict. An environment of intellectual challenge supported by norms of candor should characterize a creative laboratory—and challenge and candor will inevitably produce debate and disagreement. The conflict that is the subject of this chapter is disagreement that literally gets in the way of work. Such disagreement produces indecision, uncertainty, anxiety, frustration, and anger. In contrast, the disagreement produced in a climate of intellectual challenge is full of enthusiasm and excitement. When conflict occurs, much of people's energy is spent not on work but on trying to deal with their feelings. Healthy disagreements result in more productive efforts, not less.

If conflict is a fact of life in organizations, then you must learn to resolve it skillfully; otherwise, you risk being deemed an ineffective leader. According to our expert panel respondents in Chapter 1, the second most frequently listed description of why leaders are ineffective is that they cann deal with conflict. Instead, ineffective leaders (in scientists' own words):

- "Relied on avoidance and smoothing of conflicts"
- "Took no responsibility for dealing with unpleasant issues"

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- "Avoided dealing with problems"
- "Allowed problems to fester"
- "Routinely avoided even the possibility of confrontation"
- "Let problems linger"

Dealing with conflict was also given as the second most frequent difficulty respondents face in terms of typical problems they encounter. Respondents also noted that conflict in the laboratory reduced productivity. As described in Chapter 1, until conflict is resolved, it tends to draw in formerly disinterested parties. Scientists and technicians take sides. Even those who are marginally involved find that more and more of their energies go to the conflict situation rather than the science. That is why you must deal with conflict swiftly and effectively.

In this chapter, I describe potential sources of conflict in the scientific workplace and the most effective conflict resolution methods. I begin with possible sources of conflict because there is no use intervening unless you have some confidence that your solution addresses the problem. As in medicine, without intelligent diagnosis, you run the risk of exacerbating an already troubled situation. Short scenarios using characters and situations from prior chapters are provided to illustrate conflict resolution techniques.

POTENTIAL SOURCES OF CONFLICT

The word *conflict* comes from battle terminology and means the striking together of opposing forces. Conflict implies differences, and the major sources of differences in any organization also represent the major potential sources of conflict. It must be emphasized that these are *potential* sources—not every difference leads to conflict. The following discussion focuses on differences inevitably found in science organizations that are also likely sources of (i.e., may lead to) conflict. You cannot eradicate differences, but you must understand these sources in order to intervene more appropriately.

Scientists in our expert panels described three types of conflicts that they faced. One was personality conflict (people conflicts, interpersonal problems, people in the laboratory not talking to one another). A second was conflict among groups, implying groups over which one had no authority. The third was conflict that involved an asymmetry of power, such as conflict between junior and senior faculty, between a postdoc and the PI, or between a PI and the director of the facility. Included in the latter type of conflict was the ubiquitous *authorship conflict* as well as conflicts over *limited resources* (space, equipment). The three types of conflict mentioned by our expert panels reflect the primary sources of differences in science organizations: (1) individual differences, (2) organizational differences, and (3) power differences. These are reviewed below.

Individual Differences

Your and your colleagues' dominant work-related need (power, achievement, or affiliation; Chapter 3) and associated leadership style (task or relationship focused; Chapter 4) constitute important sources of individual differences and potential conflict. The reason, as implied in Chapter 4, is that the way you inspire others and direct them in a course of action, in decision making, and in problem solving is in large measure determined by the above aspects of your personality (or, the human aspects of your personal competencies). By the same token, how you communicate and how you deal with conflict is also influenced by these two aspects of your personality.

These differences in personality are a likely source of conflict because different people may behave very differently when faced with the same issue (but they will *perceive* it and behave consistently with those human aspects of their personal competencies). For example, if you have a high need for power coupled with a very task focused style, you will perceive the world and behave differently from a colleague with a high need for affiliation coupled with a very relationship focused style. Thus, what you or a colleague may initially believe is stubbornness, willful disregard of "facts," or a contrary stance in another person may simply be a reflection of these differences. If they are not recognized for what they are and if people believe that another's perception and behavior are intentionally opposing, then conflict may be the result.

In addition to being different by virtue of these aspects of personality, people differ from each other by virtue of gender, race, ethnicity, and age (what might be termed manifest or visible differences,) as well as by education, background, experience, religion, political persuasion, and so forth (latent differences). As discussed in Chapter 2, humans are adaptively adept at recognizing patterns from sensory data and deriving categories. Some categories may become belief systems or schemas, "implicit, or nonconscious, hypotheses" about how a class of people does or should behave.[1] Schemas/belief systems are the foundation of attitudes, which are predispositions to behave in a way that confirms our belief systems.

An individual who holds the belief system "older scientists have lost touch with the state-of-the-art" is predisposed to act toward people in that class as if they have lost touch with their field. Complicating the matter is that a person with an unrecognized schema/belief system rarely perceives disconfirming evidence but "re-fences" the belief system to exclude an anomalous individual.[2] For example, an older scientist who is in the forefront of the field may be put into another class, such as "MIT scientist" rather than "older scientist," by the person holding the stereotype.

Unrecognized schemas and the resulting distorted perceptions are not limited to gender, race, ethnicity, or age. People may hold stereotypes about academic versus industrial scientists, MBAs, Democrats, Mormons, salespeople, mid-Westerners, and so forth. Again, we cannot avoid belief systems about various classes, such as *the research of academic scientists is free of the pressures of commerce,* but failure to recognize "how our perceptions are skewed by nonconscious beliefs" and then behaving in conformance with those beliefs are almost guaranteed to produce conflict.[3]

Organizational Differences

The nature of scientific work (actually, any complex organizational effort) produces two principal sources of organizational differences. One source of differences arises by virtue of the interdependence of tasks, whether tasks be carried out by individuals or large departments. Like personality and belief system differences, *task interdependence* cannot be eradicated, but it is a likely source of conflict among groups.

There are three types of task interdependence.[4] *Sequential interdependence* implies that task A must be done before task B can be initiated, and task B must be completed before task C can start, and so forth. In biomedical R&D, for example, drug discovery (task A), preclinical development (task B), clinical trials (task C), production (task D), marketing (task E), and sales (task F) are sequentially interdependent tasks. A compound must be discovered (task A) before it can undergo preclinical development (task B), which must be completed before clinical trials can start (task C), and so on, until the product is sold on the market (task F).

In sequentially interdependent tasks, conflict is likely to arise if one task is delayed, if the output from one task is not of the quality expected by the person or people responsible for the following task, or if incomplete or inaccurate information accompanies the product from one task to the next.

Pooled interdependence implies that all the input tasks must be completed before the output tasks can begin. Pooled interdependence accompanies mediating technologies, technologies that link customers with the desired outputs, such as moving money from a bank to borrowers. Clearly, for example, money must be accumulated via the input tasks of accumulating and investing it before it can be "output" as loans. In the above example of biomedical R&D, pooled interdependence occurs within the task of clinical trials. All the patient information from clinical trial physicians must be gathered and processed (input tasks) before each set of required regulatory documents can be submitted (output task).

In pooled interdependence, conflict is likely to arise if some of the inputs are received in nonstandard format, if too few inputs are received to produce the desired output, or if inconsistent processing of inputs results in inconsistent quality of output. Pooled interdependence requires the rigorous application of uniform standards to both inputs and outputs and sufficient volume of inputs to warrant the output.

Reciprocal interdependence implies that the output from one task (task X) is the input to another task (task Y) and the output from Y is the input to X as well. Reciprocal interdependence occurs often in a research laboratory. For instance, the output from a nuclear magnetic resonance (NMR) analysis (task X) may be a molecular structure that is the input for chemical synthesis (task Y) and the output from chemical synthesis is a compound that will undergo NMR analysis. This iterative and reciprocal processing continues until the chemistry department is satisfied that the compound structure matches what was desired.

In reciprocally interdependent tasks, conflict can occur if either output is delayed, if either output is not of the quality required, or if incomplete or inaccurate feedback accompanies either output. Note that the potential sources of conflict are the same as those in sequentially interdependent tasks but the intensity of conflict is much higher (there is less slack). Of all types of task interdependence, reciprocal interdependence is most likely to be a source of conflict. In the laboratory, reciprocally interdependent tasks should be physically close to one another, people involved in the tasks should reach consensus on the desired quality of outputs, and they should have a basic understanding of both tasks to ensure that appropriate feedback will be given.

The second source of organizational differences arises because the scientific organization is *differentiated* by discipline (and specialty, skill, function). As described in Chapter 5, each discipline, specialty, skill, or function represents a group of people who share common training and experience and a common language, which is why there are likely to be language barriers between groups. Like personality differences, discipline and the other organizational differences result in a particular way of looking at the world and behaving in response to that perception. There are numerous amusing (and some not amusing) anecdotes about the differences between chemist and biologist, clinical physician and molecular biology PhD, research scientist and project scientist, hardware engineer and software engineer, and so on. Again, what may appear to be intransigent or wrongheaded behavior on the part of a colleague may simply be a manifestation of organizational differentiation.

A pioneering study (in nonscience firms) revealed that

> differentiation contributes to differences in attitudes and behaviors on the part of members of the differentiated departments. These differences include orientations toward the particular goals of the department, emphasis on interpersonal skills, and time perspectives. Departments, therefore, vary not only in the specific tasks they perform but also in the underlying behavior and outlooks of their members.[5]

If we substitute *functional groups* (or specialty units, etc.) for *departments* in the above citation, then organizational differentiation is clearly a source of conflict.

Power Differences

Perhaps the most obvious source of differences in the science organization is power:

> There is general agreement that [power] has to do with relationships between two or more actors in which the behavior of one is affected by the behavior of another. . . . The power variable is a relational one; power is meaningless unless it is exercised. . . . .Power relationships entail mutual dependency.[6]

The greater the dependence of one individual or one part of the organization on another, the greater the ability of the more powerful to influence the less powerful. Power derives from having resources that another wants and being in control of their allocation, especially when there are no alternatives. If there are alternatives (whether they are being used or not), the power of the agent holding the resources is diminished.

In the science workplace, junior faculty are dependent on senior faculty for promotion and tenure; postdocs are dependent on the PI for intellectual support and a good reference at the end of their fellowship; the PI is dependent on the director of the facility for appropriate laboratory space, organizational support, and so on. In each instance, one agent has control of the allocation of resources the other agent needs/wants, and there may be few (or no) alternatives. In fact, in the three examples just listed, the differences between the powerful agent and the dependent agent may be so marked as to constitute an *asymmetry* of power.

In each of the above examples, what the powerful agent controls is *access.* Senior faculty control access to visibility opportunities, key information, critical relationships, authorship order, space, equipment, and funds. The PI controls access to the appropriate direction of experiments, visibility opportunities, key information, critical relationships, references, space, equipment, and funds. The director controls access to general support, visibility opportunities, key information, and critical relationships. These differences (or asymmetries) in control of access between the powerful and the dependent agents in science organizations are also potential sources of conflict.

CONFLICT RESOLUTION

Most management texts describe five approaches to conflict (note that I said "approaches," because not every approach "resolves" conflict). One of the most common approaches is *avoidance*—which is somewhat of an oxymoron, because avoiding conflict is the opposite of approaching it. In a very few situations, avoidance may be appropriate. For instance, if an individual is in serious emotional distress, then at that moment the leader needs to help him or her find assistance rather than to deal with the conflict.

The problem with avoidance is simple: "Avoiding a conflict neither effectively resolves it nor eliminates it. Eventually, the conflict has to be faced."[7] Interestingly, avoidance was mentioned most often by the expert panels as the typical approach of the ineffective leader ("allowed problems to fester"). As one scientist said:

> [X] hates conflict and avoids it, letting problems linger rather than dealing with them. As a result, the parties "duke it out" until the problem is much bigger, which hurts morale, any cooperative spirit, and collaboration.

Another common approach to conflict in many organizations is *smoothing.* The term implies that the leader minimizes the differences between individuals or groups and emphasizes the commonalities (smoothes the bumps between them). Occasionally, smoothing is helpful, particularly if the parties generally get along well or if the issue is minor. "But, if differences between groups [or individuals] are serious, smoothing—like avoidance—is at best a short-run solution."[8] In the words of another respondent:

> [Y] relied on avoidance and smoothing of conflicts. This was ineffective, because it left the decisions to subordinates, who had no authority and whose decisions threatened the leader's authority.

A third approach to conflict is *compromise*—each party gives up something or shares a resource equally (whether equitably is another matter). In some authorship situations, compromising ("you be first author for this one, I'll be first author on the next one") may be an effective resolution of conflict. Similarly, compromising over some resources may be effective ("your group uses the spectrometer on Tuesdays and we use it on Thursdays"). For most other conflict situations, the effectiveness of compromise is problematic: "With compromise, there is no distinct winner or loser, and the decision reached is probably not ideal for either group."[9]

A fourth approach is *forcing,* that is, using authority to command a particular decision ("you will *only* use the spectrometer on Tuesday"):

> [Forcing] usually works in the short run. As with avoidance, smoothing, and compromise, however, it doesn't focus on the cause of the conflict but rather on its results. If the causes remain, conflict will probably recur.[10]

In some time-critical or crisis situations, forcing may be the appropriate option. When time permits, however, the real source of the conflict must be addressed.

What approach is effective? *Confrontation* has been found to be an important technique because it addresses certain *causes* of conflict, such as individual and organizational differences:

> The confrontation method of problem solving seeks to reduce tensions through face-to-face meetings of the conflicting [parties]. The purpose of the meetings is to identify conflicts and resolve them. . . . For conflicts resulting from misunderstandings or language barriers, the confrontation method has proved effective.[11]

Resolving Individual and Organizational Differences

When most people read or hear the term *confrontation,* what is conjured up in their minds is an image of two red-faced individuals arguing heatedly. Certainly, one meaning of the verb is "to accuse," but the sense in which it is used in this chapter is based on its derivation from the old French term for *sharing a common frontier.* To be skilled in effective confrontation is to be skilled in finding the common frontier between you and another person. This requires going beneath the surface, probing and exploring issues, to discover the common ground. And, probing and exploring will involve acknowledging your own and the other person's feelings as well as perceptions, emotions, and ideas. As should be clear, skillful confrontation depends on active listening skills (which will be illustrated in the conflict scenarios). There are other straightforward and commonsense guidelines for effective confrontation.

Know Yourself. Becoming skilled in effective confrontation begins with understanding your personality—work-related needs (Chapter 3) and leadership style (Chapter 4). For example, if your style is to focus on the task, you must be cautious not to neglect the feelings aroused in you and the person you confront. If your style is to focus on relationships, you must be cautious not to avoid exploring areas that may be painful to the other person (and therefore painful to you as well).

Have an Agenda. Having an agenda means that you have thought about what may ensue during confrontation and you have a plan based on your reflection. The agenda can be:

- Written and distributed ahead of time
- Written and distributed at the meeting
- Reviewed orally at the meeting
- Kept in your head

There are reasons for each of the above tactics. Distributing a written agenda ahead of time conveys the manifest message (cf. Chapter 5) that the other person should come prepared to the confrontation meeting. Distributing the agenda at the meeting, either in writing or orally, allows you to set the focus and sequence of the discussion, which may be helpful under certain circumstances. It is sometimes appropriate to take the other person off guard, if by doing so you believe you can reach your "common frontier" more quickly. Keeping the agenda in your head is appropriate for the situation in which (1) you know the other person very well, (2) the issue you are confronting is minor, or (3) you believe this will help to keep the person from becoming extremely defensive before the meeting.

Rehearse. Effective confrontation requires that you think through the possible scenarios. In the best case, you and the other person readily find your common frontier and you are able to resolve the conflict. In the most likely case, the person will at first become defensive and argue, and you will have to engage in intense active listening before resolution is possible. In the worst case, the person "blows up," and you have to deal with very strong emotions (tears, shouting, etc.). Thinking through the confrontation scenario is actually an important learning tool. In the words of a prominent learning theorist, "mental rehearsal . . . increases proficiency."[12] To be skilled at conflict resolution, you must mentally rehearse.

Choose an Appropriate Location. As you rehearse the scenario, consider the latent messages conveyed by the meeting place. Before you call a meeting in your office or the other person's, in a boardroom, in the cafeteria, or at an outside restaurant, reflect on the implications of the location. If you choose your office, you are sending the message that you are in charge. If you choose the other person's office, you are in effect stating that you are both on equal footing. If you choose the boardroom, you imply that this is a formal meeting. If you choose the cafeteria or a restaurant, you imply that this is an informal meeting.

Dealing with Power Differences

Although effective in resolving conflicts caused by individual or organizational differences, confrontation is less effective than some other approaches for conflicts caused by power differences (or relational asymmetry). One approach to conflicts resulting from power differences is the *superordinate goals technique.* This involves

> developing a common set of goals and objectives that can't be attained without the cooperation of the [parties] involved. In fact, they are unattainable by one [party] singly and supersede all other goals of any of the individual[s] . . . involved in the conflict.[13]

For example, both senior and junior faculty may want the prestige deriving from a national research grant (such a grant would also help the junior faculty in the tenure process). Achieving the grant is the superordinate goal, and the junior faculty can discuss her inclusion in the grant submission by framing the issue as one of contributing to this goal attainment, as opposed to trying to resolve the power asymmetry through confrontation. In another instance, a postdoc may frame his need for access to the PI for consultation on an experiment as contributing to the PI's developing reputation in the field (again, rather than trying to resolve the power asymmetry). Clearly, a reference from an even more highly reputable PI will be of benefit to the postdoc. Finally, a PI may present her need for equitable space by framing this as one means of contributing to the stature of the director's program.

All these instances presume a willingness to discuss the issues by the more powerful person. The reality may be that a power asymmetry represents too high a gradient for meaningful communication between parties. For example, much has been written about the situation of postdocs. Despite the formation of special offices in the university, postdoc associations, and postdoc councils (at the state level), many of these scientists-in-training remain feeling "neglected, taken advantage of, and most of all, disillusioned."[14] And, for every scientist encouraged by a mentor in his or her experimentation, there are others who are capable but not supported in their attempts to climb "the career ladder."[15] Although not a conflict resolution technique, banding together in the face of power asymmetries and trying to make a general problem (e.g., postdoc treatment) more visible can sometimes achieve results. Dependence in power relationships is a difficult situation to alleviate, and I do not assume that conflict resolution techniques can provide the answer.

CONFLICT SCENARIOS

Despite the somber note regarding conflict situations involving power differences, most conflict situations are resolvable. To illustrate some approaches, several brief conflict scenarios are provided. The first two scenarios are based on the example in Chapter 5 of the meeting to discuss visitors from the corporate board. At that meeting, one of the communication problems, distrusted source, arose because of experience differences among the individuals. In that example, the manager had come from academia to industry and appeared to be stereotyped as an "ivory tower" scientist by one of the staff.

Differences in Experience as a Source of Conflict

You (Dr. A) have observed for some weeks that a staff member (Dr. B) is not committed to your plans for the organization. She is cynical about your vision for the future, refuting a number of statements behind your back and arguing in meetings about your intended strategic direction. Worse, her cynicism is beginning to affect a number of the scientists who were originally enthusiastic. She has worked in industry since receiving her PhD and appears to have stereotypical views of academic scientists. After identifying this as the likely source of the conflict, you decide to call her into your office and confront her. You decide to keep the agenda in your head.

Dr. A: Thanks for meeting with me this afternoon. I want to talk about some concerns I have about the way you and I are working together. I feel that you're not confident I can lead this organization.

Dr. B: Why do you say that? I've never said you were unqualified. . . .

Dr. A: You've never said to me that I was unqualified, but I have noticed that you're clearly less than enthusiastic about my plans for this group. I wonder if you're worried about me in particular or just academics who come into industry?

Dr. B: I know you have the right degrees and scientific experience, but you don't have much understanding of corporate R&D. It's not like academia, where you can tackle a problem because it's interesting and not worry about the commercial consequences.

Dr. A: I appreciate that my lack of industrial experience is cause for concern. I believe, though, that there have been changes in academia you may not appreciate. I've always been interested in the application of my research to "real-world" problems, and I had to seek corporate funding for much of my work. So, I have some understanding of the commercial implications of what we do.

I also know you have enormous industry experience, and I would like to be able to use that expertise in building our capabilities. I am concerned that you appear unwilling to contribute in positive ways to our group discussions.

Dr. B: I wasn't aware I was not contributing. . . .

Dr. A: What I've observed, and I'm sure it was unintentional on your part, is that you react very cynically to my ideas, putting them down without a good rationale, arguing with me, and not proposing alternatives. What is now very worrisome to me is that other members of the staff, who were previously enthusiastic, are sounding much less committed to change.

I'm sure you don't want to undermine my position, but you have influence in the group based on your experience with the company. And, it's that experience I want the whole group to be able to rely upon.

In this scenario, Dr. A would further explore the issue of academic experience versus corporate experience and the possibility of stereotyping, always returning to the common frontier of the best interests of the whole organization. Note that the leader made sure that Dr. B faced the fact that her behavior was detrimental to the group, not just to Dr. A. And, Dr. A gave her the opportunity to acknowledge that she was unaware of her behavior's effects on others.

In a worst-case situation, this person may be trying to sabotage the leader's efforts. If so, the initial confrontation will serve to put the scientist on notice that this behavior will not be tolerated. The manager may have to set up another confrontation meeting, including a person from human relations and with a written or oral agenda, to help Dr. B change, or to find another position outside the group.

Organizational Differentiation as a Source of Conflict

In the second scenario, another communication problem, defensive behavior, arose because of organizational differentiation: the chemical synthesis versus high-throughput screening groups.

It was not until the meeting to discuss the corporate visitors that you (Dr. A) realized how defensive this staff member (Dr. C) was regarding his production group. As you reflect on this over the next few days, you realize that the scientist in charge of chemical synthesis believes the high-throughput screening scientists are privileged because they are working with state-of-the-art equipment. Those scientists have reinforced his perception because they appear quite unconcerned about pragmatic problems in synthesizing compounds. You ask to see the director of the chemical synthesis department in his office and you keep the agenda in your head.

Dr. A: I just wanted to tell you how much I appreciate your work with this production group. As I think about the organization's future, this group will play a big part in achieving the research vision of the corporation.

Dr. C: It will. We have a superb group of scientists—and manufacturing engineers and techs—working at the cutting edge of computer-automated production. Three of them just presented a paper to the [international society].

Dr. A: I saw that and I spoke to them. Clearly, you have recruited good people and managed the group so that they enjoy working here. I also hope that your department and the new high-throughput screening group will work closely together because I believe the next breakthrough for this organization will come from your collaboration.

Dr. C: Well, we let them know if we're having a meeting to discuss our work, but they seem to be off in their own world most of the time. They just don't appreciate the practical problems of synthesizing some of the difficult compounds.

Dr. A: I'm sure they don't understand anywhere near the level of detail that you and your staff do. But, you and they can learn from each other. I really encourage you to see how you can be helpful to the director of that group. And, I'll make sure she understands what contributions your group can make to the work they're doing as well.

In this scenario, the leader and the director of chemical synthesis would continue to explore how the two groups could work together for the common good of the company. In the process, the leader would reinforce the director's value to the organization. Dr. A would also arrange to meet with him and the director of the prototype facility to give visible support to collaboration across disciplines.

In two cases presented previously, conflict got in the way of work. in Chapter 3 when Geoff was promoted over Shelly and in Chapter 4, when Lee moved a corridor of scientists. In each case, the conflict arose from differences in personality (work-related needs and leadership style).

Differences in Work-Related Needs: Shelly and Geoff

After moving to the smaller company, Shelly and Geoff worked in related departments until their director took a position in Asia and named Geoff his successor. When Geoff was promoted, Shelly was "hurt and furious at being 'passed over.'" She spoke only if spoken to, and everyone in the laboratory was aware of how she felt. Consistent with his dominant need for affiliation, Geoff let this continue for nearly 3 months, avoiding the problem rather than facing Shelly with the painful truth that he would make the better manager. Consistent with her dominant need for achievement, Shelly had viewed the promotion as a deserved reward for her accomplishments, rather than representing a fundamental change in work expectations. She responded to the perceived oversight with distress and anger.

In the following scenario, Geoff has asked Shelly to meet with him in a neutral location, the conference room. He recognizes that his need for affiliation was keeping him from facing this difficult problem with his friend, and he arranges a meeting the second week after the promotion because he realizes the impasse is detrimental to everyone. He gives Shelly the agenda when they sit down (rationale for promotion, role of lead scientist, and importance of working together).

Geoff: Look, I know you're upset, but we have to talk.

Shelly: What do you mean? We have been talking. I told you the equipment we needed was delayed because of the transit strike. . . .

Geoff: [Interrupting] You know what I mean. You've been very abrupt all week and you barely speak to me. It's clear to me that you're upset about my promotion.

The promotion has nothing at all to do with the intrinsic worth of either one of us. You're the best scientist we have. It would have been foolish to pull you away from what you do best and jeopardize the potential breakthrough. I'm a competent scientist, but I really believe that I'll make a better manager.

Think about it. As the manager I can help you get all those supplies and equipment and technicians you need, and you can continue with the work you love to do. Don't be angry about this.

Shelly: I'm not angry. . . .

Geoff: It appears to me that you're acting as if you're angry, and I'm very upset as a result. You have been very curt during staff meetings, and everyone believes that you're unhappy about my promotion.

I know it sounds trite, but we have to work together if this company is going to survive. That's why I wanted to talk to you.

In this scenario, the initial confrontation would require a lengthy and emotional encounter. Geoff would actively listen to help Shelly finally admit that she was angry and hurt because she thought her accomplishments were not valued. Geoff would continually reassure her and stress her importance to the organization as a bench scientist. In the best-case situation, Shelly would slowly thaw, and staff would no longer feel caught in the middle.

Note that Geoff has to face Shelly with her behavior and its consequences. He has to emphasize that he feels her anger and is upset by it, and he has to reassure her about her own importance. Emotions have to be recognized and accepted before Shelly and Geoff can move towards their common frontier—the survival of the company and the effectiveness of their group.

Differences in Leadership Style: Lee and Dr. X

At one point in the discussion between Lee and Stefan about their styles (Chapter 4), Lee described how she moved an entire corridor of physicists in order to create a place for another highly regarded scientist. She admitted that the director of the group that was moved was very angry about her decision ("barely spoke to me for months").

Consistent with her task-focused leadership style, Lee neglected to take into account the full impact her decision would have on the people involved. She should have met with this director (Dr. X) well before the move took place.

The scenario described below is based on Lee's awareness of her task-focused style and her desire to avoid precipitating a disagreement that will get in the way of the work of the institute. She sets up a meeting in Dr. X's office, before the move, and sends an agenda ahead of time (laboratory space issues, effective use of major equipment, and department contributions to overall strategy).

Lee: Thanks for making the time to get together. I want to talk to you about the current location of your laboratory. I've been concerned that you are not as close as you might be to the equipment and colleagues with whom you work, so I've found another site in building A. It's much more convenient, and the space is better suited to the work you're doing.

Dr. X: I hadn't found this location inconvenient. We have to set up appointments to use the other equipment, but that's worked out well. And I like this building.

Lee: Well, I'm sure you're downplaying the inconvenience. Building A is much better, but I have another objective in suggesting this. You know Dr. Z? I know you agree that his work is important for our institute, as is yours. But, right now there is no suitable location for his laboratory, except for this corridor.

It strikes me that the move would be a win–win situation for everyone. You gain more convenient space, Dr. Z gains a laboratory, and the institute gains two satisfied scientists.

Dr. X: Ah—so you want to move Dr. Z here and that's why you're moving me out?

Lee: [She is prepared for this.] Not quite. I really have been concerned

> with your location. In my vision for this institute, your work, as well as Dr. Z's, is important. I want to do what I believe is best for the both of you. The advantages of the new location, for you, are quite obvious: equipment, colleagues, better physical space. And your old location is perfectly satisfactory for Dr. Z. You both gain.
>
> I want you both to be in the best possible sites, so I would like to arrange for this move in two months. What do you need me to do to help bring this about as smoothly as possible?

In this scenario, the physicist would initially be disgruntled about moving, and Lee would have to reassure him that this move was beneficial to everyone. She would be explicit that she wanted the move to take place and was willing to listen to him, to find the common frontier: better space for both scientists.

In the ideal situation, Lee would appreciate that she has to focus on the relationships between her and Dr. X and Dr. X and Dr. Z. After this meeting, she might call the directors together and discuss how they could plan the move so it would be least disruptive to everyone. She would emphasize the gains for each and listen actively to ensure that Dr. X does not feel manipulated but could honestly concede that his laboratory would be better off in the other building. She would also ensure that Dr. Z voiced his gratitude to Dr. X for accepting the inconvenience the move would cause.

CONCLUSIONS

I want to learn how to respond to conflict, in the interest of an amicable resolution.

Responding to conflict effectively was cited as a critical skill by our expert panel respondents. As described in Chapter 1, these scientists found themselves, in their leadership position, refereeing "which music is played in the lab." They discovered that it was their job to "keep people from sniping at each other," to handle jealousy and moodiness, as well as to resolve which experiments have higher priority. Panel respondents also had to deal with space conflicts and limited reagents, conflicts with the director of research in the department, and authorship priorities.

Certainly, the few brief scenarios provided above cannot do justice to actual conflict situations faced by all leaders in science. Nor were they meant to suggest that resolving conflict is straightforward or easy. Handling conflict well is based on both experience and training. Leaders whose conflict resolution abilities I respect have taken courses in principled negotiation; they have been trained in group dynamics; they have studied psychology (including managerial courses in organizational behavior). No one expected you to conduct experiments in molecular biology without training. Why should they expect you to be effective in leading people without training?

Despite the need for training in conflict resolution, much conflict that arises can be defused readily and simply—if caught early. Dealing with the emergence of disagreement that could get in the way of work is far better than waiting for full-blown conflicts among members of the laboratory. Often, emerging disagreements can be settled by skilled active listening. Being taken seriously and realizing that one is heard can resolve many problems. Knowing that one can talk to a caring and compassionate leader allows disputes to be handled as they arise.

The conclusions I would like you to draw from this chapter are these:

- Conflict is inescapable. Its existence does not reflect on your ability or inability as leader.
- Dealing with conflict effectively does reflect on your ability or inability as leader.
- Skill in resolving conflict is based on training and experience.
- Much conflict can be defused by effective communication, especially active listening.
- Being caring and compassionate is fundamental.

NOTES

1. Valian, V., *Why So Slow? The Advancement of Women,* Cambridge, MA: MIT Press, 1999, p. 2.
2. These dynamics were described in *A Theory of Cognitive Dissonance,* by L. Festinger, New York: Harper & Row, 1957.

3. Valian, op. cit., p. 3.
4. See *Organizations in Action,* by J. Thompson, New York: McGraw-Hill, 1967.
5. Referring to Organization and environment, by P. Lawrence and J. Lorsch (1967), in *Organizations,* 8th ed., by R. H. Hall, Upper Saddle Ridge, NJ: Prentice-Hall, 2002.
6. Ibid., p. 107.
7. Gibson, J. L., Ivancevich, J. M., and Donnelly, J. H., *Organizations: Behavior, Structure, Processes,* 10th ed., Boston, MA: Irwin McGraw-Hill, 2000, p. 234.
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9. Ibid.
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15. Park, P., Of mentors, women, and men, *Scientist 15*(13), 32, June 25, 2001.

7

CREATIVITY: INFLUENCE OF STRUCTURE, SIZE, AND FORMAL SYSTEMS

> Creativity is a complex subject. Innovation is a difficult objective. . . . [The] temptation is to give up, and look elsewhere for more tractable propositions.[1]

NONSCIENCE ACTIVITIES AND QUALITY OF SCIENCE

Introduced in the prior chapter on conflict were issues related to organizational administration and management: work design (e.g., task interdependence and departmental differentiation) and performance and reward systems. These constitute, among others, management responsibilities that leaders have to balance with their scientific responsibilities. As our expert panel respondents stated, achieving this balance was their most difficult problem (*becoming a leader,* in terms of balancing scientific efforts with management responsibilities; Chapter 1). In fact, one scientist even declared that he was often overwhelmed by the "NON-SCIENCE activities" now part of his leadership role.

There are a number of nonscience activities that are mundane, such as having to deal with parking and chase after borrowed equipment that is not

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returned (Chapter 1). These should be dealt with quickly and delegated to those with solely administrative responsibilities. Your time as leader must be spent on the nonscience activities that influence the quality/creativity of science—the activities that are the topic of this chapter. In fact, the larger the scope of your role as leader (e.g., multiple laboratories vs. single laboratory, department head, division chief), the more critical are the nonscience activities of designing the structure, determining the size, and creating or modifying the formal systems of your part of the organization. Yes, innovation is a "difficult objective;" but the effective leader of science does not "look elsewhere for more tractable propositions."

This chapter takes up again the Venn diagram depicted in Chapter 3, in particular, the third sphere of *organizational characteristics.* From earlier chapters, it might be concluded that a motivated group of scientists is a necessary but not sufficient condition for creativity. In addition, organizational characteristics must support collaboration, intellectual challenge, candid and transparent communication, and willingness to take risks in order for novel science and technology to emerge. Like the other two spheres of personal competencies and job demands, the third sphere of the Venn diagram encompasses human and technical aspects. The human aspect is culture, addressed in Chapter 9. Technical aspects include structure (how work is organized), size, and such formal systems as recruitment, performance appraisal and reward, decision making and approval, and information systems. Because of their impact on creativity, these are among the most important nonscience activities for you to master to be an effective leader, and they are the focus of this chapter.

The pragmatic question to be addressed is: What structure, what size, and what formal systems are appropriate from the perspective of science quality/creativity? Before addressing that, however, I want to provide a background review of three topics relevant to the creativity of scientific work: (1) attributes of creative scientists, (2) some factors that affect creativity, and (3) organizational-level concepts that foster creativity. The following section draws on the results of a personal selection of studies that I have found reflective of my own experience and observations of creative individuals and groups as well as the influence of social (i.e., organizational) factors on creativity.

CREATIVITY

Attributes of Creative Scientists

From her study of productively creative people—those whom society determined have produced something original, novel, and valuable—Ochse described a number of characteristics that were common to them[2]:

- Intelligence ("well informed, set a high value on intellectual matters")
- Perseverance ("persistent and enthusiastic dedication to work")
- "[F]lexible and open to new ideas [and to] intuitive feelings"
- "Intellectually independent . . . [with a] passionate regard for exacting *standards*"
- "Autonomous and self-sufficient; reject external regulations; need personal mastery; display initiative."

Consider the individual disguised as Shelly (Chapter 3) as an example because later in her career she was recognized as productively creative (in fact, awarded the Nobel Prize).

In the beginning of her career, Shelly focused on a phenomenon that, in her words, had no "existential element, it was simply not an acceptable part of the discipline jargon." Because she was intellectually independent, though, she could tolerate working outside the accepted conventions. She was also intensely curious to know the relationship between a cause and effect she had observed, and she kept "walking around the phenomenon." She convinced one of her colleagues to share her curiosity and walk around the same phenomenon. When he did, the two of them collaborated on the experiment that would lead to Shelly's first breakthrough discovery.

In addition to curiosity about the phenomenon, Shelly was also able to perceive juxtapositions that others had not noticed:

> I like to turn things upside down to see if they are symmetrical. Symmetry and asymmetry of models and theories are important to me. I think about what would be the consequences scientifically if the opposite of what was predicted were true.

Shelly's predisposition to turn things upside down echoes remarks made by Gerald Holton, an academic physicist and keen observer of science and scientists. He found that creative scientists were able to provide insight into a phenomenon "in a way that amounts to a special perception."[3] He later described "sensitivity to previously unperceived formal asymmetries or to incongruities of a predominantly aesthetic kind" as common to creative scientists.[4]

Finally, consider how persistent and dedicated Shelly was. When she described her work in the small company, she commented:

> I don't remember any decisions one way or the other. The truth is, I just went on working. . . . As long as our salaries were being paid, as long as I had all the technicians I needed and the right equipment, I just kept on with the experiments.

What are some implications of these attributes for you as leader?

Ochse stated: "You would be wise to put your money on those who have been very creative in the past when you bet on who will be creative in the future."[5] In other words, if you are looking to hire creative individuals, seek evidence that they have been creative in the past, even as undergraduates or in jobs outside science. You want to be confident that they possess the above personal attributes (personal competencies) in addition to the required scientific and technical competence (job demands).

Some Factors That Affect Creativity

Ochse also observed that "the development of transcendent creativity . . . is impeded by confinement to a narrow perspective—to a limited range of information and poor standards."[6] Harrington noted in his positively stated definition of a "creative ecosystem" that the opposite factors supported creativity: interesting problems, access to new techniques, norms for sharing information, people with complementary skills, and people able to recognize and develop what is valuable.[7] The latter, you may notice, were hallmarks of the organizations in which Geoff and Shelly initially worked (Chapter 3).

Other studies reveal remarkably consistent responses to the question of what inhibits creativity. Creative people do their work because it is inherently interesting, enjoyable, and satisfying. As a consequence, they do not respond to such extrinsic "motivators" as management pressure, project evaluations, or competition for rewards. Studies of scientists at the Center for Creative Leadership revealed that organizational factors were considered to be much more important than personal factors in inhibiting creativity. Prominent among these organizational factors were[8]:

- Constrained choice
- Overemphasis on tangible rewards
- Evaluation
- Competition
- Perceived apathy by leaders towards the scientists' work
- Unclear goals
- Insufficient resources
- Overemphasis on the status quo
- Time pressures

In addition to factors that can impede creativity and factors that can promote it (e.g., interesting problems, wide range of information, high standards, access to techniques and people, recognition and support), another study of companies that employed creative individuals (including the real "Shelly") noted:

> Managing creative people is never easy. . . . It can be personally threatening. Creative people seldom manage to sweeten their criticisms and complaints, but can at the same time show a massive sensitivity to even token criticism of themselves.[9]

The attributes of creative people—curiosity, drive, self-confidence, autonomy, persistence—also can make them difficult to deal with in the laboratory. Geoff described people on his staff like Shelly as those who, when they came into his office, "were going to be blunt—quite outspoken about what I had or had not done—and they were going to be demanding." Another experienced leader said that creative scientists tend to be "logical, critical, opinionated, clannish, and do not suffer fools gladly."[10]

Thus, a critical factor that affects the creativity of science is the *leader* of creative individuals. Dealing effectively with such scientists may require, for instance, that you redefine your boundaries of what is acceptable. As Stefan noted in Chapter 4:

> I have scientists working for me who are very eccentric and yet very brilliant. When I am asked where I draw the line when they cause trouble, I say that I draw the line very far away. I try to keep these eccentric scientists from getting into trouble in the first place. But I understand what they're like and I understand that, if I don't have people like that, I will have a very mediocre institution.

In addition, as Whatmore described (and as respondents of the expert panel in Chapter 1 reflected), to foster and support creative output, the leader must be

> empathic, understanding, and unusually sensitive to "process" in their groups; . . . warm and approachable, passionate and enthusiastic; and generous of spirit.[11]

Finally, because scientific activity often appears to outside observers such as top management to be "slow, risky, and full of intermediate failure," leaders must be prepared to buffer creative people from the "powerful process avoiding and process-terminating forces brought into play by uncertainty, fear of failure, intolerance of ambiguity, and pressures for quick and certain results."[12] From Shelly's descriptions we may infer that Geoff exhibited that ability.

Fostering Creativity

In addition to the above-mentioned studies of creative individuals and factors influencing creativity, there are studies in the field of cognition that illuminate ways in which and reasons why certain organizational-level concepts are associated with creative output.

One of the attributes of creative individuals—variously defined as perceiving juxtapositions, as an ability to combine disparate elements, as sensitivity to asymmetries and incongruities—is associated with the use of what are called "fluid" cognitive structures. (Cognitive structures are defined simply as mental constructs or rules by which we process stimuli like sense data, thoughts, and images.[13])

Cognitive scientists have described two types of cognitive structures using the metaphors of rigid or fluid. Rigid structures are "tightly interconstrained, so that one part [of the knowledge base] strongly predicts another."[14] Fluid structures, on the other hand, can result in more creative thinking because they permit the knowledge base to be "turned upside down" (in Shelly's terms) and searched for what Holton described as previously unperceived formal asymmetries and incongruities.

What is important for you as leader of scientists to understand is that organizational conditions can affect which of the two types is utilized. The same people who, under certain conditions, are able to solve problems in a creative and flexible way (i.e., utilizing fluid cognitive structures) will, under different conditions, solve them in a stereotyped and uncreative way (i.e., utilizing rigid cognitive structures).[15]

Organizational conditions associated with the use of fluid cognitive structures include (among others) ambiguity, intellectual challenge, and a climate of risk willingness. Whatmore observed that the "creative 'process' addresses persistent paradoxes, controversies, and ambiguities, especially those which appear tough."[16] Similarly, in their study of firms, Nonaka and Takeuchi noted that dialogue, discussion, experience sharing, and observation

> can involve considerable conflict and disagreement, but it is precisely such conflict that pushes employees to question existing premises and to make sense of their experience in a new way. . . . Ambiguity can prove useful at times not only as a source of a new sense of direction but also as a source of alternate meanings and a fresh way of thinking about things.[17]

In the science organization, the necessary ambiguity can be achieved by ensuring, for example, that leadership of a working group is not determined by seniority or other formal mechanism but rather emerges according to expertise. It can also be achieved by ensuring that people do not perceive themselves to be in a superior–subordinate relationship but rather in a relationship of peers (this will be addressed later in the chapter).

The above noted organizational conditions were found by seminal research in the 1960s to be characteristic of technology-based companies able to adapt to new technologies.[18] *"Organic" structure* is the term that was given to the design of work in these companies. Characteristics of the organic structure, in addition to challenge and ambiguity, included informality, complexity, broad delegation of responsibility, and a lateral (horizontal) pattern of relationship and communication.

Although I have touched on these only briefly, the findings are important for this chapter. They suggest that a science organization can be designed in a way that fosters creative thinking or, conversely, in a way that inhibits creative thinking. In short, creative thinking (metaphorically) involves use of fluid cognitive structures, enabling people to perceive juxtapositions, asymmetries, and incongruities. Use of fluid cognitive structures is enhanced by the organic design because such design of work promotes the organizational conditions of ambiguity and challenge. As I will discuss next in terms of general guidelines, the quality of science is influenced by the right organization structure, the right size, and the right formal systems.

ORGANIZATION STRUCTURE AND SIZE

When we use the word *structure,* we often picture an organization chart, with boxes neatly arranged in some logical order. However, as used here, the word has a more fundamental meaning. Organization structure is the pattern by which people relate to each other and communicate with each other. The organization chart, on the other hand, depicts the formally established lines of authority, which may be very different from how people actually relate and communicate.

Vertical and Lateral Structure

There are two fundamental patterns (i.e., structures) of relating and communicating that sociologists describe as emerging from family structure. One is vertical: superior-to-subordinate, pyramidal, or hierarchical relationship and communication. This pattern is based on the parent–child model. The other pattern is lateral: equal-to-equal, network, or horizontal relationship and communication. This pattern is based on the sibling (peer) model.

In organizations, each pattern has been found to be more effective in certain situations.[19] Vertical structure is appropriate in a stable environment and for the design of work for which rules and established procedures exist (also called algorithmic work processes). Lateral structure is appropriate in an environment of rapid change and high uncertainty and for the design of work for which few rules and established procedures exist (also called heuristic work processes).

Why might this be so? In a lateral structure, people relate to each other as peers and, because of this, are more apt to collaborate. Relating as peers, people are also more apt to communicate openly and informally. Peer relationships and open, informal communication foster debate and intellectual challenge, qualities supporting good and original science. Finally, scientific research is often accomplished by activities for which few rules and established procedures exist, and science itself is characterized by rapid change and high uncertainty.

Lateral structure can also produce the requisite ambiguity that supports use of fluid cognitive structures. In a lateral structure, the person who leads each problem-solving effort is determined by who is the expert in the group. When problem topics change, problem-solving leadership changes. The answer to the question "who's in charge?" depends on the nature of the problem. As observed by Whatmore, "leadership in creative groups 'hops from shoulder to shoulder.'"[20] For this reason, it is very difficult to draw an organization chart of a lateral structure beyond listing those few individuals with formal authority.

Lateral Structure and Size

Lateral structure is a prerequisite of the organic design, and *lateral structure constrains size.* That, in essence, is the relationship between the quality/creativity of science and the technical aspects of organization structure and size. Lateral relationships and communication enable use of fluid cognitive structures, and lateral relating and communicating (hallmarks of the organic design) constrain size. We can only relate as peers with those whom we know, and we can only know a limited number of people. We can only communicate openly and informally with a limited number of people. We can only engage in intellectual challenge with a limited number of people. Many conditions for a creative organization are incompatible with large size (more than about 200 people):

> Size [of an organization] is again the potential killer [of innovation]. The amount and level of communication required to sustain a consistently far-reaching, leading-edge, collectively identified community . . . is very high and needs to have great fidelity.[21]

Guidelines or general rules for you to heed regarding structure can be stated another way. When the work is heuristic—that is, it does not follow rules and established procedures, such as scientific research in novel areas—then the structure should be lateral (i.e., organic) and the size, therefore, small. When the work is algorithmic—that is, it does follow rules and established procedures, such as in late-stage technology development—then the structure should be vertical and the size can be much larger. As a general rule, a large development organization will be more efficient than several small units.

Of course, even in later stage technology development, problems may arise that require the use of fluid cognitive structures. Under these conditions, the problem-solving unit should be organic (lateral structure, small size). Small groups of people on task forces or small teams from vertical functions must relate to and communicate with each other as peers, collaborating and challenging each other's ideas. Such groups should be informal, responsibility should be broadly delegated, and the pattern of relating and communicating should be lateral.

Some Leadership Implications

The vertical structure, modeled on the parent–child relationship, is commonly found in organizations and is (frankly) the easier structure to design and manage. Work is divided by department, responsibility is clearly ordered, and there is a visible "top" and "bottom." But, as Thorne whimsically noted: "Parents are not creative. They are defenders of the paradigm. They use words like 'ought' and 'must.'"[22]

If you are leading people engaged in scientific research, work that benefits from the use of fluid cognitive structures, then the vertical model is inappropriate. Moreover, imposing controls and rules will actually degrade scientific creativity. Unfortunately, when faced with qualities of the lateral structure, attributes of creative people, *and* the need to meet cost and/or time constraints, leaders' unthinking tendency may be to put in tighter controls and more explicit rules and to expand the hierarchy. In this situation, leaders "are often tempted to employ too close a supervision of scientists. In addition they tend to impose too much formalization."[23] (I will address these tendencies in the concluding section of this chapter.)

It may sound counterintuitive, but to support creative thinking, you need to encourage conditions that may at first feel completely wrong. In a lateral structure, conditions of ambiguity, lack of a designated leader, informality, and conflict are desirable. The organic structure appears to be a "messy" structure, and it is. It also supports creativity.

Now, creative science is not incompatible with constraints or with clear goals and objectives. Whatmore observed in his study:

> However important freedoms may be, some of the best creative work is often done against the greatest constraints. . . . Effective leaders match up constraints to the needs of individuals, so that they become challenges which . . . individuals use for the development of their own talents and skills. . . . In the most creative and successful project groups . . . the leaders of these groups [were able] to set clear goals, aims, objectives, and responsibilities. [Constraints and freedom are individual feelings.] . . . What matters to creative people is that the constraints they accept do not run counter to their "intrinsic motivations."[24]

Similarly, Shelly recounted (Chapter 3):

> What I want to find in my research activities, whether I'm in industry or academia, is not to do whatever I please. I look for specific goals. I

> also look for constraints and restrictions, because I think that is how I succeed. I have noticed that, whenever people decide that no constraint is going to stand in their way, nothing does.

FORMAL SYSTEMS

The quality/creativity of science is also influenced by formal organizational systems, such as recruitment, performance appraisal and reward, decision making and approval, and information systems. Similar to structure and size, organizational systems must support collaboration, intellectual challenge, candid and transparent communication, and willingness to take risks. Each system is discussed below.

Recruitment Systems

Thorne noted:

> Organisations need to introduce mutants and invasives to enable them to adapt to their changing worlds. However, most organizations' immune systems are resistant to such a seeming parasite.[25]

Too often, recruitment systems are designed to find people who "fit" the organization. No matter what the rhetoric is about diversity, many recruitment policies and procedures are (unintentionally) designed to weed out those whose personal and intellectual styles are different from the majority. The consequences are likely to be conformity and uniformity, people who are unlikely to challenge the status quo, and lack of real creativity:

> [T]he power of 'people who are like me' to be directly interpreted as 'people who are best for our organisation' is enormous. Its converse: 'If I do not like them as people, it cannot be good for me to have to work with them,' is a fundamental error of any manager in a creative field.[26]

As Stefan noted (Chapter 4), not employing people who are eccentric in comparison to the norm results in a very mediocre institution despite what might be the glowing text of the annual report or other public materials. To avoid conformity and mediocrity, then, you must actively seek people who, at first, may make you uncomfortable because they are the "competent eccentrics." In other words, you must look for people who *don't* fit, who stand out in your mind as quite different.

Moreover, once the competent eccentrics have been recruited, you must support their eccentricities by encouraging them to voice their perceptions of the world, and you must encourage others to listen to those perceptions, especially if they contradict what has been taken for granted. You are trying to improve organizational creativity by supporting and encouraging the use of fluid cognitive structures, and the eccentric is by definition more apt to perceive issues differently and, thus, to raise the level of creativity of the whole group. As I noted in Chapter 2, people of different race, nationalities, and gender (i.e., women scientists) may be perceived as eccentric, and your role is to ensure the inclusion of their contributions and to support their unorthodox ways and thinking.

In addition to recruiting heterogeneously, you can also encourage eccentric thinking by bringing in visiting scholars, fellows, and other experts who are not in the mainstream disciplines but who may provoke your scientists to perceive juxtapositions by their very difference from accepted convention. Although not usually considered part of recruitment systems, policies for, for example, visiting scholars are certainly part of intelligent retention and training systems:

> Clearly the best attribute for managing creativity in people is to pick the right people in the first place. Most organizations take relatively few pains over the process of getting the mix of people right.[27]

Performance and Reward Systems

Similar to recruitment systems, performance appraisal and reward systems may unintentionally promote safe mediocrity. Consider a few of the qualities required for quality science. First, you must support collaboration. This implies systems that take account of collective performance (such as group self-assessment) and reward collective performance as appropriate. Of course, group self-assessment is more complicated and time consuming than individual assessment. In addition, group self-assessment assumes that you and your colleagues trust and respect one another's judgment of the people being reviewed and value collaboration.

Second, you must reward intellectual challenge. This means challenging your staff and encouraging them to challenge you, really challenge you, by disagreeing openly without fear of being publicly humiliated or privately rebuked. It also means being patient with the apparent confusion and delay that challenge may produce in the process of work. When your scientists have argued and then come to some agreement about the problem, the solution will be more creative than if you forced a solution. If you are a task-focused leader (Chapter 4), then rewarding intellectual challenge may require you to be very patient.

Third, you must reward candid and transparent communication. Again, you must model this type of communication and encourage it in your laboratory. You must also be prepared for the fact that candid communication is not always good news, and the bad news is to be received as respectfully and thoughtfully as the good news. Many leaders are surprised to discover that their scientists are unwilling to be open about problems or mistakes, preferring to send reassuring messages instead. Why? Because the leader had, in effect, punished candor by (1) reacting vigorously and negatively to the bad news, (2) immediately dismissing the sender until the problems were ironed out, or (3) rushing in to "micromanage" the issue, and so forth.

Finally, you must reward willingness to take risks. This implies that you are willing to reward people for what might appear to be poor results (not, of course, poor judgment) and you will not punish those who take a risk and fail. You might ensure that there is "free" seed money for experimental projects, money outside the traditional budget categories and not seen as coming from other committed allocations. You must also give wide visibility to those who have taken risks and succeeded. You should also agree to take risks, even though you might fail.

Decision-Making and Approval Systems

Even in organizations dedicated to research, people have often designed or accepted the design of decision-making and approval systems that are cumbersome and slow and indicate lack of trust in the intelligence of those who use them. If you have hired intelligent people and encouraged candid and transparent communication, then very few formal decision-making and approval systems will be necessary. Certainly, the "big ticket" items or decisions will require a formal mechanism for approval, but it is surprising how many items or decisions do not need formal mechanisms, yet remain bogged down in these systems.

Some typical problems encountered by our expert panel respondents illustrate this situation. One assistant professor was frustrated in "obtaining promised items from the institution, so that laboratory planning is possible." Another chafed that he had "no financial authority and required confirmation for the PI on purchases" for his work group.

If you have budget responsibility, you should ensure that the budget is developed in the context of overall organizational objectives and with the input and understanding of people in the laboratories. Then, the relevant units or departments should be given their allocation and be trusted to expend it wisely, even if you sometimes disagree with their decision (again, this is part of rewarding willingness to take risks and encouraging challenge). If there is a true spirit of collaboration in the organization, then appropriate "horse trading" can take place among units for spending that may exceed the budget of a specific unit. People should agree (and mean it) that all are working for the good of the organization rather than the aggrandizement of their particular laboratory. You should have as one of your objectives that "turf" be defined as the whole of the organization (as relevant), rather than just one unit of that organization.

Similarly, project budget decisions should be made by those closest to the issues. If communication is really candid and transparent in your organization, then the necessary information will be communicated to management as a normal part of working together. If management input is needed, it will occur without decision rules.

Information Systems

Although you may not perceive them as such, information systems (of all the formal systems) can actually provide the most opportunities to enhance the quality/creativity of science. The following brief review is by no means exhaustive of how such systems can be utilized.

Collaboration can be supported, for example, by electronically linking scientists, no matter in what part of the organization they work; ensuring wide distribution (electronic or paper) of provocative material, including notes on work-in-progress within the organization; providing ease of (electronic) access to scientists outside the institution as appropriate; and providing easy access to useful external data banks.

Intellectual challenge can be supported by these same tactics as well as by distributing information widely on a want-to-know rather than a need-to-know basis. Candid and transparent communication can be supported by all the above and by sending the good news as well as the bad news through the system with similar alacrity. Willingness to take risks will follow if your information systems conform to these guidelines.

CONCLUSIONS

Skilled Incompetence[28]

Earlier I addressed the fact that imposing controls and rules can, in the wrong circumstances, degrade the quality of science. Yet, this is often resorted to by leaders who hope for just the opposite. When leaders persist in using skillful behaviors that nevertheless produce "consequences that are counterproductive to [their] intentions," they exhibit what Argyris called *skilled incompetence*.[29] Scientists who are technically competent may have been promoted to a managerial position for which they are not competent or they may find themselves in such a position without training or mentoring (see Chapter 1). In a leadership position, they may receive inadequate or inappropriate feedback (or no feedback) as to the root causes of the incompetence.

Scientists are trained to construct and test theory with a goal of understanding some phenomenon as much as possible. Assumptions are tested to determine if they reliably explain and/or predict what is observed. Every effort is made to disconfirm hypotheses as well as to uncover the likelihood that the theory/model is well constructed. During this process, feedback is crucial. Yet, during the *leadership process,* feedback is also crucial, especially immediate, uncensored, candid communication of feelings about and reflections on observed leadership behavior.

As leader, a scientist is implicitly using or constructing normative theories about how people should act in research laboratories, how scientific activities should be carried out, how groups should behave, and so on. Without training in the relevant disciplines and with no feedback on those theories, however, the scientist-leader may provoke a vicious circle in which he or she acts on the basis of untested assumptions (e.g., "rules will solve the problem efficiently"), observes that the results are counterproductive, and behaves in a more intense but similar manner (e.g., "*more* rules will solve the problem efficiently"). In this example, the scientist has not made the connection between the necessity for feedback in both the scientific and the managerial realms.

Argyris described skilled incompetence as a situation of single-loop learning: taking action to solve a problem, without addressing "the more basic problem of *why* these problems existed in the first place."[30] When leaders move beyond the apparent problem to question assumptions and to probe their *governing values,* they are able to make unvoiced hypotheses explicit and seek feedback on the truth or falsity of their hypotheses. They engage, in other terms, in double-loop learning (also called learning how to learn). Leaders are then able to "produce the insight [e.g., into why a problem is not being solved efficiently] . . . and can also produce new consequences from the insight"[31] (e.g., ambiguity *is* needed for creative problem solving).

Tacit Knowledge[32]

The prior discussion of organizational systems did not take into account that a crucial resource of the scientific organization is tacit (as opposed to explicit) knowledge. The word *tacit* is derived from the Latin verb *tacere,* "to be silent," and it means that which is implied but not actually expressed or expressed or carried on without words or speech. Faulkner and Senker called it "person embodied, . . . on the hoof."[33] Tacit knowledge can be shared or communicated *without words or speech* when someone "rubs shoulders with" (works side by side, observes) the person who possesses the tacit knowledge until that knowledge is absorbed. According to more recent neural models of cognition, most of what we know (and know how to do) is determined by unconscious neural processes that cumulate to tacit knowledge and know-how.[34]

There is also a useful typology of professional knowledge, the knowledge of a scientist or clinician, that allows me to illustrate the importance of that which is tacit:

- propositional (theories, findings, etc., typically learned in formal education),
- personal (acquired through experience and including information and interpretation, as well as intuition),
- process (general "how to" or methods for accomplishing a task), and
- know-how (specific, context-dependent understanding of how to accomplish a task).[35]

Each type can exist as explicit or tacit, although personal knowledge and know-how are more likely to exist in tacit form.

When scientists are hired, they bring with them state-of-the-art, explicit propositional knowledge from their formal education. They also bring state-of-the-art, explicit process knowledge, or general approaches to problems and methodologies customarily used in their discipline training. This explicit *intelligence to do the job* is demonstrated by answers to questions put to interviewees during the hiring process and to their references as well as by their presentations and publications. Scientists also bring propositional and process knowledge that is tacit. They will have a reservoir of background, unconscious, tacit knowledge of their discipline propositions and processes.

Scientists bring unique understanding from their prior professional experience, or (what is usually) tacit personal knowledge, even highly trained new recruits with no organizational experience beyond the postdoc. However, such new recruits have, literally, neither explicit nor tacit *know-how* (i.e., context-dependent process knowledge). If hired and retained, these scientists will develop over time that (usually) tacit know-how.

I want to emphasize that the explicit propositional and process knowledge that each person brings is really a small part of the expertise potentially available to the work group. Experienced scientists hired from other universities or companies bring tacit propositional, personal, process knowledge, and know-how from first-hand experience, gained over an extended time (and at considerable expense to the organizations in which they formerly worked and trained). Not to recognize, appreciate, and capture all their knowledge are tantamount to seeing only the "tip of the iceberg." Even the postdoc hired into the first staff scientist position brings important tacit knowledge. Yet, most of the focus of recruiting is on explicit propositional and process knowledge.

One way to capture systematically the tacit knowledge of new recruits is by pairing them with an experienced scientist in a relationship similar to mentoring. However, the focus of this relationship is on the protégé's tacit knowledge, rather than on the mentor's expertise. The experienced scientist, in other words, is charged with looking for what is novel as well as different in the protégé's content and methodologies.

Tacit knowledge represents a powerful intellectual resource. If all the scientific and technical knowledge possessed by scientists were explicit, we would only require the relevant reports or journal articles written by these scientists to be stored for future use. However, a brief reflection on the occasions when honed intuition was used to solve complex problems or when a highly developed "feel" accounted for the success of an experiment should reveal that a not insignificant portion of the knowledge possessed by scientists is tacit. If attention is not paid to capturing it, there can be glaring omissions and delays in scientific efforts as old mistakes are repeated and useful knowhow is overlooked. Similarly, knowledge can be completely lost whenever a scientist leaves a group or the organization.

In thinking about the formal systems of your organization, you must be aware that one of your objectives is to recognize and capture the professional knowledge of your scientists. By themselves typical orientation programs are not sufficient. Rather, consider establishing an informal, regular, and continuous mentoring process by which new scientists meet with and observe the seasoned expert scientists. Perhaps "mentoring" should become part of the performance appraisal and reward system, with appropriate and measurable objectives linked to an intellectual asset development program. You should also ensure that *reverse mentoring* occurs as well by putting experienced scientists with new recruits to observe novel content and methodologies in their protégés.

Finally, do not allow the scientist or technician to leave the laboratory without a systematic endeavor to capture his or her tacit propositional, process, personal knowledge and know-how. Hold a series of informal meetings between the person who will exit and others in that person's field, allowing sufficient time for extensive questioning and informal discussions.

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8
PROJECT MANAGEMENT

INTRODUCTION

A special case of organizational systems is the system of *project management.* As defined by *A Guide to the Project Management Body of Knowledge,* a project is "a temporary endeavor undertaken to create a unique product or service." Examples include "developing a new product or service; effecting a change in structure . . . ; constructing a building or facility; running a campaign for political office; implementing a new business procedure."[1]

Leading a project (as distinct from organizational operations) is relatively new in management history and, like other management concepts, has its roots in military strategy. Project management is analogous to campaign or battle management, as opposed to "war management."

The approach was first used in the U.S. air and space industries. Traditional organizational structures at that time, with their tall hierarchy, vertical relating and communicating patterns, and clearly separated functions, worked well when the task was predictable and relatively little information was required by generalist workers to complete it. However, when the task was complex and uncertain and required a multitude of specialists to collaborate to complete it, an enormous amount of information had to be processed. Dividing this type of work into a horizontal grouping of related subtasks and assigning multidisciplinary teams to each subtask was found to be more effective. Eventually, the subtasks became known as projects and the multidisciplinary teams as project teams.

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Applicability

The examples listed in the above definition of project contain important verbs, *develop, construct,* and *implement*. . . . Conspicuously absent from the list are such verbs as *explore* and *discover.* The reason is that some organizational endeavors are not appropriate for project management. The knowledge, skills, tools, and techniques that are effective for leading development efforts may not be effective for leading discovery efforts.

Project phases are "marked by completion of one or more deliverables . . . a tangible, verifiable work product . . . [These] deliverables, and hence the phases, are part of a generally sequential logic."[2] In scientific discovery, when novel concepts are being explored and tested, there are rarely tangible, verifiable outputs, and the logic is generally not sequential. As I described in Chapter 1, research is an activity that occurs *between the ears* of scientists in a nonlinear, iterative fashion in order to generate new knowledge and ideas. Unlike *work products,* generating new knowledge and ideas is hard to predict, unwieldy to measure, and difficult to judge except in hindsight. Thus, some of the systems of organizational administration, including project management, may not be directly applicable to planning, managing, and evaluating research.

The U.S. National Aeronautics and Space Administration (NASA) utilizes two sets of metrics that help to illuminate the difference between what is and what is not appropriate for project management. The first is the R&D Degree of Difficulty (R&DDD), which defines "how much *difficulty* is expected to be encountered in the maturation of a particular technology."[3] The metric consists of five levels with their associated probability of success (the inverse of risk) and ranges from level I (a "very low degree of difficulty is anticipated in achieving research and development objectives for this technology; probability of success . . . 99%") to level V (the "degree of difficulty anticipated . . . is so high that a fundamental breakthrough is required; probability of success . . . 20%"). The second metric is the Technology Readiness Level (TRL), which consists of nine levels that support "assessments of the maturity of a particular technology and the consistent comparison of maturity between different types of technology."[4] These range from TRL 1 ("basic principles observed and reported") to TRL 9 ("actual system 'flight proven' through successful mission operations"). R&DDD levels provide a framework for rough estimates of time and cost at NASA, but it is not until TRL 3 ("analytical and experimental critical function and/or characteristic proof-of-concept") that customary project management may be appropriate. So-called technology programs at the earlier technology readiness levels do not even have milestones.

I am not suggesting that there are no tools and techniques that can be applied to research, discovery, and exploration endeavors. The entire book up to now has described and discussed them. I am emphasizing that there is a difference between the formal system (the tools and techniques) of project management—such as scope management, earned-value management, risk management—and the administrative systems used in discovery organizations.

This chapter assumes *proof of concept,* or that some tangible and verifiable work product has been achieved, and the verb *develop* is now the operative term for what must happen next. It also assumes that developing the technology is a *temporary endeavor* and a complex task, one that is characterized by uncertainty and requires a number of collaborating specialists to complete it. In short, it assumes that you are leading a project as defined by the project management literature.

Collaboration

Despite the length of time that project management has been used and refined and the wide range of organizations in which it is practiced, leading projects effectively remains a challenging goal. In scientific organizations, it is quite difficult because it depends on collaboration among individuals with varied backgrounds and from different disciplines.

Collaboration, which means "to work together," is easy to espouse but hard to achieve. It implies literal contiguity (physical and/or interactive electronic) and that the end result will represent more than the sum of the individual contributions.

Project management entails formal collaboration. Informal collaboration arises because people want to work together. A scientist determines that he or she needs the input of another scientist and so approaches that person. In these informal situations, the job of the leader is to remove hindrances to collaboration. In contrast to informal collaboration, project collaboration requires advance planning and very high interpersonal skills on the part of the leader. Just putting people together in collaborative units like project teams does not mean they will collaborate. Achieving genuine collaboration requires appreciation for the different world views that specialists will bring (Chapter 2), an understanding of work motivation needs (Chapter 3) and leadership styles (Chapter 4), skills in communicating (Chapter 5) and resolving conflict (Chapter 6), and the capacity to design and maintain lateral structures (Chapter 7).

On the other hand, the ability to lead projects effectively is generalizable. That same ability is needed to ensure effective collaboration between academic units, between research and development functions, and between in-house scientists and external partners (wherever they may work). Moreover, the same ability is needed to ensure effective collaboration between organizations as a whole, such as two or more universities or institutes or a merger of two companies.

As you might expect from the origins of project management, the project is really a microcosm of an organization. Multiple disciplines and/or functions are represented, and each makes a critical contribution to the desired output. Work must be accomplished under resource (time-and-cost) constraints. Thus, the project leader is essentially a general manager. Problems occur within projects that mirror those occurring within organizations as a whole. Fortunately, fewer people are involved in projects, so project management is often viewed as a testing ground for future general managers.

Consistent with the focus of the book, this chapter emphasizes behavioral as opposed to technical aspects of project management. There are numerous books on the latter subject, and the field itself publishes an excellent body of knowledge. In this chapter, first, I discuss the project team: size, structure, composition, and roles. Next, I review the project life cycle and relevant leadership challenges over the life cycle. Then, I explore technology transfer, by which the "technology" (including proof of concept from exploratory research) is handed over to successive teams for further development. (A special case of technology transfer—technology alliances—is highlighted.) Finally, I define and describe the matrix organization and some implications of that project management structure.

THE PROJECT TEAM

Perhaps the best example of a formal collaborative unit is the project team. By definition, it consists of people from different disciplines (e.g., molecular biology, acoustics engineering, epidemiology) and/or organizational functions (e.g., research, development, manufacturing) who are chartered to achieve a specific goal (build the Y prototype, test Z to determine if development should continue, and so forth). Other formal collaborative units are task forces and committees, but they are not discussed here.

Team Size

Contrary to what is sometimes practiced in many organizations, project teams should consist of up to a maximum of seven or eight people. *Team* implies that the members are close knit; they are expected to interact frequently and over a fairly long duration (years in the case of some projects). A larger team is unwieldy for collaboration that requires close interpersonal interaction and communication. If the desired goal requires more disciplines or functions than seven or eight, then the group should be divided into subteams. Plenary meetings of the entire group can be held as needed, and the subteam leaders can meet among themselves to address issues common to all teams. Calling a group of 15 or 20 (or more) a team does an injustice to the concept and to the members who are expected to work as a unitary whole. After all, the word originally referred to a small group of draft animals used to pull a plow. (Too many were literally unworkable in the field.)

Team Structure

All collaborative units, from the smallest team to the largest matrix organization, must have a lateral structure. As discussed in Chapter 7, there are two basic patterns of relating and communicating in organizations: vertical, which involves superior-to-subordinate relating and communicating, and lateral (peer to peer). The so-called diagonal slice, consisting of several reporting levels from multiple disciplines or functions, is also a lateral structure.

Lateral is the required "direction" for effective collaboration because lateral supports equal-to-equal relating and open, candid, and informal communicating. Peer relationships and open, candid, and informal communication in turn ensure that there will be fruitful scientific debate and intellectual challenge among project team members. Information search processes will be wide and unconstrained by assumptions of authority; they will thus produce superior results to those achieved by processes that are narrow and constrained. Lateral structure, as already noted, promotes the use of fluid cognitive structures and supports creativity.

From a scientific and technical perspective, the project leader is one among equals, the formally designated liaison to the larger units from which members are drawn and is the "general manager" of the project. However, exactly who directs team members in scientific and technical problem solving and decision making will depend on who has the expertise required. As the problems and decisions change, leadership in this sense must change as well.

One of the most important tasks of the project leader is to build the lateral structure, and this requires taking explicit steps. The first is bringing people together to meet face to face (this is also part of team building). When team members have been identified, a series of informal meetings, over dinner or lunch, should be held at sites convenient for all parties. At the initial meetings, the leader must encourage general conversation that facilitates getting to know one another. Rather than discussing work topics immediately, members should engage in free-ranging discussions of the background, training, and outside-work interests of each individual.

Topics that should be brought up include how this group of collaborators will work together. In one of the early meetings, the leader should encourage the group to develop team rules about communicating, dealing with lateness, accommodating absence, reaching agreement, and so on. Also, the leader must make certain that all team members understand the value of working together toward the common goal: an effective and successful collaboration leading to the desired outcome. Finally, inappropriate behaviors should be addressed as soon as possible. If you were to detect lukewarm or negative attitudes about the project and/or the collaboration, you should resolve them as quickly as possible. Opposing viewpoints are to be heard and considered, but the constantly negative person will be harmful to the collaborative process.

To facilitate and support a lateral pattern of relating and communicating for the duration of the project, the following tactics are recommended:

- Disseminate information to team members on a want-to-know rather than need-to-know basis.
- Do not designate people for specific tasks ahead of time. Leadership in problem solving is contingent on the relevant expertise at the time.
- Emphasize and model wide consultation beyond members of the team.
- Call short meetings of the entire team (face to face or virtual) as needed to keep people in each other's "mind's eye."
- Model and encourage wide-ranging discussion and challenging communication.

As you may have inferred from Chapters 2 (diversity) and 5 (communication), lateral communication in project teams can be difficult because of language barriers. Individuals from the same discipline will share a common meaning for words they use and will communicate effectively. When multiple disciplines are involved, as they invariably are in a project team, people may use the same words but they will mean different things to those in different disciplines. Consider this example from an experienced project manager in pharmaceutical R&D, who told me the following:

> When the chemist uses the word, 'product,' she means the new substance or compound that is shown to have some *in vitro* activity. When the formulation specialist uses the word, he means the substance that has been formulated into a capsule. When the physician uses the word, she means the packaged and labeled drug available for clinical trials. And when the marketing person uses the word, he means the approved and launched drug that will produce income. When early candidate management teams discuss the 'product,' there may be at least four different interpretations of the same word.

The same language problem occurs when multiple functions are involved. Thus, at the start of the project, the leader must interpret and translate as necessary, asking the apparently simple questions ("how long, in days, do you mean by 'soon'?"), and encouraging team members to question each other freely in order to clarify meaning.

In many organizations, lateral teams must coexist within a vertical structure (e.g., lateral research teams within vertically organized science departments). Dealing with the tension between the two types of structures will be addressed later in the chapter in the discussion of the matrix.

Ideal Team Composition

The technical composition of the project team, the requisite skill mix, must obviously be based on the desired result. If successful development in a particular area requires expertise in molecular modeling, gene splicing, chemical synthesis, and in vivo testing, then the technical composition of the project team must provide the appropriate disciplines and skills. If successful development of applications software requires expertise in Linux and multimedia, then the composition of the development team must include engineers proficient in these disciplines. From a technical perspective, the composition of the team is straightforward.

The human composition is also straightforward, but the ideal is rarely if ever achieved. What almost always happens in organizations is that technical competencies are identified and "anyone" who possesses those competencies is assigned to the team. Ideally, however, a team should reflect a particular balance among work-related needs (Chapter 3). Ideally, there should be one or two people with a dominant need for achievement to drive the technical progress of the project plus three or four people with a dominant need for affiliation to hold the members together by dint of their attention to interpersonal relationships. The leader should have a dominant need for power or a dominant need for affiliation with a secondary need for power.

[In many organizations, the scientist who made the discovery is put in charge of the development team, without taking into account that person's dominant work-related need. If the scientist is a *high achiever* like Shelly (Chapter 3), she is unlikely to appreciate the diplomacy, patience, communication, and confrontation skills, among others, that are required to build and lead a multidisciplinary or multifunctional team and to deal with the competing demands of the discipline or functional heads.]

In my experience, one recurring human (as opposed to technical) problem of team composition is the presence of a *difficult scientific expert.* Now, not every expert is difficult to manage in situations calling for teamwork. But, I have heard of and observed enough examples of difficult experts that I want to address this issue explicitly. Many experts do best as solo contributors; their training, education, and experience have taught them to be individualists. They are generally not interested in leading others, in how the collaboration is doing, or in how the organization is doing. They are interested in how well they are doing, scientifically and technically. Their personal need for achievement (i.e., high nACH) and scientific reputation are their primary concerns.

Yet, their tacit knowledge is extremely valuable. As was discussed in the prior chapter, sharing tacit knowledge requires that one scientist *rub shoulders with* (i.e., work side by side) the scientist who possesses the tacit knowledge. Only by working, reviewing results, discussing experimental conditions and outcomes, and setting up the experiments together can tacit knowledge be shared.

To deal effectively with a difficult expert, one recommendation is to treat the person as a virtual member of the team. This scientist should always be informed of the scientific and technical issues but not necessarily included in meetings that address nonscientific or nontechnical topics (such as general strategy or the team's collaborative processes). When the scientist must attend a meeting, he or she should come for that particular scientific agenda item. All team members should be prepared with their questions and issues and, as far as possible, at least a short list of these should be given to the expert ahead of time. The objective is to minimize the number of surprises for this scientist, thus reducing the possibilities for defensive behavior. The scientist should be considered an invited expert and encouraged to teach, show, or demonstrate, rather than discuss. During the meeting, individuals should be encouraged to seek clarification from the expert. Afterward, team members can converse and discuss what was presented.

Another recommendation is to identify a scientist who will be responsible for "rubbing shoulders" with the difficult scientist in order to gain the needed tacit knowledge. This scientist should be relationship oriented, not easily intimidated or annoyed by the expert, competent in the appropriate scientific and technical arenas, and able to communicate what he or she learns to the other members of the team. In short, this person becomes both the physical link between the virtual team member and the "real" team members and the bridge from the tacit knowledge of the expert to the explicit knowledge of the team.

Having said all that, I want to remind the reader that, challenging though they may be at times, difficult scientists are important. As a project leader in a biotechnology firm told me:

> There are delicate flowers of egos—every organization has them and every organization needs people like that. You just have to know how to handle them. You need them because you're not producing widgets; you're producing things that never existed before. You get strange people and prima donnas in science. You may get more in discovery, but you need them! You have to have them, to create what did not exist.

Team Roles

Even if the ideal team composition in terms of work motivation needs is hard to achieve, the leader must strive for an ideal composition in terms of team roles. A role is defined as a function assumed by an individual for a particular situation. Particular situations, or particular work (projects), require particular roles. "Project leader" is a function/role assigned to an individual for the duration of a specific project or program. *Role* is an important construct because roles determine required *competencies.*

With regard to science and technology innovation projects, researchers who have studied team and project performance have found certain roles to be critical:

- "*Idea generating.* Analyzing and/or synthesizing . . . information . . . from which an idea is generated for . . . a new technical approach or procedure or a solution to a challenging technical problem.
- *Entrepreneuring or championing.* Recognizing, proposing . . . a new (his or hew own or someone else's) technical idea, approach or procedure for formal management approval.
- *Project leading.* Planning and coordinating the diverse sets of activities and people involved in moving a demonstrated idea into practice.
- *Gatekeeping.* Collecting and channeling information about important changes in the internal and external environments. . . .
- *Sponsoring or coaching.* 'Behind-the-scene' support-generating function of the protector and advocate . . ."[5]
- *Boundary spanning.* "Multilingual translator, fluent in the language of customers, engineers, . . . translator between customer experience/requirements and engineering specifications."[6]
- *Boundary management.* "Representing the teams to others and protecting the team from outside interference . . . ; coordinating and negotiating with other groups . . . ; and general scanning for ideas and information . . . , building a general awareness and knowledge base."[7]

The role of boundary spanning is one that entails extending project communication across research sites, across different disciplines, across different functions, across different parts of the organization, and so on. To accomplish the boundary spanning role effectively, the boundary spanner must interpret the information provided by one constituent so that it is understandable by another and be able to communicate across the language barriers that separate constituents.

The role of boundary managing entails managing the organizational boundary between the project all other constituencies. This role is important, because research has indicated that "the ways teams managed their boundaries were strongly related to their performance."[8] Moreover:

> As studies of boundary spanning roles have shown, effective teams do not rely on extensive external communication by all members, but instead have individuals (gatekeepers or liaisons) who collect, inter-

> pret, and triage information from sources outside the team or organization. . . . [Such] external communication must be carefully managed to ensure that effective boundary tasks are accomplished.[9]

To accomplish the boundary managing role effectively, the individual must possess the competencies of an ambassador ("representing the teams to others and protecting the team from outside interference"); a task coordinator ("coordinating and negotiating with other groups"); and a scout ("general scanning for ideas and information . . . , building a general awareness and knowledge base").[10]

For optimum performance, scientifically and interpersonally, science and technology project teams must have people capable of assuming and carrying out the above roles. Interestingly, studies of these team roles found that:

> [Some] individuals fulfill multiple critical roles concurrently or in different stages of the same project. But even more people are likely to contribute critically but differently at different stages of their career.[11]

Some scientists may fill several of these roles in a given project; however, according to the prior authors, they are more likely to fill some of the roles at different stages of their career:

> [The] technical professional may begin as a technical problem solver, spend several years primarily as a creative idea generator, add technical gatekeeping to his performance while maintaining his earlier roles, shift toward entrepreneuring projects . . . and eventually accrue a senior sponsoring role.[12]

The implications of these prior studies are several. First, project leaders must understand where they are in their scientific careers and what roles make sense for them to assume in a given project. Second, they must understand where team members are in their respective careers and what the consequences might be for the remaining team roles. Finally, given the nature of the project, leaders must understand which of the above seven roles are more critical, when (see discussion of the project life cycle, below), and why. Only after these questions are addressed can the leader achieve ideal composition in terms of team roles.

LEADERSHIP CHALLENGES OVER PROJECT LIFE CYCLE

The familiar logistic curve illustrating the proportion of work completed over time (or the growth of populations over time, adoption of innovations over time, pattern of scientific citations over time, etc.) is often used to denote the project life cycle. There are generally four stages of varying length:

- Formation or emergence (project startup)
- Buildup (often divided into two substages: early and late growth)
- Main (when most of the work is accomplished)
- Completion or termination

The four-stage model of a project life cycle is helpful because there are leadership challenges that occur in each stage. Many are generally predictable and can be planned for and intelligently managed. Moreover, different skills and abilities are needed by leaders at different stages in the project life cycle, and different team roles will be more or less crucial at different stages. For example, the idea-generating role may be one of the most important during project startup.

This section discusses specific leadership challenges of uncertainty and equivocality over the life cycle, with a short postscript on types of project conflict likely to occur at each stage. The following section reviews the appropriate matching of project communications with types of communication media, again from a life-cycle perspective.

Uncertainty and Equivocality over Life Cycle[13]

In Chapter 5, I described the concepts of uncertainty (imperfect information) and equivocality (multiple and competing interpretations of information). I noted that, under conditions of high uncertainty, information seeking, processing, and communicating activities must be intense and broad. Under conditions of high equivocality, on the other hand, communication activities must be face to face (ideally) and intense until shared agreement about interpretations is reached.

In this chapter I want to introduce two types of uncertainty and equivocality: task and team. *Task* refers to the scientific and technical work of the project; *team* refers to the interpersonal dynamics of the scientists who are members of the project team. Levels of task and team uncertainty and equivocality will vary over the project life-cycle stages and require different strategies to deal with effectively. Each of the four combinations (task uncertainty, task equivocality, team uncertainty, team equivocality) and the requisite communication and leadership style are discussed below. It must be emphasized that, any time the levels of uncertainty *and* equivocality are high (task and/or team), equivocality must be reduced first. In all cases, the team must agree on what something *means* before they can decide how to approach it.

Task Uncertainty. During the startup or emergence stage of the life cycle, the work of a project is likely to be characterized by highest levels of task uncertainty (i.e., the largest gap between what members need to complete the project and what they possess at the start). A leadership goal is to reduce this level efficiently by ensuring that members seek, disseminate, and share information widely. Reaching agreement on experimental design is crucial because task uncertainty is most effectively reduced by experimentation and the dissemination of new results. Also important regarding uncertainty reduction is that the project plan allow sufficient time during the first stage for relevant scientists to work side by side with their colleagues. Working together is crucial given the tacit knowledge (see above) needed from scientific experts.

With regard to leadership style, as Chapter 4 described, if the tasks and duties of the project are clearly stated and known to the people performing the job, if there exists a framework to solve problems, and if the team's success can be demonstrated by comparison of the results with the published work, the leadership style should be task focused. Under conditions of high task uncertainty in this stage of the life cycle, effective leaders initiate structure. They help to define criteria for evaluating progress; they identify weak points in the project plan; they challenge team members and direct them to potential experts in the fields; they monitor and assess progress to goals. With regard to communication, effective uncertainty reduction will occur when leaders structure the problem of information gathering and disseminating and make use of lean media to transmit uncertainty-reducing messages (media matching is discussed in next section).

Scientific and technical uncertainty will decrease over the life cycle. Thus, the amount and intensity of information-processing activities and communication and need for initiating structure will decrease as well.

Of course, the representation of the task uncertainty curve as a downward-sloping line from project start to project finish is an ideal. There can be spikes in the levels of uncertainty, particularly in the buildup and perhaps the main stages, for two reasons. The first is endemic to science. Development efforts that follow discovery are characterized by areas of imperfect knowledge, no matter how detailed the project plan. Throughout the project, scientists will become aware of gaps between what they know and what they need to know to move the project forward. Imperfect knowledge that impedes progress (e.g., when experimental results are unexpected or inconclusive) represents a spike in the level of task uncertainty.

The second reason that the level of task uncertainty can spike is the loss of a team member. Every person who leaves takes both explicit knowledge about the project and tacit knowledge. Metaphorically, loss of a team member leaves an individually sized gap between the knowledge the team had with the team member and the knowledge available after he or she leaves the team. In other words, the level of task uncertainty will predictably rise with the loss of a team member. When that occurs, the project leader must oversee an assessment of progress to date, rapidly involve outside experts if needed (at least to fill the gap in explicit knowledge), and make sure that a replacement team member is brought up to speed as quickly as possible.

Effective project leaders learn to watch for subtle cues that the level of uncertainty is rising, instead of waiting for a formal review meeting. One project leader in a biotechnology firm said to me that his cue was a series of empty places where the bench scientists usually worked. If people were buried in journals, sitting at their desks reviewing data for a lengthy period, or off in twos or threes looking at results, he knew he had to inquire about problems:

> Once I know the people, I understand how they telegraph their enthusiasm. In chemistry, I judge morale by the ratio of people at the hood versus at the desk. Better at the hood! In biology, people usually want to talk to me about what is going on in the experiments. If they do not want to talk to me, that is a bad sign. Another bad sign is talking too much about what won't work.

Dealing with technical difficulties and unexpected results (spikes in the level of task uncertainty) is part of the role of project leader, but achieving the right balance between intervening and preserving the scientists' autonomy is crucial. A scientist in another biotechnology firm described to me the effect of micromanagement is the following way:

> We had a person heading projects who was described as a 'femto' manager, because he managed so minutely. If there was a cell biology experiment, he had to know what was in the medium, where you bought it, how long it took the cells to grow. People like that can really put the brakes on the work.

Task Equivocality. The emergence stage of the life cycle is also likely to be characterized by highest levels of task equivocality (ambiguity). Like uncertainty, this condition can be described as a gap or difference—this time between the degree of shared interpretation, meaning, and understanding needed to accomplish the work and the degree the team shares at the time.[14] A leadership goal is to reduce this level efficiently by bringing team members together to interact and share their different values, perspectives, and interpretations (not information) and resolve their conflicting views.

To reduce the level of task equivocality, team members must interact with one another directly until they come to share the same perceptions of "reality." Rich communication media are important at this stage, especially face-to-face meetings, and the project leader must use a relationship-focused style. Reducing task equivocality requires that the leader support good interpersonal relationships, attend to interpersonal dynamics, and ensure that openness, respect, and candor characterize team behaviors. Put another way, effective equivocality reduction occurs when leaders model these behaviors and facilitate appropriate interaction during discussions.

Like task uncertainty, task equivocality will not be a downward-sloping line over the project life cycle but will "spike." It might appear improbable that the shared meaning of the task, including interpretations of results, should change over the life cycle. Intuitively, if task equivocality has been reduced at the emergence stage, there should be no more disagreement because a common understanding has been reached.

However, there are two sources of spikes in the level of task equivocality in the buildup and main stages of the life cycle: results and people. When unexpected or contrary results are obtained in the course of the planned experiments, task uncertainty rises (as was discussed). Task equivocality may rise at the same time if the unexpected result is so anomalous that people question not only "What should we do?" but also "What does this mean?" When results are open to different interpretations and team members disagree about what the results mean for the project, the level of task equivocality is high.

The second source of a spike in the level of task equivocality is a change in team composition. If the team remained stable, with no new members, there would be no rise in the level of task equivocality associated with team composition. However, organizational priorities may change and more people may be assigned to the project. Leaders can expect that, when new members join the team, the level of task equivocality will rise.

I want to emphasize that *each new individual causes a rise in the level of task equivocality.* Every scientist who is new to the project brings an interpretation of the scientific and technical activities, and about the project plan, that is somewhat different from the interpretation other members hold. Effective integration of new personnel is accomplished by ensuring that at least a few "old" members of the team spend face time with every new member, listening for areas of difference and conveying the team's common ground as effectively as possible. Orientation of new members with respect to the project is accomplished by communication that utilizes rich media and is facilitated by a relationship-focused leadership style.

Team Uncertainty. Team uncertainty arises because of a gap between information on team-specific *behaviors* (such as reporting relationships, performance evaluation systems, work norms, etc.) needed to complete the project and that which is possessed by the team at the start. In the emergence stage, scientists on the team may have very limited information about each other. The project charter, if it is well designed, should provide information on formal communicating lines, reporting relationships, and some work norms. In addition, the leader must ensure that the team creates and lives by good team rules about working together. Good team rules define how and how often people will be informed (and about what). They articulate desired norms of communication ("open," "candid," "respectful") and of listening ("active," "respectful"). Team rules describe how people will relate to each other ("as peers," "leave hats outside the door") and the values that all members will seek to uphold ("collegial," "challenging"). What is vital is that the team distinguish between how they will *adhere to* institutional policies and how they will collectively *abide by* team rules.

Good team rules that emerge from passionate discussions about collaborating will do much to reduce the high level of team uncertainty expected in the emergence stage. As in the case of task uncertainty, the level of team uncertainty is reduced when leaders structure the problem of information gathering and disseminating and make use of lean media to transmit uncertainty-reducing messages without compromising lateral structure. Unlike task uncertainty, the level of team uncertainty should be a relatively smooth, downward-sloping line over the project life cycle. Loss or addition of team members, which may cause spikes in the level of team uncertainty, should be managed by discussing team rules as soon as possible.

Team Equivocality. Team equivocality represents another gap and emerges from the differing perspectives that team members have with respect to their roles within the team. As was described earlier in this chapter, science and technology project performance was shown to depend on team members' performance within seven roles. However, there are other roles applicable to interpersonal dynamics, such as *cheerleading* (responsible for morale and support), *affiliating* (responsible for seeing to interpersonal issues that may get in the way of work), *mentoring* (responsible for bringing along new team members), and so on.

At the start of the project, the level of team equivocality will be high. When the team is first assembled, none of these interpersonal roles can be prescribed ahead of time (unlike collaborative behavior, which can be prescribed by team rules, and unlike the scientific and technical roles, which will ultimately be assigned by the leader). Rather, they will emerge in accordance with the personalities of the scientists as part of team-building efforts. Like task equivocality, the level of team equivocality is reduced by rich communication media, especially face-to-face meetings, and a relationship-focused style.

The level of team equivocality will also spike when a new member is brought into the team. Every new member brings different perspectives about the project and different assumptions about individual role identity within the team. For instance, a new team member may have enjoyed the role of cheerleading in a previous project but find that this role is "taken." Or, a new team member may have no strong role preference but discover that he or she is regarded as occupying a role for which he or she feels less competent (e.g., affiliating). Or, the new team member may not want to be part of the team, let alone play an important role in team dynamics. Of course, there are combinations and permutations of these instances.

The appropriate specific intervention cannot be defined. The general rule is that team equivocality about role, role competence, or taking a role can only be reduced by communication using rich media facilitated by a relationship-focused leadership style. New team members must be effectively integrated by equivocality-reducing efforts. They cannot simply be added to distribution lists and invited to meetings, given materials to read, told where activities are on the project timeline, and assigned to tasks.

Interestingly, the one exception to the general rule of *reduction over successive stages* is the level of team equivocality. If there were a way to plot measures of divergence and convergence of meaning shared by the team over the life cycle, we would find a U-shaped curve. The level of team equivocality should reach its nadir at some time in the late growth or early maturity stage, but it will rise again toward the end of the mature stage and into the completion stage. The level of team equivocality rises because members of the team face the loss of their collaborative identity and the disruption of established interpersonal relationships. Again, a relationship-focused leadership style must be employed by the leader, who should plan to spend the time needed to speak one on one with team members at this stage. If not addressed effectively, the high level of team equivocality can jeopardize the project schedule, delay the handing over of project work, and turn colleagues into strangers.

In summary, a relationship-focused style and use of rich communication media will be more effective when the level of equivocality (technical and/or team) is high. A task-focused style and use of lean media will be more effective when the level of uncertainty is high. Skills in selecting the appropriate communication media (discussed in the next section) as well as in matching leadership style to the requirements of the situation are vital to effective project leadership.

Postcript: Project Conflict. In addition to all the reasons why conflict can occur in an organization (discussed in Chapter 6) and, thus, a project, there are also certain project-related conflicts that can be expected at each stage of the life cycle.[15] Research has found that the most intense conflict in the emergence and growth stages is over project priorities. In the mature stage of the life cycle, the most intense conflict is over the project schedule. During the completion (or termination) stage, intense conflict is predictably over personality as well as over schedules. Personality-based conflict may erupt, for instance, between people who approach completing the work with very different styles. It is also likely to occur as a consequence of the approaching end of a highly satisfying collaboration. Ironically (but understandably), the more cohesive the team, the more difficult the dismantling of relationships when the project ends. No matter what the cause, the mandate of the project leader is to resolve the conflict quickly and effectively.

Matching Project Messages to Communication Media

The distinctions between lean and rich communication media (Chapter 5) are relevant to this review of "media matching." Simply stated, to reduce the high levels of task and team equivocality characterizing the early stages of a project, rich media (such as face-to-face communication) should be used. If the project leader does not involve team members in sufficient face-to-face discussions at this time, their misunderstandings and conflicting interpretations may persist and jeopardize project performance.

When levels of task and team equivocality are reduced, leaner media (electronic and paper) can be used. However, the project leader must be sensitive to the spikes in levels of equivocality that can occur over the course of the work. For example, the technical endpoint could change midway through the effort as the result of an unforeseen discovery or failure. To resolve problems that will arise when the team must define and agree upon a new endpoint, the leader must utilize rich media for communication.

In the completion or termination stage, levels of task and team uncertainty will be lowest, so lean media will be appropriate. However, the rise in the level of team equivocality at this time requires that the leader use rich media to deal with the human (as opposed to technical) messages regarding members' next assignments. To sustain morale in the face of the impending dispersal of a cohesive unit, project communication must be face to face.

The relationship between the level of equivocality and media choice is illustrated below. The four cells also indicate the problems that can arise if the wrong medium is used[16]:

	Lean Media	Rich Media
Low task or team equivocality	*Effective match*	*Overcomplication* (too many cues, too much data, too much "noise")
High task or team equivocality	*Oversimplification* (too few cues, impersonal, limited feedback)	*Effective match*

Overcomplication and oversimplification are not trivial communication problems. Faced with too few cues for a high-equivocality issue, people may spend a disproportionate time to seek more information or they may "fill in the blanks" themselves (often differently from what was intended). Faced with too many cues for a low-equivocality issue, they may spend too much time sorting the wheat from the chaff (and may not "keep" the right understanding).

TECHNOLOGY TRANSFER

Complex science and technology development almost always involves multiple project life cycles in the *proof-of-concept-to-product* process. *A Guide to the Project Management Body of Knowledge* provides several illustrations, ranging from the U.S. Department of Defense (four general life cycles from concept development to support) to pharmaceuticals (as many as nine general life cycles).[17] If there are N identifiable steps to go from concept to product, there will be $N - 1$ transfers of technology across each of the interfaces between one project team and another.

If the proof of concept (or equivalent) emerges from discovery in novel areas—if, in other words, the output will be a "breakthrough" innovation as defined in your field—the early transfers of technology (project handoffs) are most likely to be rate-limiting steps in the overall process. Why? The early transfers across the interface will be characterized by high task equivocality. Because the innovation represents a "break" from the past, there will be little past knowledge and experience to guide the solution of problems that arise in the next stage following discovery, and the stage after that, and so on. Both the problems and their potential solutions will be open to multiple and conflicting interpretations by members of the respective project teams, but shared agreement must be reached before further development can take place.

During early handoffs, the most important aspects of the project to be transferred are in fact the knowledge (especially tacit knowledge) and experience gained by the prior team. When the transfer is also characterized by high levels of task equivocality, a special form of communicating that knowledge and experience "across" the interface is required for the handoff to be timely and effective: transactive (or two-way), interpersonal communication.[18]

Complicating this situation is the fact that each step in the development process may take place at a different geographic site. In the pharmaceutical example (above), discovery facilities may be in different countries from where clinical development takes place. The transactive, interpersonal communication required for technology transfer to be timely and effective must be carefully planned and managed. The effectiveness of the early transfers, and the overall speed of process completion, will be contingent on how well the knowledge and experience gained by each team are communicated across the interface to the subsequent team.

Ideally, all members of these teams should be able to communicate face to face whenever necessary. However, when organizational units are geographically distant, the leader has two choices.[19] First, the leader can plan to bring a few scientists from the follow-on team to work with the current team scientists and then communicate the tacit and explicit knowledge and experience to their own team face to face when they return. If that is not feasible, the leader can use scientists on a contract basis (assuming they have relevant experience) in the same way. After working with members of the current team, they can literally carry the innovation and communicate the tacit and explicit knowledge and experience to the subsequent team.

Timing the overlap of these scientists is critical. Given the expected rise in the level of team equivocality in the main and completion stages, scientists should be brought into the current team during the winding down of the main stage of the project life cycle. If face-to-face meetings and collaborative work are arranged for the completion stage, the handoff will be unnecessarily protracted. Scientists will be dealing not only with the high level of task equivocality associated with further development but also with the high level of team equivocality aroused by the impending dissolution of the current team.

A special case of technology transfer is that which occurs in a strategic alliance between two firms.[20] For example, one biotechnology company enters an alliance with another firm to provide (say) a genetically engineered protein for clinical development. At the time this agreement is signed and the respective team members are identified from each company, however, there will be an unavoidable asynchrony in experience and in project life-cycle stages between the partners. In effect, for scientists in the biotechnology company, the project is close to the mature stage (low task uncertainty and equivocality). For the partner scientists, the project is by definition in the emergence stage (high task uncertainty and equivocality).

Because there will be differences in individual and collective experience on either "side" of the alliance, leaders must recognize that what is less uncertain to some may be more uncertain to others. At the start, partner scientists must reduce the level of task uncertainty and "catch up" by reviewing data and results and by replicating some of the experimental work. Given the differences in experience, however, initial replication of a biotechnology experiment is likely to require more than a single attempt by the partner. Even the definition of "replication" can differ between the two partners, so that very explicit questions should be asked.

Following the leadership challenge of integrating project life cycles at the start of an alliance is that of dealing with the handoff of the completed product (protein in the above example). At least two issues complicate this process. The first has to do with the nature of science; the second is interdependent with that but has more to do with the nature of human beings.

Particularly in rapidly moving fields, scientific and technical achievements will prompt scientists to expand their focus, to address new questions, to elaborate hypotheses, and so on, in short, to continue working. In fact, it may make sense to continue, but the decision of when to stop should be made by leaders in the partner company. The second issue complicating the handing over derives more from the nature of human beings. Many biotechnology scientists use images of *babies* and *children* when they speak about completing their work and transferring it to the partner. As one scientist told me:

> It is very hard handing over what feels like "control" to your partner. It is like handing over your children! Men and women in this company have spent their professional lives working on the project, and they worry about handing it over and not being able to touch it every day. "How is my baby doing?!"

Scientists from the two companies who worked well together earlier in the project life cycle may now experience problems. Those who were confident of their colleagues' expertise may now question it, as the reality of "not being able to touch [the baby] every day" becomes clearer. Trust may become an issue, simply because one "parent" is perceived to have had more experience. Thus, it is important that the leader understand and empathize with the situation and facilitate open discussion about these feelings.

THE MATRIX

A matrix is defined as a network of intersections of vertical and horizontal lines, similar to the warp and woof in a piece of cloth. In an organization, the analogy to the vertical "line" is usually the functional or discipline unit, such as "research" or "chemistry." The analogy to the horizontal line is the product or technology unit, such as "flight systems" or "genomics."

When a project is identified, the respective team members will be drawn from and report on technical issues to the functional and discipline units. They will also report to the project leader on project issues. Each team member, in effect, has two bosses: the discipline boss and the project leader (who is usually drawn from the product or technology unit). In effect, each team member operates in a matrix. Within the team, however, members will relate to each other and communicate with each other as peers. Authority will shift as problem expertise shifts. No one discipline can dominate; all are needed to complete the task.

In a pharmaceutical company, a person with, say, expertise in bioinformatics might be assigned to a cancer gene therapy team. That person, then, will work at the intersection of the bioinformatics group (vertical line) and the gene therapy project within the cancer therapeutic area (horizontal line). The bioinformatics team member will be responsible to the project leader for achieving, equally with other members, the project charter (e.g., the goal of moving a discovery toward practical gene therapy). At the same time, the bioinformatics member will be responsible to the bioinformatics section head for the caliber of his or her technical contribution.

The matrix requires equal sharing of performance evaluation between the project leader and leaders of the scientific and technical functions. Although the discipline heads are responsible for the technical caliber of team members, overall assessment must be based on the project outcome and the performance of the team as a team. Individual members should receive two evaluations: one for the project accomplishment and one for the caliber of their functional contribution.

What makes the matrix difficult to lead is the need to maintain a balance between technical and product requirements. The matrix "sits" on a fulcrum and is intended to ensure equal contributions of technical and product expertise (i.e., customer needs) as needed. In reality, rather than representing functions and products equally, the structure may be lopsided. Either technical and discipline managers dominate decisions and resource allocation or managers from the product "side" dominate, and who dominates may change over time.

As a result, the project leader is always caught in the middle. The project leader represents the customer, in the sense of understanding the potential use of the innovation, even in an early development team and before any input from traditional customer functions such as marketing. The project leader in a matrix will always be in the cross-fire between the requirements of the potential user and the requirements of the scientific and technological disciplines that contributed to the innovation. These conflicts are never resolved to the complete satisfaction of the different functions, but they must be resolved to the complete satisfaction of the project. That is the fundamental and inherent paradox of the matrix.

For the above reason, if effective project management is highly dependent on communication skills, effective matrix management is highly dependent on confrontation skills. Because the project leader works at the intersection of the project and the disciplines, he or she will always be working to find the common frontier between the project and the disciplines. In the abstract, this frontier is the effective completion of the project and successful transfer of the innovation to the next team. In day-to-day work, however, the frontier will not be so easy to find.

Each discipline will perceive its contribution as critical to overall project success. This conflict, between project and discipline, endures for the life of the project. That is why the project leader must be able to bring the discipline or functional heads, again and again, to recognize and agree upon the common frontier. The project leader lacks the authority to force a resolution in favor of the project; he or she cannot compromise the project, and the leader cannot avoid the conflict. Matrix management requires, as Jay Galbraith noted more than three decades ago, "complete commitment to joint problem solving and shared responsibility."[21]

CONCLUSIONS

Skills in managing intragroup dynamics (the project team) are eminently generalizable to managing intergroup dynamics.

The effective project leader understands what *formal collaboration* means and the planning required for it to be effective. He or she knows how to keep the collaborative units (teams) small enough for people to interact closely and how to choose the members of these units on the basis of their technical competence and their suitability for the requisite roles, as far as possible. The effective project leader has the interpersonal skills to build a team by ensuring peer relationships among the people who should collaborate and by dismantling any language barriers to their lateral communication.

The effective project leader does not lay claim to expertise in solving all problems but is confident in the problem-solving expertise of legitimate experts, no matter what their organizational title. This is one key to the success of general managers.

The effective project leader is able to keep the "big picture" in mind.

The effective project leader understands that managing the beginning and ending stages of the project well is critical to overall performance. He or she is sensitive to the patterns of task and team uncertainty and equivocality levels over the life cycle and is able to match leadership style as well as the medium of communication to the requirements of these situations.

Finally, the effective project leader is capable of balancing competing pressures on the collaboration and can always discern the common ground that everyone shares (and help them discern the common ground themselves).

The person who has successfully led projects should also be able to lead collaborations between the R&D functions, between R&D and other functions such as manufacturing, between in-house R&D and external alliances, between divisions, and between two organizations. The person who has successfully led projects is likely to be an effective general manager.

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9

DISCERNING AND ASSESSING ORGANIZATIONAL CULTURE

> The means by which creativity and innovation can be influenced [at the organizational level] are many and various but hard to measure. This is cultural. . . . The organization's culture must reward and encourage behaviour which challenges it, which burns with the desire for change. There must be sponsors who provide microclimates that nurture and nourish creative beginnings.[1]

In my experience, organizational culture shares at least two attributes with individual personality: (1) both have a profound impact on the work environment, as the above citation suggests, and (2) both are very difficult to change. This chapter focuses on the first attribute (Chapter 10 focuses on the second).

Culture is the major human aspect of the organizational characteristics sphere in the Venn diagram presented in Chapter 3 and reviewed in Chapter

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7. To emphasize what was discussed in the latter chapter, ensuring a match between (1) the technical and human aspects of the job demands and (2) the technical and human aspects of your and your scientists' personal competencies is a necessary but not sufficient condition for creative science. Innovation requires that all organizational characteristics—structure, systems, and culture—support collaboration, intellectual challenge, candid and transparent communication, and willingness to take risks. Unless both the human and technical aspects of the larger social context support these qualities, novel science and technology may not emerge.[2]

In this chapter, I first present a model of organizational culture to help you discern the culture of your organization (or your part of the organization) and assess how that culture either fosters or inhibits scientific creativity. Then, I provide three case examples drawn from real organizations of cultures that did *not* support challenge, open communication, collaboration, or willingness to take risks. My hope is that these illustrations will help you reflect on how the culture of your laboratory or department affects the quality/creativity of your science.

A MODEL OF CULTURE

Culture, like personality, has been described as a "layered" phenomenon consisting of manifestations, justifications, and core.[3]

Manifestations

The outer layer of culture includes such tangible manifestations as the formal logo or symbol of the organization found on stationery and business cards, the physical facilities (especially headquarters or the equivalent), the geographic site(s) of the facilities, dress codes, and the like.

Informal symbols also manifest culture. In many organizations, there is an image that is widely held as illustrative of what the organization is really like. For example, an R&D facility was described by its scientists as a "chemical fortress." Not surprisingly, efforts to introduce different technologies such as molecular biology were extraordinarily difficult. Another was depicted as a longboat in which those at the oars faced in opposite directions. Scientists felt that, though they pulled energetically, there was no agreement on or movement toward a coherent scientific direction. (This was drawn for me on a napkin by one of the researchers.)

Finally, intangible behaviors manifest culture, such as rituals around:

- Meetings (having food or not, arriving late, arriving promptly, seating arrangements, etc.)
- Decision making (seeking wide input, rarely asking for input, gaining consensus, etc.)
- Communicating (going only through channels, circumventing channels, relying on the grapevine, using email, not using email, etc.)
- Eating (at one's desk, in the lunchroom with one's discipline colleagues, sharing food among the team, etc.)
- Socializing, and so on

Justifications

Below the surface, the next layer of culture consists of the reasons or justifications people give for organizational actions, either directly in response to questions or indirectly in formal communications. Justifications may be found in published documents, such as annual reports ("We decided to invest in X because. . ."), brochures ("Our organization is committed to Y because . . ."), or newsletters ("You will have noticed that we changed Z because . . .).

They are also found in the stories that make up organizational traditions handed on to new employees or repeated under certain circumstances (such as success or crisis). For example, development engineers in a mid-sized European software company explained that their quiet and polite way of dealing with each other derived from the death-bed wish of the company's founder. According to tradition, this man gathered his seven direct reports around his bed and admonished them: "Never fight with one another."

Core Ideology[4]

The most important part of culture, however, is the core or deepest layer. At the core are a few, key beliefs about those fundamental qualities that embody, for members, the organization's very reason for being. These beliefs affect the warp and weft of organizational life and are at the root of assumptions rarely questioned by organizational members but often reflected in the justifications or second layer of culture. The three layers of culture are connected, but the direction of influence is from the core. Both the surface manifestations and the justifications for organizational action provide only clues. To understand the culture, you must understand the core.

Core ideology emerges from the founding history of the organization, including the experiences and background of the founder(s). It is forged in the early successes and crises of the organization. Schein noted that, if the organization prospers, then people continue with what was successful and stop what was not. If there are failures, people learn how to avoid the painful situations, and they will continue to behave in a similar way no matter what the situation (as one of the case examples will attest).[5]

Culture, the core ideology, was described to me by a colleague as a *handbook for organizational survival,* which makes it extremely powerful.[6] People learn that their "survival" quite literally depends on holding certain beliefs and modeling certain behaviors, such as the politeness described above. Moreover, core beliefs act like lenses through which people in the organization perceive their world. If these beliefs are interpreted in a way that is incongruent with the qualities required for scientific creativity, then the core ideology acts like astigmatism in a lens—a source of distortion. Such distortions are difficult for those in the organization to examine and recognize. Each of us is, in effect, psychologically embedded in the organizational culture. In addition, because culture is linked with survival, its distortions are difficult to challenge once they are recognized. That is why culture, like individual personality, is so hard to change.

The core ideology that emerges from the founding history of an institution is handed on to generations of organizational members by at least three means. First, newcomers to the organization tend to imitate other members and, by that means, come to share their beliefs. Second, job tasks provide a means for people to talk together and come to a shared understanding of "the world" as viewed through the lenses of the core beliefs. Finally, (1) hiring policies (often described in terms of finding people who "fit" the organization, as discussed in Chapter 7), (2) formal training, (3) job descriptions, (4) apprenticeships, (5) mentorships, and (6) all the formal and informal means by which organizational members convey appropriate language and behaviors to new members also transmit the core ideology.

To help you understand how core ideology emerges and the potential impact of culture on scientific creativity, three annotated illustrations are provided. All cases are of real but disguised organizations, and the conversations (sometimes disguised as to organization and place) are drawn from verbatim conversations of real scientists.

FIRST ILLUSTRATION OF CULTURE: JENSEN A/S

Founding History: Henry Arnoldsson

Ole Jensen Arnoldsson, a Swedish chemist, moved to Denmark around 1850 and settled north of Copenhagen in what was then farmland. He went to Copenhagen University and completed a doctorate in organic chemistry, married, and began to work as the first research chemist in a local fertilizer manufacturing company. The couple had five children, all of whom were sent to the university, and three (two sons and a daughter) went on to receive their PhDs in chemistry.

After completing their doctorates, sons Henry and Stig joined their father as company researchers. Shortly thereafter, while tinkering in his home workshop, Henry discovered what he believed to be a novel method for producing fine chemicals. At the age of 34, he formed a partnership with his brother and they opened a small firm. They named their company "Jensen" and set up operations in what was formerly a large outbuilding of one of the local dairy farms.

Jensen prospered and by the turn of the century was producing fine chemicals that were used throughout Scandinavia. Henry's insistence on "quality foremost" was understood to be one of the reasons for Jensen's success, and this slogan was printed on all the stationery and labels used by the company.

Henry was president of Jensen for 35 years, and three of his seven children also worked in and then took over the family business when he retired. He built one of the first research departments in the fine-chemicals industry, and he oversaw the expansion of sales to Europe and then to Asia. Overshadowing his business and scientific acumen, however, was his reputation for paternalism. Even before Jensen was profitable and before it became standard practice, Henry allowed employees to leave work early on Saturday and shortened the work week to 35 hours (at full pay) during July and August. Like his father before him, Henry was active in the cultural and political life of the community, donating money to build schools and a hospital, support the symphony, and expand the museum. He also served nearly 20 years in local government.

> He was a distinguished man, but he was also interested in his staff . . . He was generous to the church and to the village club.[7]

In 1935, Henry's middle son became president of Jensen, and the tradition of Jensen family leadership continued into the 1950s, when the company went public (Jensen A/S). From the time of its founding, all employees were on salary, and no one was ever laid off. In a company history written in the 1970s, the Jensens were praised as a prominent local family who, unlike other corporate founders, did not move away to become absentee landlords of their original company facilities.

By the 1970s, Jensen's products were known for their high quality and the company was known for its dependability. Sales of fine chemicals formed the mainstay of the corporation and accounted for nearly $1 billion by 1975. At that time the company expanded into additional international markets and became organized by product line for the end customer (e.g., food, perfumes, leather).

> There is no desire to rail against one's immediate superior. . . . The worst mistake any employee can make . . . is to bypass someone in the hierarchy [which] is immediately interpreted as a personal affront.[8]

Core Ideology. This very brief overview of the founding history suggests that at least three beliefs might constitute the core ideology of Jensen's culture: belief in education, belief in quality, and belief in family and community. Such beliefs can have very positive effects, depending on how they are interpreted. A belief in education can be interpreted as valuing highly trained scientists and intellectual achievement. A belief in quality can be interpreted as valuing excellence of organizational output, quality of product, and quality of science behind the product. A belief in family/community can be interpreted as valuing humane regard for all organizational constituencies.

Beliefs can also be interpreted in such a way as to inhibit collaboration, intellectual challenge, candid and transparent communication, and willingness to take risks—organizational qualities required for scientific creativity. At Jensen, the belief in education became, over time, the rationale for a quasi-academic approach to research that complacently deemphasized the need for novel products, on which the company ultimately depended, in favor of "good science." The belief in quality, and Henry's slogan was still printed on all company labels, became the rationale for time-consuming and risk-averse decision making. Finally, the belief in family/community became the rationale for paternalism, interpreted to mean one's superior knows best, challenge is not respectful, and being nice (at least to one's face) is most important.

Paternalism also kept Jensen headquarters and R&D facility in a small town in Denmark, although most similar companies were located in larger European countries and in the United States. Jensen's relative isolation made it difficult to recruit leading-edge scientists, many of whom chose to work closer to the universities at which major discoveries were being made. However, the company had originally prospered with these beliefs, and employees kept repeating what had been successful. Even a century later, as the Taiwan decision discussed below demonstrated, these beliefs influenced Jensen scientists.

Taiwan Decision. Jensen had set up a sales office in Taiwan in the late 1950s and had added a small laboratory for onsite testing of chemicals to be sold there. Because of the potential size of the Asian market, in 1980 the company sent a research chemist from Denmark to conduct a feasibility study of expanding this small laboratory to a full-sized R&D facility. The chemist discovered that the current location would not be suitable for expansion, and Jensen managers had to decide whether to build in another location in Taiwan, to expand the Danish facility, or to build an R&D facility elsewhere in Europe or in the United States. Under the direction of the vice president of R&D, Steen Tastrup, a study team was sent to Taiwan in 1982. The team concluded that a full-scale R&D facility should be built at another location in Taiwan. By 1988, a site had been chosen and the construction begun.

In a 1992 conversation between the manager of the new Taiwan laboratory, lb Dissing, and Steen Tastrup (both PhD chemists), the *justifications* for the Taiwan decision were as follows:

Steen:

We considered locating a facility in Germany, and we considered the U.S. Because Asia is one of our biggest markets, we decided that the best way to meet their needs was to build a research facility there.

Ib:

In addition to the commercial aspects, we decided that building in Taiwan would open new doors to a different approach to the science. And, because we would open up a new network of scientific institutions, we might also be aware, earlier, of innovations useful to our business.

I think there are two key reasons for deciding to build up an R&D presence in Taiwan. First, we want to be a global company rather than a Danish company doing business in Asia. Second, I believe we need to be open to different inputs and a different way of thinking about our science.

Such justifications for organizational action are logical, given the industry. Notice, though, how long it had taken for people at Jensen to make this decision. The initial report was sent to headquarters in 1980; a team was sent to Taiwan in 1982; and a site was chosen in 1988, almost a decade later. In comparison with its competitors, Jensen was very late in adopting a global strategy, as Steen and lb implied:

Steen:

More than a decade ago we considered opening a European R&D facility. [The company had not built one at this time.] So, we have a history of responding to external forces. But that should not be confused with the strategic thinking that led us to build a laboratory in Taiwan.

Ib:

This time we decided to be at the forefront of internationalization in our industry. We decided to be a little bit more risk taking.

With regard to being a bit more risk taking, lb continued that he saw himself as an advocate for “culture shock” within the company:

To some degree, I have taken on the role of exposing Jensen to healthy culture shock. I have always said to Steen that we needed some culture shock, and I was also very vocal about efficient size in R&D. I find that, as our organization gets bigger, our bureaucracy gets bigger. We need multiple copies of reports, decisions take longer, and creativity declines.

Well, creativity declines perhaps not so much because of size as because of culture. I think that our top management have become more formal and remote, and scientists are pressured to deliver formal proposals for new research efforts.

I would say, and Steen agrees, that the culture shock of Taiwan is important to us at this juncture. If we go to Germany or the U.S., we go after every other fine-chemical company has expanded there. Jensen has been very conservative. We wait and see how others fare before we decide to follow suit.

As Steen went on to describe how management at Jensen had come to make the Taiwan decision, he revealed much about the way in which their core beliefs had actually been interpreted:

We talked a lot about what type of organization we wanted Jensen to be and how big a research facility we could manage. Year after year,

> we would test ideas in our own R&D organization and in forums with corporate management. After a while the ideas that first appeared so startling and different began to have a certain familiarity, like your favorite slippers. I describe this as a breaking-in process, breaking in your favorite slippers. Soon, all are comfortable with the decision.
>
> This is what strategic planning is about. You have to involve people, and you have to create scenarios that have no surprises. Everyone should believe the decision was their own idea and be familiar with all of the elements. Everyone in Jensen has talked about the idea of a Taiwan laboratory many, many times over the past few years.

What is important for you to notice is that, in the same conversation, these scientists discussed the need for "culture shock" at Jensen and the "breaking-in," surprise-free process of making decisions. The contradiction was not apparent to them because they saw the world through the lenses of their core ideology.

A similar contradiction between what they intended to do (the justification) and what they might actually do was revealed in their discussion of the relationship between the Taiwan laboratory and the Danish headquarters. In the following dialogue, note the influence ("lens") of their belief in paternalism.

First, lb stated that the two facilities must be independent, to ensure the challenge of "a different input and a different way of thinking about our science":

> We realized that we could not just build a satellite laboratory in Taiwan, or we would miss the different way of thinking and different approach to the science that we needed. So, we will have Denmark and Taiwan evaluating each other, as peers, according to the expertise of the relevant scientists.

Then, Steen used the image of parent and child, revealing that the independence of the Taiwan facility and the needed intellectual challenge at Jensen might be difficult to achieve:

> Denmark is the home, the parent, and the Taiwan facility will be built to serve all of the children. But none of the children is designed to serve the global market except Taiwan.

Other research scientists at Jensen alluded to the company's problems. They realized they were coming to "diminishing returns to scale in Denmark—more money invested in R&D with less return." They also admitted that they were anomalous in the industry by remaining in Denmark. As one chemist noted:

> To me, the strategic question is: How do we turn a company that's based in a small town in Denmark into one that truly has a global perspective?

She, too, was concerned that the Taiwan facility might not remain independent:

> Our organizational challenge will be: Do we stamp out a carbon copy of the Denmark facility, or do we build something radically different? We have to be careful not to develop the attitude that the Taiwan laboratory is an extension of the one here. We have to be careful that our R&D people don't over-control the scientists in Taiwan.

In a statement that reveals much about how paternalism had been interpreted, one group manager commented:

> Jensen invites you into the family and makes you captive. It's a nice company, a good company to work for.
>
> Sometimes I wonder, though, if you can't be smart and nice!

lb Dissing left the following week for Taiwan. Sometime later (1995) he recounted:

> Senior management in Denmark have been very wary of letting scientists come over to Taiwan and of allowing open and free discussion be-

> tween the two groups. I've been working very hard to loosen that. Decisions must go through the proper channels, but discussion should not be inhibited by our organizational chart.

Consequences of Culture. Jensen was known as a solid company ("dependable") in the industry, and its scientists were respected for good work. Industry analysts began to be concerned in the early 1990s about the company's ability to remain profitable without novel products. Although Jensen had two or three successful lines, both the process and the product technologies were mature, and customers were moving to new offerings from competing firms.

Jensen's core ideology was, in fact, inhibiting scientific creativity. The company had no new products in the "pipeline" because collaboration, intellectual challenge, candid and transparent communication, and willingness to take risks (in managing as well as in science) were not supported. Collaboration was not encouraged, as evidenced by Ib's statement about the wariness of managers to let Danish scientists spend time in Taiwan. There was little intellectual challenge because challenge was not considered "nice." Communication was through channels, and candid assessment of the organization was seen as lack of loyalty to the company. Finally, risk aversion was pervasive in their managerial ("breaking-in") processes and scientific decision making.

> People are generally very kind to each other. . . . A member related that when she was appointed she was given to understand quite plainly that it was more important to visit and congratulate someone who was celebrating a birthday . . . than to [accomplish the tasks in her job description].[9]

One Swiss professor, who had attempted to collaborate with Jensen scientists, commented:

> I think their scientists are very, very careful, very good, extremely high quality, nothing sloppy. They pay a great deal of attention to quality control. But they move extremely slowly in research and development. It's a strange culture, though. They close the laboratories early in the

> summer. Also, because they are located in a rural environment, that slows them down even more. It takes them forever to move a project forward.

In a not-unfamiliar tactic, Steen and lb were replaced as managers, but their successors also left after a short time. Another Jensen family member was appointed president, and the company's reports spoke confidently that Jensen could remain independent. Unfortunately, it could not. In 1998, a midsized American company acquired Jensen, emphasizing the comfortable "fit" of the two company cultures. A period of cost cutting and more layoffs followed, but the merged entity was unable to meet competitive standards. In 2002, Jensen and the midsized acquirer disappeared without a trace. They were bought by one of the top global firms and totally integrated into that structure:

> This is an organization which almost glories in its resistance to change. . . . Intellectually [the need for change] is recognized but has yet to be engaged. Perhaps [if people do engage in trying to change], it will already be too late.[10]

Intellectually, the need for change was recognized in 1992—at least, according to Ib Dissing's desire to provide a "healthy culture shock." However, by the time steps were taken to change the culture of the organization, it was already too late.

SECOND ILLUSTRATION OF CULTURE: POLARIS PHARMACEUTICALS

In the late 1990s, about the time that Jensen merged with the American company, a task force of scientists from all therapeutic discovery areas of Polaris Pharmaceuticals met to discuss their company culture. By the end of a day-long meeting, the group concluded that a culture for innovation appeared to be lacking. They believed the culture that existed produced, instead, the following norms:

- People needed permission for "empowered action."
- A top-down structure was encouraged.
- People were shunned if they failed to conform.
- There was a strong organizational memory for past mistakes.
- The organization was generally conflict and confrontation avoiding.

Scientists agreed that Polaris norms encouraged a top-down, hierarchical structure, reinforcing the dynamic of dependency. The practice of shunning people when they failed to conform was openly admitted. Tactics such as leaving people out of important meetings and the use of corrective interviews had resulted, they said, in conformity and stifled independent thinking. Most seriously, the group feared their culture would result in scientific mediocrity—if that had not already happened.

People also admitted there was a strong organizational memory for past mistakes. One recent example concerned an altercation that had taken place 10 years earlier but was cited as a reason for not promoting (10 years later) an otherwise qualified individual. Finally, they described many instances of conflict and confrontation avoidance. In such an environment, they said, innovation may be hampered by unsolved disagreements and an atmosphere that prevents the intellectual challenge so important to advancing scientific knowledge.

Attributes of the right culture, as described by these scientists, included appropriate scientific autonomy in the context of strategic accountability, risk willingness, independent thinking (many stated that independent thinkers did not exist anymore), and accommodation of mavericks. These were the attributes missing within Polaris. One of the scientists asked, "How could this occur in a firm admired so many years for its scientific excellence?"

Founding History: Three Themes (and a Core Ideology). The 100-year history of Polaris described a firm that was run "with extraordinary fervor and fidelity" by three generations of the Bigelow family. The individual deemed to be "the individual whose character this organization bears" was Lucas Wendell Bigelow.[11] Homer Bigelow, a physician, founded the company; it was his son, Lucas, who put nearly 70 years of his life and influence into shaping its character. Lucas Bigelow came to work in 1881 and was actively involved with the institution until his death in 1950. From historical documents and company archives, three themes emerged as the likely source of Polaris's core ideology.

The Polaris Island. Founded in upper New York State, Polaris had been and still was a major employer in the area. According to company history, the Bigelow family (like the Jensens) felt a sense of real consanguinity with and responsibility to the city that nurtured it. Even during a period of urban decay in the 1960s, the Bigelows never considered leaving the site.

In a number of respects, Polaris was like an island, close knit, and closed to the outside group. A Polaris employee was expected to be intently focused on Polaris, following Lucas Bigelow's example and admonition not to be interested in too many activities and duties outside the company. Similarly, he urged managers to keep away from outside business ventures.

Since its founding, both the geographic location and the special sense of the company fostered (in the words of a current senior manager) "isolationism":

> Polaris is an island. There are few connections or communications from the island outward. Recently, some of the veils of corporate isolation have dropped, as it has become clear we can't continue to live on an island. Polaris is a world apart from the world. It's in a bubble.

Employees felt themselves to be part of an extended, long-term, loyal family. There was a saying that, if people worked for the company for 5 years, they were likely to stay for the rest of their lives. Moreover, members of the same family worked for Polaris as the rule, rather than the exception. Even in the early history of Polaris research, husband and wife scientists worked in the same laboratory (a tradition continuing today).

Lucas Bigelow called employees, literally, his "boys and girls." How boys and girls were expected to behave in this extended and tightly knit family can be inferred from his advice to his sons: "Have your differences, if any, out in the closet." That practice of having your differences, if any, out in the closet was reflected in a widely held and strongly reinforced norm of conflict avoidance. Similarly, scientists stated:

> There is a lot of conflict avoidance. Management is not willing to deal with conflict, and the company does not train people in these skills. . . .
>
> People try to bury conflict here, not dig it up and confront it. This is a constant, daily problem. . . .
>
> A lot of attention is paid to making sure everyone is OK with a decision. There is a lot of time spent in pre-selling the individuals, which is time consuming, but the people to whom a presentation is made expect to have been pre-sold. . . .
>
> You have to be nice at Polaris!

Greatest Science of the Century. Lucas Bigelow described Polaris' research as "the greatest science of the century." At the 1940 dedication of a new research facility, he said research "must consist of devoted men and women consecrated to the search for truth and completely free from commercial influence or control." The first director of research, Dr. Duncan, was personally recruited by Lucas. Interestingly, the new research facility included a well-appointed library and study rooms, "where privacy is assured for writing papers and other work of similar nature." In such an atmosphere, great importance was placed on publications and patents. Duncan's publication record was duly noted at the dedication, as was the patent record of one of the chemists.

Decades later, scientists still talked about the "two Ps" (publications and patents):

> We're evaluated on our ideas and contributions. The emphasis on publications changes, depending on who's in charge. But, patents and publications are always on the list of desirables.

Good Advice Still Promulgated. Bigelow family leaders were described as men who believed in the incalculable value of sound traditions and seeing that these were carried on at Polaris. One tradition was growing the business cautiously and steadily. Lucas recommended that managers keep steadily and consistently to an honorable and correct policy and be conservatively progressive. *Caution* and *conservatism* (as interpreted by successive generations) explained the length of time Polaris had taken to move from being an international pharmaceutical company to a global one. As a senior manager noted: "For a long time, Polaris was 'international.' The international business was small, and they sat a little lower at the table."

Another tradition that emerged from the founding history was quality bordering on perfectionism. Homer Bigelow learned, in his early apprenticeship, habits of industry and exacting and painstaking precision. In the first years of manufacturing, when the gelatin coating on Polaris' pills was pricked by the available drying apparatus, one woman was specifically responsible for touching up with a paintbrush each capsule before they were sent out. Also reflecting perfectionism was one story about Lucas's elder son, Caleb. He regularly toured the company and, if he found part of the facility did not meet his standards, he hung a sign stating: "This is the dirtiest department in Polaris." (There was even a photograph of the sign in the company archives.)

Painstaking precision appeared to be reflected in a propensity at Polaris to plan very carefully and, perhaps because of the norm of caution, to implement slowly or not at all. A number of people noted: "We'll do strategic planning but not implement a thing" and "Scientists here are very slow to start their work. They do things slowly, step by step."

Polaris Today. Unlike Jensen, Polaris remains a stand-alone, going concern. The company's rank in the industry continues to drop, and it occasionally appears on analysts' lists of potential takeover candidates. However, I believe the most telling sign of a serious situation is neither industry rank nor analyst prognostication. Rather, it is the tenor of responses of research scientists to inquiries about their work. For example:

> Burying conflict is a constant problem. There is a lack of challenge. . . .
>
> Problems here are lack of challenge and openness. People don't collaborate because rewards are for individual achievement. . . .
>
> People are so reluctant to express their opinions that we have a hard time moving forward. . . .
>
> Problems occur because of conflict avoidance and lack of challenge—people are afraid to speak out.

Despite changes in senior leadership at Polaris, a newly publicized corporate vision, and several attempts to change the culture, norms impeding innovation appear to remain unchanged.

> Establishments . . . continue their quest to capture a core culture and a core vision for the organization as a whole. . . . Once this is in place—usually put there by a new and newly high-profile chief executive—[this] newly found order [is] packaged, sold and supported. . . . The essential drift of this process is toward a new conformity. The essential consequence is that innovation is encompassed within the plan horizon. It is again constrained. It may well be killed altogether.[12]

THIRD ILLUSTRATION OF CULTURE: JEAN SAVOIR INSTITUTE

I want to repeat that core ideology emerges from the founding history of the organization and is forged in early successes and crises. In Schein's terms, if the organization prospers, then people continue with what was successful and stop what was not. If there are failures, people learn how to avoid painful situations and continue with the pain avoiding behaviors.

The cultures of both Jensen and Polaris emerged from founding circumstances that were positive. There were no major crises or failures during the first decades of these firms; rather, people were successful and their successes reinforced the early beliefs. The culture of the Jean Savoir Institute emerged under very different founding circumstances—an authoritarian founder and a "ruinous" successor. Scientists at this institute learned, over the years, a set of behaviors that helped them avoid pain. The consequence was a recent instance of incompletely reported clinical data (only the positive results) which seriously damaged the institute's reputation and caused a precipitous drop in grant funding.

Founding History: Savoir and Colbert. Jean Savoir was an internationally renowned biologist who, as a professor in a French university near Paris, had discovered a key mechanism of cell proliferation in certain cancers. The founding circumstances, and the founder and his successors, were described by a former postdoc from his laboratory as follows:

> Savoir had very fixed ideas about research. He ruled the laboratory in a very authoritarian way. Although he built up the group of researchers, he always maintained that cancer research was special and you could not deviate from his prescribed approach to discovery. That was his attitude, and the research stagnated.
>
> Also, he did not invest in technology. There were scientists in the laboratory who did not have computers until the early 1990s!

Before Savoir retired, the French government created an institute in his name. For a number of reasons, Savoir's hand-picked successor moved the institute to Lyon:

> Savoir's successor in the late 1980s was Prof. Colbert. He initiated the move to Lyon. In fact, he was a "Lyon person," with large property in the area.
>
> Colbert was ruinous as a director. He dismissed people outright if they did not agree with him. You were dismissed if you said something about the institute, or Colbert's science, that you should not say. He was aloof, and people rarely saw him in the laboratory. Now, for all Savoir's authoritarianism, you could say what you thought and you could disagree. He might throw a tantrum, but you could speak out. You could not take your research in a different direction, of course!
>
> Much of Colbert's negative impact on the institute was a result of his wife's actions. She essentially ran the organization—she was always there, watching and listening. She even used laboratory technicians to take her shopping. If she wanted someone dismissed, she simply told her husband.

Under the Colbert regime, scientists and technicians did not dare say anything negative or dare to speak out if they disagreed because they were afraid they would be dismissed. It should be noted that they were not only dismissed but also reputed to be of questionable intellectual quality and, thus, found it difficult to find new positions within the system of universities. The pain-avoiding behaviors continued to be repeated, and reinforced, under successive directors:

> Colbert lasted 2 or 3 years and was followed by Dr. Parker, a South African geneticist. Parker was also very authoritarian, like Savoir and Colbert, but he did bring a different style. He would go around to the laboratories and talk to people, which went down very well, especially in contrast to the situation with Colbert. Parker was autocratic, but scientists took it better because he spoke to them.
>
> However, Colbert's dogmatism could be seen in Parker as well. The institute's research, as far as Parker was concerned, was perfect. There were no problems with bench or clinical experiments. In fact, one chemotherapeutic agent caused severe gynecomastia in some patients, but Parker refused to believe the effect was at all related to the institute's compound. He forbade anyone to talk to outside physicians about such side effects, because if there were a problem, it *could not* be from the agent itself.
>
> Then, Parker became very ambitious. He increased the number of scientists in the institute by a *huge* amount in preparation for a new round of government funding.
>
> Parker had good intentions, but he was taking over a very difficult situation. Colbert had almost ruined the institute with his poor management, and dismissals, and the turnover of scientists. Some of these scientists had been with the institute for years under Savoir but had disappeared without a trace. Soon, Parker began to lose touch with the science as the institute grew. Also, he became very dependent on only a few people to give him information about what was going on. One of the senior scientists, on whom Parker depended, required only good news about the research. There could be no adverse effects of anything that was being tested.

The "Virus." A highly publicized institute therapy for cancer began to be widely administered within France. Soon, with increasing numbers of patients receiving the compound, troublesome side effects were reported to the institute. Within the institute, however, there was pressure not to publicize or even talk about the problem:

> When side effects became impossible to ignore, Parker did not want to talk to anyone outside the institute who was critical of its actions. Parker essentially said: "Shhhhh! Not so loud! Be quiet. Don't give so much information to doctors, to hospitals, to newspapers."
>
> There was a lot of discussion in closed meetings. On the third floor where Parker's office was located, everything was top secret, hush-hush. Closed doors and only a few key scientists up there. . . .
>
> Of course, that example reflected similar behavior throughout the institute. Lots of scientists did the same thing, such as not sharing information, holding research meetings behind closed doors. People pretty much looked after themselves, covering themselves. There was almost a code of secrecy in the organization.
>
> People were not prepared to talk to each other, to share negative information. They still felt they would be dismissed.

Bad news did get out. A scientific advisory panel was convened by the government and charged with examining all the institute's research and experimental data. The issue of incomplete reporting was more widely publicized than the drug had been, striking a severe blow to the institute's formerly renowned reputation. Government funding was withdrawn for an entire area of work, and many scientists struggled to find work elsewhere.

From his vantage of having left well before that scandal erupted, Savoir's former postdoc could perceive the effect of the institute's core ideology (although he did not use that language) on several generations of scientists:

> There were too many bad experiences in the institute, with directors saying one thing and doing another, or punishing disagreement. . . . Scientists had no trust in the director or his key people.
>
> I have said that the institute suffered from a virus that was, sad to say, a legacy of its history. Even new people "caught" the virus. They got infected very quickly, and that's a shame. It was that bad situation that essentially brought the institute to the current state of affairs.

WHY AND HOW ORGANIZATIONAL CULTURE FAILS

These three cases studies—Jensen, Polaris, and the Jean Savoir Institute—are meant to provide not an exhaustive illustration of organizational cultures but rather some guidelines to help you think about your own laboratory or department. Consider the common themes.

First, in each story, one or a few key individuals imprinted the organization by force of personality (Henry Arnoldsson at Jensen; Lucas Bigelow at Polaris; Savoir and Colbert at the institute). Thus, if you are interested in understanding culture, you will find much that is helpful in histories of founders of organizations or widely renowned leaders of groups and laboratories. Often, what are individual values and beliefs become collectively held values and beliefs, as founders pick successors and successors set the example for recruits.

Second, in each organization, individual values and beliefs became collectively shared values and beliefs that were reinforced over time. For Jensen and Polaris, success strengthened beliefs in (for example) quality. For the Savoir Institute, reinforcement was not positive but negative. People who did not share beliefs in authoritarianism, who questioned or disagreed with the leader's pronouncements, "disappeared over the years." At Jensen and Polaris, the core ideologies were lively in the hearts and minds of recently hired scientists because for many years those beliefs (and the behaviors that followed from them) were confirmed as the companies succeeded. At the Savoir Institute, even "new people 'caught' the virus"—they were "infected very quickly" with the core ideology that had been reinforced by the mechanism of painful consequences.

Third, each organizational structure was rigidly vertical, with superior–subordinate patterns of relating and communicating that were based on a parent–child model. Henry Arnoldsson at Jensen had a (positive) reputation for paternalism. Lucas Bigelow called Polaris employees his "boys and girls." Jean Savoir was authoritarian (a strict "father"). Yet, as was cited in Chapter 7,

> Parents are not creative. They are defenders of the paradigm. They use words like "ought" and "must."[13]

Vertical structures, hierarchies, are inimical to creativity. What these stories illustrate is the (unintended) fit between the human and technical aspects of organizational characteristics. The cultures (human aspect), with ideologies supporting paternalism and authoritarianism, were matched by paternal/authoritarian structures. As Thorne noted about one of the companies he studied (not Jensen):

> The organizational culture . . . is indisputably permeated by the culture [of the founder and the early community in which the company was founded]. . . . prominent figures are still respected. There is no desire to rail against one's immediate superior. . . . The worst mistake any employee can make . . . is to bypass someone in the hierarchy [which] is immediately interpreted as a personal affront.[14]

In none of the case studies did people value experimenting with other ways of doing and other ways of thinking, nor did they value a rigorous assessment of their own assumptions by means of systematic feedback. What they exemplified was skilled incompetence, or single-loop learning: taking action to solve a problem without addressing "the more basic problem of *why* these problems existed in the first place."[15] As the world changed, members of these organizations continued to view it through the lenses of the core beliefs, and they continued to behave as usual.

In all three organizations, people were most likely hired because they fitted in with a particular belief system. Interviewing weeded out those who were "eccentric" in comparison with the desired type, and competent eccentrics who were hired soon left or gave up trying to change what they initially perceived as the problems in research. Even in Jensen's Taiwan facility, lb Dissing had managed to find people who fitted the Danish mold, thus making it unlikely that he could bring about "culture shock."

In many organizations, initial success and homogenization by means of recruiting and hiring policies result in scientists who talk mainly to each other, who too quickly dismiss challenge if they even really seek it from those deemed eccentric, who are only partially aware of the turbulence of the external environment and the consequences for their organization, and who become more and more risk averse at the same time as they complacently assure themselves they are engaged in highly uncertain (i.e., novel) research.

In the three examples, the qualities required for novel science and technology were not valued or were given only lip service. There was little or no collaboration across disciplines, at the "interstices" of the science; little or no intellectual challenge from those who could be counted upon to bring a radically different way of thinking; little or no candid and transparent communication, often under the guise of valuing civility; and no genuine risk taking, often under the guise of valuing quality.

For two of the organizations, only crises brought the possibility of self-assessment. However, the warning signs, including loss of customers (Jensen) and the importance of only "good news" (Savoir), were clear before the crises.

It is not that culture actually fails, of course. It is that people interpret the original core beliefs in a way counter to the qualities required for creativity, and they fail to discern that this is happening.

When culture "works," people collaborate because norms encourage them to ask questions of anyone, anywhere. Organizational norms encourage intellectual challenge, reflected in impassioned arguments about principles and techniques. Communication is open and everything, including criticism, comes "straight." An atmosphere of questioning and collaboration, of challenge and candor is by definition an atmosphere in which risk taking is encouraged. In such an atmosphere, novel science and technology can emerge.

Such a culture is not achieved more easily in an academic or public institution than a commercial one, nor is it more likely to be found in small rather than large organizations. As lb Dissing stated, scientific creativity declined at Jensen "not so much because of size as because of culture." One of the tasks of the effective leader of scientists is to evaluate whether shared beliefs support the qualities required for scientific creativity. If they do not, then changing culture must begin with insight into the incongruities between what is encouraged in the organization and those requisite qualities. As long as the contradiction between what people intend to do and what they actually do is not apparent to organization members—as was the case at Jensen, Polaris, and Savoir—there can be no improvement in the quality of science.

CONCLUSION: EFFECTIVE AND INEFFECTIVE LEADERS

With this examination of culture we come full circle to the subject of effective and ineffective leaders discussed in Chapter 1. As you must have deduced from the descriptions of Jensen, Polaris, and the Savoir Institute, culture (the core ideology) provides the context that supports certain leadership behaviors.

For example, in all three illustrations of organizational culture, conflict was not allowed. In Chapter 1, the second most frequent response describing ineffective leaders was their inability or unwillingness to deal with conflict. Let me repeat some of the verbatim comments—ineffective leaders:

- Avoided conflict and let problems fester
- Looked the other way
- Hid from the conflict
- Delayed dealing with interpersonal problems until they grew out of hand

We have no way of knowing the cultures of the institutions in which the expert panel respondents worked, but it is a reasonable hypothesis that some norms support (or at least do not dissuade) the above leader behaviors. In addition, as studies of organizational culture attest, allowable and desirable ways of behaving are transmitted by hiring policies and processes (screening in those who fit), by performance evaluation and reward systems, and especially by observing how others are allowed or encouraged to behave.

By the same token, it is a reasonable hypothesis that the context of culture supports behaviors of effective leaders, such as encouragement of unorthodox ways of thinking, of innovative/novel/different ideas, and of a fun and productive atmosphere in which each person can thrive in his or her own individual way.

Effective and ineffective leadership does not exist in a vacuum. If leaders' behaviors persist over time, they have to be supported by some larger context. That context is culture.

NOTES

1. Thorne, P., *Organizing Genius,* Oxford, UK: Blackwell Publishers, 1992, pp. 23, 158.
2. See, e.g., G. Holton's foreword to *The Twentieth Century Science,* G. Holton (Ed.), New York: Norton, 1970.
3. Described by E. H. Schein in Organizational culture and leadership, in R. H. Kilmann, M. J. Saxton, R. Serpa, and Assoc. (Eds.), *Gaining Control of the Organizational Culture,* San Francisco, CA: Jossey-Bass, 1985.
4. Drawn from Believing is seeing, by A. M. Sapienza, in R. H. Kilmann, M. J. Saxton, R. Serpa, and Assoc. (Eds.), *Gaining Control of the Organizational Culture,* San Francisco, CA: Jossey-Bass, 1985.
5. Schein, op. cit.
6. I am indebted to the personal correspondence of Ivan Jensen for his insights into culture.
7. Thorne, op. cit., p. 115. I must emphasize that none of Thorne's citations refer specifically to any of the case organizations.
8. Ibid.
9. Ibid., p. 116.
10. Ibid., p. 117.
11. A statement by James Bigelow, describing his father, L. W. Bigelow, at the 1940 dedication of the company's first modern research laboratories.
12. Thorne, op. cit., p. 100.
13. Ibid., p. 226.
14. Ibid.
15. Ibid., p. 92.

10
LEADING CHANGE

> Leadership is an influence process that is noncoercive in nature and produces acceptance or commitment on the part of organizational members to courses of action that contribute to the organization's effectiveness.[1]

Coming full circle as we did in the prior chapter—from individual leadership effectiveness (Chapter 1) to the organizational culture in which leaders operate—we must now address the topic of *change.* If you have devoted any time to reflecting on yourself as leader and on your organization as the support or impediment to scientific creativity, you are likely to have concluded that something (and someone) can be improved.

Perhaps more than all the other chapters, this chapter must be the most cursory. The major topic of each chapter deserves (I believe) a book-length disquisition. This chapter, however, can be the embarkation point for a lifetime of study, for here the topics include fundamental personal as well as organizational change. Because the book is devoted to leading scientists in organizational settings, the emphasis in this chapter is on organizational change. But I will, wherever important and relevant, note the link between the personal and organizational realms.

The chapter is organized as follows. The next section justifies the inclusion of this subject in six statements about change. Then, I review two schools of thought regarding behavior change because that is what the chap-

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ter is about and suggest when and how each may be effective. An organizational change effort in general terms is described followed by a case study of leaders who attempted to make fundamental changes in their organization.

IMPORTANT STATEMENTS ABOUT CHANGE

- No person in a leadership position is perfect. As *influencing individuals,* we are responsible for ensuring that we explicitly and regularly (1) reflect upon our behaviors and feelings as leader, (2) seek feedback about the impact of our behaviors on others, and (3) engage in serious, systematic ways—using outside assistance, as needed—to remain effective.
- Similarly, no organization is perfect. Much of your time and energy as leader will be spent not only working on self-change but also helping other individuals in the laboratory and the larger organization change their behaviors in small as well as in fundamental ways.
- An effective leader is capable of developing and maintaining an enthusiastic, energetic, and creative group of scientists. Thus, the laboratory must be a flexible and learning organization, experimenting in the social sciences (e.g., communicating, relating, leading, changing) as well as in the physical sciences.
- Developing and maintaining a flexible and learning science organization requires courage, focus, and persistence on the part of the leader and members. Achieving these attributes can involve painful processes (personal change is inherently difficult), and it can take a long time. Depending on the level of change needed and the size and complexity of the organization, change can span many years. Descriptions of the change effected by Jack Welch at GE note that the process began around 1985 and continued to the mid-1990s.[2]
- At least in the matter of organizational change, today's solutions are likely to become tomorrow's problems. Moving away from an interpretation of the value of quality that has become, in effect, a rationale for time-consuming and risk-averse decision making may be very appropriate (see the example of Jensen in Chapter 9). Later, however, the

leader may find that decision making is too quick and that quality is vulnerable. In many respects, even good organizational solutions may sow the seeds of future problems. A leader always has to manage organizational change. Jack Welch's successors have to manage change.

- The combination of science, an oblique and unpredictable activity, and scientists, highly trained solo contributors who are also human beings, is notoriously hard to lead well. To lead successfully, you must accept that there are no algorithms (e.g., standard operating procedures) but rather there are appropriate and continually refined heuristics (i.e., general rules that require you to seek feedback as to their applicability). Over decades of study on leadership, the agreement now is that "matching of leadership qualities and behaviors to situational demands has been and will continue to be necessary." There are heuristics about matching; there are tricks or algorithms that apply.[3]

The above finding on leadership is, in fact, reflected in this book. If you have read the chapters sequentially or at least read most of them before reading this one, you have realized that there are few recipes or sets of rules (which may make the material disappointing and somewhat frustrating). This chapter, too, contains no recipes for managing change. You should, however, be able to derive your own heuristics for managing change from this material as well as from your continued study of the subject.

The emphasis in this chapter is on fundamental organizational change, to be defined shortly, although the heuristics can be applied to change processes of any scope. I will not specifically address how you might undertake a process of personal change beyond stating again that it is a leader's (i.e., your) unavoidable responsibility.

TWO MODELS OF ORGANIZATIONAL CHANGE

External Consequences Induce Changes in Behavior

Each approach to organizational change discussed in this section reflects a different perspective about human beings. The first school of thought is concerned with *how* people behave, behavior as an observable phenomenon, and not with people's motive for behavior. The section title, *external consequences induce changes in behavior,* is a simple way to describe the fundamental premise of this approach. Behaviorists (e.g., B. F. Skinner) focus on the changes in behavior that occur when human beings discover that some behaviors have pleasant consequences (rewards) and others have unpleasant consequences (punishments). They are not concerned with

> needs, expectancies, preferences . . . or any of the inner mental processes . . . that explain why people do what they do. Instead, behaviorism simply looks at behavior and its consequences. According to behaviorism, the consequences of behavior, not any supposed inner mental or emotional goings-on, shape and determine particular ways of behaving.[4]

To change behavior, according to this school of thought, you must provide reinforcement (positive or negative) for a different behavior, omit reinforcement to extinguish a behavior, or punish a behavior to extinguish or change it.

The reason that I want to discuss the theory of behaviorism is that it is often implicit in the structures and systems of organizations and societies. For example, laws concerning equal employment opportunity have been enacted to change hiring practices by means of externally applied incentives or punishments (such as fines for noncompliance). They do not attempt to address any internally held schemas or stereotypes that might underlie an organization's restrictive, exclusionary hiring and promotion practices (see Chapter 2).

Formal and informal organizational systems are often designed to provide positive reinforcement (e.g., pay increases and other perquisites) for desired behaviors such as publishing or patenting. Some provide negative reinforcement (such as the threat of being fired) to extinguish behaviors deemed undesirable. Some omit reinforcement to change behavior, such as ignoring those who try to challenge the status quo. And some punish behavior, such as shunning individuals who have behaved inappropriately according to organizational norms.

Is this approach to change successful? Sometimes. People who might prefer not to work with anyone of a different skin color or ethnic background or gender but are required by legislation to move toward a more diverse workplace may discover that their initial stereotypes and prejudices disappear as they work together. On the other hand, there is ample evidence that, if reinforcements are not continually salient, people do not comply with them (posted speed limits are a good example). There are also sizable ethical issues associated with incentives (e.g., Enron) and punishments (which is why we try to protect "whistle-blowers").

Behavior Is a Function of Inner Mental Processes

The second school of thought is based on a different perspective about human beings. In this approach, human behavior is posited to be a function of the human psyche, of internal mental processes such as needs, motives, and attitudes. Therefore, to change behavior, you must alter these inner mental processes. Alcoholics Anonymous and other 12-step programs are based on the premise that our inner motives for drinking (or eating, gambling, etc.) must be changed in order to change the respective behaviors in a fundamental way. Disease prevention efforts are often based on the premise that a healthy lifestyle is brought about by changing people's attitudes toward health and wellness.

At the organizational level, this school of thought is reflected in the field of organizational development (OD), which emerged from work of Kurt Lewin at MIT. Lewin's field theory proposed that an individual's behavior is a function both of personality and of the environment in which the person exists, such as home, work, and so forth. (He also coined the term *action research,* in which organizational leaders and members become applied researchers, studying organizational phenomena such as culture.) In terms of change, Lewin proposed a four-step process:[5]

1. There must be a felt dissatisfaction with the status quo.
2. There must be an unfreezing of old behaviors (i.e., disinvestment in old behaviors and receptivity to new attitudes).
3. There must be a conversion to the new attitudes (and new behaviors).
4. The new attitudes and ways of behaving must be internalized and institutionalized ("freezing").

There is a large body of evidence supporting Lewin's model as the more effective means of bringing about genuine and fundamental change.[6] However, the two schools of thought, although based on very different assumptions, are not mutually exclusive. There may be a place for thoughtfully designed reinforcements in the second as well as the fourth steps in the above model of changing internal attitudes (to help unfreeze old behaviors and then to support new ones).

Some apparent distinctions of the models can be summarized as follows:

- The basic premise of the behaviorist model is that behavior is a function of external reinforcements; the field theory model assumes that behavior is a function of internal processes as well as external context (not necessarily reinforcements).
- What prompts behavior change in the behaviorist model is external to the person; in the field theory model, it is internal.
- The rate of change is generally faster with the behaviorist model, slower with the field theory model.
- The personal involvement of the leader is less in the behaviorist model, more in the field theory model.
- In the behaviorist model, the duration of behavior change is a function of the duration of the salience of reinforcers. Behavior may revert, if it is not enforced. In the field theory model, the duration of behavior change is a function of the depth of people's commitment to new ways of thinking, valuing, and so on.

How you might bring about organizational change using Lewin's model is described generally in the next section. More specific examples are given in the following section, based on the illustrations of culture provided in Chapter 9.

LEADING ORGANIZATIONAL CHANGE

As noted, there is persuasive evidence that genuine and fundamental change in organizations is brought about more effectively by the four steps described in the OD model. Fundamental change is any change in the culture of the organization (Chapter 9). For example, if the values and norms of your organization support limited and hierarchical communication, then moving toward candor, transparency, and lateral communication requires a fundamental change. What you as leader might do to change these norms (i.e., the culture) is discussed below.

Producing a Felt Need for Change

The first step in the change process, defined by Lewin as "felt dissatisfaction with the status quo," is likely to occur readily under conditions of crisis. By then, however, there is usually no time to bring about genuine, fundamental change (consider the case studies of Jensen and the Savoir Institute). When you realize that change will be critical to the survival and success of the organization, your first task is to examine your own role in maintaining the status quo and to undertake a personal change effort. Only when that is underway can you, with integrity, work to convince others of the need to change. This is a time-consuming effort, especially in large organizations, but fundamental change will not occur without the visceral appreciation, by at least a critical mass of people, that current behavior is not satisfactory or conducive to long-term survival.

To bring about a felt need for change in others, one helpful tactic is to design a two-part communication process. The first part would entail having articulate and persuasive individuals who are well respected by the community present to members of the organization "what is happening" in the environment, in the field of science, to competitors, etc. The purpose of these presentations is not to tell people that they must change but to describe vividly what is happening "out there" and allow them to draw the appropriate inferences. The more persuasive the evidence, the more likely people are to draw the inescapable conclusion that change is necessary.

Repeated emphasis of the conditions outside the organization, buttressed as much as possible by information about your own organization, is crucial to bring about dissatisfaction with the status quo. Framing the message as data to be understood and then responded to by everyone in the organization also empowers (in a genuine sense) those who must be part of the solution.

The second part of the communication process would entail charging small groups of people to discuss the implications and consequences of change for the organization, openly and candidly. These small group discussions should begin as soon as possible after the initial sessions on "what is happening." By this time you would have discerned those colleagues who, like you, were convinced of the need for change. You might use them as discussion leaders. In any case, you would keep the composition of these small groups as heterogeneous as possible using the so-called diagonal slice of the organization (across disciplines and functions as well as up and down levels).

As leader, you must model the desired new behaviors, which is why personal change is often the requisite start of organizational change. If you were trying to change from hierarchical to lateral relationships and communication patterns in your laboratories, you would ensure that the small groups you led were run as lateral structures (suggestions for leading lateral project teams were given in Chapter 8). The most important behavior for you and your discussion leaders to model is that of experimenting and learning, by asking such probing questions as: "How did we get where we are?" "Why did this occur?" and so on. No learning can occur without feedback. The objective of this step of leading change is to ensure that, as far as possible, everyone understands why change is necessary. The communication strategy described above should involve the whole organization, so your time frame will be dictated by the number of people who must hear the message. However, your small-group discussions, with their appropriate modeling of new behaviors, would begin to generate solutions and to galvanize the critical mass required to move the larger organization in new directions.

Unfreezing

Modeling or living new behaviors starts the second step, "unfreezing," which is perhaps the most painful step of the entire process. Each person, beginning with the leader, must admit that "the old ways" of thinking and behaving are not appropriate. Externally, the environment is no longer predictable. Customers no longer accept whatever is developed. Politicians and legislators question the utility of science and the amount of money spent on basic research. Communities scrutinize the safety of processes, equipment, facilities, and products. Internally, scientists may have become complacent. There may be tacit agreement that lack of challenge is tolerable, that shunning is acceptable, that "silos" are unavoidable.

I believe that this second step of the change process requires great courage. Although it takes time, it is easier to generate an appreciation that external conditions necessitate change (i.e., to produce a felt need for change) than to give up personal behaviors that have been successful in the past, to admit that how one views the world may be mistaken, and to behave in ways that feel radically different.

It is at this step that reinforcement can be very useful. If you were trying to bring candor and challenge into the discovery organization and had the luxury of designing new facilities, then designing glass-walled and open laboratories might support such attributes better than laboratories behind closed doors. Again, such a change in external context will only support the internal attitude change; it will not produce it.

More specifically, achieving genuine candor and challenge among scientists might entail:

- The painful process of realizing your own role in the lack of candor and challenge followed by a painful examination collectively of the lack of candor and challenge
- Probing for the causes of the lack of openness [e.g., at Polaris (Chapter 9), openly challenging another's scientific opinion was tantamount to breaking the "rule" for having *differences of opinion, if any, out in the closet*]
- Confronting customary ways of communicating (e.g., impersonal memos, email to distribution, "preselling" individuals prior to scientific reviews)
- Experimenting with uncomfortable and unfamiliar behaviors, such as admitting that challenge feels uncomfortable and unfamiliar, and challenging scientific opinions in an open forum

Conversion

This third step in the organizational change process is appropriately named conversion because changing values and attitudes involves the intellectual as well as emotional turning *from* one set of beliefs *to* another. Changing to candid and challenging communication will require turning from intellectual and emotional adherence to secrecy and politicking to intellectual and emotional adherence to authenticity and openness.

During this step, your understanding and support of the emotions of people undergoing conversion to new behaviors are crucial. If unsupported emotionally, people may not be able to sustain the change effort. At this step, especially, you need to be enthusiastic and encouraging, communicating in vivid terms and modeling the desired characteristics of the "new" organization.

When you do communicate, carefully choose the symbols and imagery you use because they will become the new iconography of the organization. For instance, if people describe the "old" organization as a set of "towers" (or silos or other symbols of closed, vertical systems), use an ellipse enclosing departments when you illustrate the proposed lateral structure. If the old myths are couched in the language of battle, reflecting internal competition, start new myths by constant repetition of the language of collaboration. Listen carefully to yourself and your colleagues and reflect on the implications of your symbolic language. Make your choices thoughtfully.

Freezing

By this step, the leader should have a critical mass of people in the organization with a visceral understanding of the need for change (felt dissatisfaction) who are disinvesting in the old ways of thinking and behaving (unfreezing) and are committing themselves intellectually and emotionally to new ways of thinking and behaving (conversion). The fourth step, internalization and institutionalization, is when new ways must become customary and consistent throughout the organization until the next change effort is required.

To accomplish institutionalization, reinforcement can again be useful. You should ensure that your recruitment, performance appraisal and reward, decision making and approval, and information systems (Chapter 7) support the new norms. In addition, you should be scrupulous in modeling the new behaviors and in confronting the slips and recidivism that inevitably occur.

Resistance to Change

There is a widely accepted aphorism that "organizational change produces resistance to change," usually described as if it were a disease. Certainly, fundamental change is likely to result in alterations of established power centers, and hidden agendas and obstructionism are not uncommon reactions of people who find their power base shifting or eroding.

Ideally, if you succeed in producing a real appreciation of the need to change (felt dissatisfaction with the status quo), even people whose power is diminishing will agree that change is necessary and the alternative can be zero power for them if the organization fails. However, if that first step is not effective, people will question why they must disrupt established practice, and they will try to convince you that you are tampering with something that is not broken and does not need to be fixed.

Some people may not agree that the world is changing and, therefore, do not believe that the organization (and themselves) must change. Some people have enormous capacity for denial, and nothing will shake them. In this case, you have several options. First, you (or a delegate) can spend intense one-on-one time with them to try to understand their reasoning and then respond in a way that may be persuasive. This is an appropriate tactic if the person is, for example, a highly visible scientist whose commitment to the change effort is necessary. Or, you can tell them that they will have to conform to the new ways no matter how they feel about it (this is the conflict resolution method of forcing, and it must be accompanied by an explicit "or else"). Or, you can change their context by, for instance, assigning them to a very enthusiastic group in the laboratory that is wholeheartedly adopting new behaviors. You must be careful, of course, to ensure that one person's opinion does not dampen the group's enthusiasm.

Some people may agree that change is necessary but still try to hold fast to their power. As much as possible, you should try to ensure that both these people and the organization can "win" in the change effort. Otherwise, you may have to encourage them to seek work elsewhere.

Commitment: Top Level, Bottom Level, or Both?

You may wonder if change will occur only if top leadership is committed or only if the "troops" are committed. In fact, both top and bottom levels must be committed. Your boss and your cleaning staff and everyone in between must be committed to change.

In the next section, a case study of a change effort in an Italian pharmaceutical company is provided to give you more ideas and heuristics for your own situation.

PREPARING FOR A GLOBAL FUTURE

The environment of the pharmaceutical industry in all industrialized nations presented a number of problematic trends in the 1990s, such as pressure from governments seeking to hold down medical cost inflation, changing demographics and epidemiology (including emergence of new or previously rare diseases), and the need to incorporate the technology of genetic engineering into the traditional medicinal chemistry research process.

Producing a Felt Need for Change

Managers of Bio-Farmaco, a midsize, family-owned Italian pharmaceutical company, were very uneasy about the ability of their organization to succeed in that environment. In 1991, they started a process to make fundamental changes in the organization. Aware of the changed environment and the need for Italian pharmaceutical companies in general to move from a domestic to a global strategy, Bio-Farmaco leadership began by examining their own commitment to the implications of a global strategy. Some members of the senior leadership team were completely unprepared to deal with international issues and realized they would have to be replaced. Others realized they faced a precipitous "learning curve" if they were to be effective and began a systematic effort of re-education (e.g., the leader of discovery enrolled in an international executive MBA program outside Italy). Only after these personal change processes were underway and there was evidence of personal change did leadership start to communicate about the environment to all employees.

Over an 18-month period, the 7000 or so employees became conversant with the external changes as a result of a series of "town meetings" at which respected economists and other experts presented facts and data about the environment. During this period, scientists in discovery began to question their newly minted MBA leader about the appropriate response.

Unfreezing

Once senior leadership understood that scientists were dissatisfied with the current state of affairs, the unfreezing process could begin. Interestingly, unfreezing was precipitated by shocking (to employees) statements from top management. For example, in all his communications to employees, the owner of Bio-Farmaco urged them to do something that most originally considered very strange:

> You should abandon the thought that you have only to do what you are told by your supervisor. I want you to discuss problems actively, and exchange your opinions regardless of rank and division.

The owner's commitment to this new way of communicating was reinforced by the chairman of the company, who emphatically counseled employees to contradict their company creed:

> I don't want vague and questionable harmony in research and development. Good and fruitful debate is important. Don't hesitate to contradict our creed. Don't hesitate to take a risk!

As originally articulated in the 1800s, Bio-Farmaco's creed had a number of articles, including the importance of seniority and conservative behavior. The injunction to ignore this creed by both the chairman and the owner had a powerful effect. To long-time employees, these statements had salutary shock value.

Within R&D, leaders supported the unfreezing by modeling new behaviors as well as by changing the context in several ways. One context change was to invite sales and marketing people to meetings formerly attended only by scientists to discuss research findings and compounds for development. Another context change was to require the scientists to acknowledge their personal critiques of the compounds that were discussed. A third context change was to rotate people on project teams. Alessandro Domenico, senior director of R&D, explained:

> At first, scientists were reluctant to put their names on the evaluation forms used in these meetings with sales and marketing. But, I want them to take that responsibility. They may be right or wrong, but at least they'll learn.
>
> Moreover, I now try to have development decisions made by fresh people, because sometimes the scientists have been too influenced by their own past experience. So, I rotate some people within the project teams.

In the eyes of his colleagues, especially at the start of the change process, Alessandro was considered an anomalous manager as he modeled the new behaviors:

> My colleagues think I have done many unusual things in R&D, and they have told me that I look like a charismatic director, instead of a rational or scientific director. But what's important in discovery? Is it reason, or is it intuition?

Other context changes were made to the physical facility itself. The directors of the chemistry and biology laboratories renovated their offices so that they both shared a central reception area. As the director of chemistry said, "This way we're sure to speak with each other." The open area effectively connected the formerly separate disciplines in a way required for future research success. Similarly, a new building for molecular biology laboratories was being constructed in a style very different from the traditional facilities on Bio-Farmaco's campus. Giovanni Bracca, leader of these laboratories, stated:

> In the new building we have designed the laboratories to be open, with many people sharing office and laboratory space. In addition, people from several departments will have facilities on the same floor, to help make the organization more flexible.
>
> Of course, more important than the facility is selecting the right scientists. We need to challenge established thinking, and we need people who will help us challenge it.

The most radical departure in architecture, and another example of context change, was the new basic research facility about 50 kilometers from headquarters. Unlike the conventional buildings on their main campus, Bio-Farmaco's building on this greenfield site consisted of glass-walled research laboratories and discussion areas surrounding a three-story marble atrium. The ground floor dining room looked out on a barbecue corner, where family parties were held in the summer. This architectural change in context was designed to support a radical departure in organization structure as well. Andrea Malatesta, the newly appointed leader, commented:

> We will only have about 50 PhDs at any time, and we will focus on the underlying sciences. Bio-Farmaco's impetus to set up this basic research facility was our recognition that the Italian universities were not doing as much of this kind of research as we needed for our future survival.
>
> Our group will have no organizing fields, like therapeutic areas [most applied pharmaceutical research is organized by disease or therapeutic area]. Instead, we encourage researchers to look outside the fields for new projects.
>
> All scientists report to me. It is all bottom-up, no top-down. I believe young scientists should not be squashed by a top-down system, as has happened in this company.

> The type of people I look for here have a special philosophy of research. I look for intuition, curiosity, and an ability to challenge.

Thus, in addition to top-down exhortations to contradict the company creed and challenge established procedures, to rotation of scientists, and to architectural change, leaders were also looking for a different type of scientist to recruit. For these new people, challenge would (it was hoped) come more easily.

Conversion

By 1997, Bio-Farmaco had reached the third step of its change process, conversion. One very important intervention at this step was the imagery repeated by Alessandro's assistant director, Maria Santa La Rocca. Maria spent much of her time with the scientists, exhorting them in the following way:

> I tell scientists that they must become "pookas." These are mischievous spirits who can go through walls and fly freely beyond borders. Why? These scientists must overcome the very high, very thick walls, hurdles, and barriers set in the vertical structure of our organization and of our national culture as well.
>
> Scientific creativity will be stimulated by person-to-person contact. We have to train our scientists to achieve lateral communication, and this is one way to encourage them.
>
> My hope is that scientists will take on the real character of this spirit, who flaunts the rules of society and who passes through rather than breaks down vertical barriers, and will catalyze our organization in all the ways needed for future success.

The pooka is a complex character. It is not simply a spirit but can be seen as the alter ego to the "civilized" or "cultured" individual. When Maria exhorted scientists to become pookas, she was, in effect, exhorting them to become like that alter ego—nonconforming and creative, engaged in debate rather than harmonious consensus, and willing to undertake the risk of innovative and different R&D activities. She encouraged the scientists, in other words, to disrupt their normal order and (in effect) to ignore organizational barriers by becoming organizational ghosts.

Institutionalizing Change

To summarize the chronology of the change effort at Bio-Farmaco: Top managers began in 1991 with an intense process to educate themselves and then employees about the volatile and competitive global environment of pharmaceutical companies to help produce a felt need for change.

In 1992, the owner and top management began publicly to encourage employees to challenge their superiors and to contradict the company creed to help unfreeze their attitudes. In support of the unfreezing, a number of context changes were made. These included open physical space, rotation of scientists (to establish lateral relationships throughout R&D), and new management systems requiring signatures.

By 1997, when the company was at the third step (conversion), Maria's imagery of the pooka was another means of helping people envision the new organization.

The institutionalization of new behaviors (freezing) was supported by both the physical changes and management system changes that included new hiring and rotation procedures, new information systems, and new organizational structures.

Outcome

Today, Bio-Farmaco ranks among the top 15 pharmaceutical companies worldwide. The company has also entered a number of partnerships with U.S. and European biotechnology companies, opened an investment arm in the United States, to focus on licensing opportunities there, and greatly enlarged its new glass-walled laboratories in Italy. By these standards, it is much better prepared for a global future, although no one in the company is complacent.

In a smaller organization, a fundamental change such as that undertaken by Bio-Farmaco might have been accomplished faster (in 2 or 3 years). However, Bio-Farmaco's experience was consistent with that of other effective change processes. It was time consuming, it required great courage on the part of leaders to renounce established procedures, everyone suffered the pain of admitting to past mistakes, and there was inevitable backsliding. Bio-Farmaco's leadership persisted, and the results today reflect its determination.

SUMMARY

So much of every organizational change effort consists of communication and, therefore, successful change is dependent on the leader's skills in effective communication. The entire first step, producing a felt need for change, is often no more and no less than communication of the external conditions prompting change and of the internal issues that are problematic given these conditions. Unfreezing consists primarily of communicating first to oneself and then to others that the old ways of thinking and behaving are no longer appropriate and of probing to discern why and how those ways became problematic. Conversion can be helped or hindered by the imagery with which the vision of the new organization is communicated.

Successful organizational change also depends on the leader's skills in effective confrontation. When people refuse to acknowledge the new external conditions, they must be confronted. When people avoid questioning why problems arose, they must be confronted. When people display the old behaviors, they must be confronted.

As always, knowing oneself is important in leading change successfully. If you have a dominant need for power, you are likely to enjoy the challenge of aligning organizational behaviors with the requirements of the external environment. If you have a dominant need for affiliation, you are likely to enjoy the interpersonal involvement of the change agent and to do well in this role. Because successful change requires both activities, consider what complementary assistance you might need.

You will also have to adjust your leadership style (see Chapter 4) throughout the four steps. In the first and second steps, a task-focused leadership style will be more effective because the issues are unambiguous—external conditions are changing and internal behaviors are not appropriate. During the third step, conversion, a relationship-focused style will be more effective. For some time during this step, there will be different interpretations of the vision of the new organization, and a focus on relationships, to ensure wide and challenging discussion of these interpretations, will be required. In the fourth step, a task-focused style will again be more appropriate because of the reduced ambiguity of the situation (the institutionalizing of the new ways of thinking and behaving).

As Thorne stated:

> The means by which creativity and innovation can be influenced [at the organizational level] are many and various but hard to measure. This is cultural. . . . The organization's culture must reward and encourage behaviour which challenges it, which burns with the desire for change. There must be sponsors who provide microclimates that nurture and nourish creative beginnings.[7]

NOTES

1. Vroom, V. H., Situational factors in leadership, in S. Chowdhury et al. (Eds.), *Organization 21C,* Upper Saddle River, NJ: Financial Times/Prentice-Hall, 2003, p. 70.
2. Tichy, NM and DeRose, C. The death and rebirth of organizational development, in S. Chowdhury et al. (Eds.), *Organization 21C,* Upper Saddle River, NJ: Financial Times/Prentice-Hall, 2003.
3. Vroom, op. cit., p. 76.
4. Hampton, D. R., Summer, C. E., and Webber, R. A., *Organizational Behavior and the Practice of Management,* 3rd ed., Glenview, IL: Scott, Forseman and Co., 1978, p. 25.
5. An excellent overview of OD is provided by R. Beckhard and R. T. Harris in *Organizational Transitions: Managing Complex Change,* 2nd ed., Reading, MA: Addison-Wesley, 1987.
6. See Tichy and DeRose, as well as other authors in *Organization 21C,* op. cit.
7. Thorne, P., *Organizing Genius,* Oxford, UK: Blackwell Publishers, 1992, pp. 23, 158.

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