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Synthetic Worlds

Emerging Technologies in Education and Economics

Springer

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Preface

In a way, virtual worlds enable us to open a door to a fascinating and magical place. Where we are generally limited by the physics and our resources, virtual worlds allow us to go a step further and create new worlds, worlds that replicate our known reality or elaborate our phantasy to create fantastic places with new, innovative, creative, and unlimited objects and characters. And similar to Peter Pan, we can live our dreams while keeping a tight connection to the reality as the user and its avatar becoming a functional homogenetic unit taking the advantage of both worlds.

Expressing creativity and implementing new worlds bring a new opportunity for learning spaces, where learners have systems restrictions, can apply multiple media to realize their content, and experiment on ideas without risks. On the one hand, avatars allow consciously hiding behind their avatar, expressing a new identity, and, on the other hand, are able to conduct projects too dangerous or complex for the real world. Machines too expensive or available due to environmental reasons can be generated and used, for example, using lunar vehicles to learn about the moon surface. The handcrafted objects by learners follow the constructivist understanding of learning as it is characterized by idealized types of learning environments. Using virtual worlds in the context of teaching and learning showcases the possibilities of interconnected and scalable metrics of time, processes, and an Internet-based decentralized access.

The benefits of virtual spaces are not limited to educational scenarios but have great advantages for businesses, independent of being service-oriented or being a manufacturer. Virtual worlds incorporate all technologies necessary to promote brands and products by building showcases for displaying the product as well as the associated processes from development to production. Furthermore, the usage of products in defined scenarios is observable and direct as well as indirect individual feedback can be used for product improvement.

In contrast to the real world, rapid prototyping allows far shorter product cycles, i.e. to mass-customize the product. In most virtual worlds, trade and sale of virtual goods and services is common and even cross-selling and ticketing for the real world is becoming more popular. Where real-world limitations like space, time, or distance are causing organizational problems, virtual worlds can be used for extension.

It becomes common to have synchronous streams of live events in virtual worlds, where everyone can participate without being physically present at a certain real-world location. The 3D spaces supersede, for example, video streaming by providing a high degree of immersion and interactivity. Avatars experience a full 3D audio, interact with other users through their avatars at the same place at the same time, and can interact with objects. Thus, virtual worlds facilitate socializing and building networks similar to social networks like Facebook. Communication through avatars increases credibility, reduces the impression of anonymity, and reduces by this the wastage of resources in addressing others than just the target group.

By those means, the hype and run for all the possibilities using Second Life as synonym for virtual worlds in 2006 wasn't very surprising in the aftermath. Nevertheless, expectations were not fulfilled after a short period of gold-mining the virtual space. There are many success stories but mainly on educational areas and certain niches like simulation. The Gartner IT research company, originally predicting the hype, changed their expectations after some years, although still seeing public virtual worlds as a key technology for the next 5–10 years. Reasons for the rather low acceptance of virtual worlds are manifold. One often mentioned criterion is about the intention why to use virtual worlds. While games are defined by goals and specific game principles, open virtual worlds don't provide a structure and the aims are non-specific or defined with respect to the context. Other constraints can be seen in the proximity of the "look and feel" of open virtual worlds in relation to digital computer or console games: social bias against digital games, the disbelief in effectiveness of game-based learning concepts as well as the digital divide in terms of instrumental media literacy in the use of game-like user interfaces and patterns of navigation. While users without or less connection to digital games associate the image of virtual worlds as "too playful" and, therefore, more likely to be unserious, *gamer* criticizes the lack of graphics compared to the state of the art in digital game productions which usually retrace the quality of the content.

Last, the technological aspects further constrain the acceptance. The need for installing a client combined with the affordance of high hardware specifications is scaring off the casual user. Additional technological limitations like exporting avatars or inventory to other worlds are resulting in insular situations in which no user wants to be trapped.

Nevertheless the European media coverage of virtual worlds and alternative realities is covering both expectations and critical reviews. International business, education, and research activities in online environments are still emerging exponentially. In comparison, Europe's participation in the new market shows promising technological advances but hampered partly unjustified prejudices and naïve implementations that do not take characteristics and opportunities of the innovative and future-oriented media into account. Even though several European institutes conduct intensive research in conjunction with alternative realities and have gained international reputation for their achievements, there are still several barriers to be defeated in the years to come.

Book Overview

In this spirit this book is not a manual to enter or navigate in alternate realities but demonstrate the manifold opportunities to unlock a promising, innovative, and not yet fully developed market in education and business. The general focus is set on the scientific community but integrates the practical application for businesses. This book bridges a gap in the growing market of virtual world literature. Nevertheless, the book has a unique position as it is the first to combine education and economics to provide answers from experts on how to handle the virtual worlds phenomena and create a business model with Return on Investment (ROI). The theory is combined with applications and descriptions of use cases in education and business.

As virtual worlds flatten the world by bringing people from all over the world into the same environment, we provide chapters about the influences and impacts in and around virtual worlds. International authors—all experts in their field with several years of practical experience—discuss the current state of the art of alternate realities, the target group, and how virtual worlds will develop over the next years.

Part I covers the subject of "from where" virtual worlds are coming and "to where" they are going to. A retrospective by *Jean Miller*, responsible for Linden Lab's service Second's Life and international development, titled "How Linden built a virtual world for business and education," gives a deep insight view to the genesis of the first idea of a 3D-online-game environment to the probably most known, popular, and contemporary public virtual world named Second Life.

Within this open environment real-world-like content adaption is proceeded. *Yesha Sivan*, head of the Information System at the School of Management and Economy at the Tel-Aviv-Yaffo Academic College, describes this phenomenaon as "real virtual worlds." His chapter presents an outlook to the potentials and challenges of those worlds and predicts, in analogy with Gartner's Report, a substantial relevancy in the next 5–10 years.

Part II is about the social dimension in the use of virtual worlds. *Tanja Adamus* and *Axel Nattland*, both research associates at the Learning Lab University Duisburg-Essen/Germany, and *Lars Schlenker*, research associate at the Media Center of the University of Technology Dresden/Germany, explore and interpret Second Life as the "social environment" which facilitates interpersonal interaction and communication by demonstrating three examples in the context of higher education.

The meaning, finding, and organization of social groups in virtual worlds in the context of learning processes are questioned in the article "social navigation for learning in immersive world" by *Jon Dron*, professor at Athabasca University.

Part III focuses on the topic of "collaboration." *Michael Schuler* from Hamburg University outlines the requirements for team processes and opportunities for supporting team management and development in virtual worlds. *Dennis Maciuszek* and Professor *Alke Martens* at the eLearning and Cognitive Systems Lab, University of Rostock/Germany, discuss together with Professor *Ulrike Lucke* and her scientific assistant *Raphael Zender* at the Institute for Multimedia Application Systems, University of Potsdam/Germany, the potential of virtual worlds for inquiry-based teaching of science and engineering topics. The authors incorporate their experiences from their virtual lab for learning about cognitive modelling and applied artificial intelligence. Despite their tough start in creating the virtual environment, they conclude that virtual worlds are in fact useful for creating virtual lab environments.

Part IV is about (distant) education with focus on learning environments and experiences, pedagogical models, and the effects on the different roles in the educational sector.

Sue Gregory, adult educator and lecturer in ICT in the School of Education and Chair of the Australian and New Zealand Virtual Worlds Working Group, is dedicated to virtual worlds as a medium for distance learning. She describes her research results and comes to the conclusion that participants in virtual worlds achieve better learning results as they—in comparison with conventional learning management system users—are more involved, maintain and build up their social contacts, and have a higher motivation. From the results shown in her chapter, it is clearly recognizable that virtual worlds support learning and lead to better engagement in distance learning.

Professor *Andreas Hebbel-Seeger*, Vice Dean at the MHMK, Macromedia University of Applied Sciences for Media and Communication at Campus Hamburg/ Germany, highlights and elaborates the educational and psychological aspects of virtual environments. He depicts some best practice cases for the use in education, theoretical approaches, and their implications.

Suzanne Aurillio, Director of Technology Enhanced Instruction and Faculty Support in the College of Extended Studies at the San Diego State University/USA, takes a closer look at adult learners as a target group and raises the question about adults as learners and the circumstances under which they engage in purposeful learning. She tries to familiarize the reader with examples from Second Life and several recreational world-building practices as comprised by the desire, creativity, and purposeful learning of Second Life residents.

Lincoln C. Wood, a senior lecturer at Auckland University of Technology (New Zealand) and an adjunct research fellow at Curtin Business School (Perth), and *Torsten Reiners*, a senior lecturer in Logistics and Supply Chain at Curtin Business School, examine the role of bots in virtual worlds and how they can be upgraded to non-player characters (NPCs) to support educational processes. This rests on improvements in technology, game-based elements, and gamification; concepts that can be incorporated into instructional design processes to facilitate the development of effective learning scenarios in virtual worlds.

To complete the educational perspective, *Dennis Schäffer* and *Jörg Heeren*, both at the Faculty of Education at the Bielefeld University/Germany, introduce "e-learning 3D." They researched and worked over a period of 3 years on a university project, which focuses on the development of a virtual learning environment in which students as well as lecturers could interact without being actually on the campus. Besides the practical description of the learning sites and the set of applied tools for educators, they provide an insight into the different university user groups and their experiences as learners in virtual worlds as well as an outlook on the development of Second Life as a learning space. In **Part 12.5** use cases and scenarios of integration are described: from design and implementation up to application. The authors focus on business models and how companies can participate in virtual worlds while receiving a return of investment.

Jan Northoff, founder and manager of the 3D Internet agency "Youin3D," located in Berlin/Germany, explains the parts and key aspects of the revenue model for his company. He also looks at the key aspects of setting up a business concept within Second Life and OpenSim. He also explains the special features about the development of the virtual city "BERLINin3D.com," a three-dimensional replica of Germanys capital Berlin, using Second Life technology.

IT-manager *Frank Boerger* of German-based TÜV NORD Group and *Hanno Tietgens*, owner of BÜRO X Media Lab and initiator of "Campus Hamburg in 3D," give the practical example of a virtual world being applied profitably in a business context. They used Second Life to enhance corporate education, distance collaboration, and avatar-based trainings for TÜV NORD's international staff of engineers, certification experts, and safety solution providers, producing ROI within just 1 year. Following the rapid convergence of online, mobile and games technology beyond Second Life, their article also describes for the first time how toolkits and services as diverse as OpenSim, OpenWonderland, Twinity, Unity3D, Blue Mars, ProtoSphere, and more were explored and evaluated. Educational 3D content was even staged in Facebook, Google Earth, and browsers supporting WebGL, taking the benefits of 3D to the open Internet.

The final Part highlights the development and implementation benefits of dynamic learning environments. *Christian Gütl*, senior lecturer at the Institute for Information Systems and Computer Media at the University of Graz/Austria, Professor *Vanessa Chang*, head of School at Curtin University/Australia, and research fellow *Stefan Freudenthaler* at University of Graz/Austria describe their development of a tool which supports instructional designers, teachers, students, and learning groups to easily design a learning environment, which the authors also illustrate through a case example. Furthermore some "workarounds" to limitations in Second Life are presented and explained. Nevertheless, the feasibility of an application that enables users to create and reuse the virtual learning environments is emphasized in detail in this chapter.

Carl Dreher, research fellow at Curtin Business School, *Torsten Reiners*, senior lecturer for logistics at the Curtin Business iSchool, and *Heinz Dreher*, professor for information systems at the Curtin Business School, Curtin University/Australia describe the benefits and limitations of using 3D digital ecosystems (3DDE) for research, development, and commercialization. Based on their lessons learned from various university research projects they introduce a new system development methodology including a guideline for 3D ecosystem projects. They develop suggestions for future innovations in research, development, and commercialization of information systems incorporating systems like virtual worlds.

This book emerged from the belief in the specific potentials of virtual worlds, despite the mapped restrictions, problems, and challenges.

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The Story of Virtual Worlds

Chapter 1
TÜV NORD IN 3D: Avatars at Work—From Second Life to the Web 3D

Frank Boerger and Hanno Tietgens

1.1 Introduction

1.1.1 World Wide Change

In 2011, the World Wide Web turned 20. It went live on August 6, 1991, when British engineer and computer scientist Tim Berners-Lee introduced the first web service on the Internet. He had proposed the idea of a global hypertext system to the management of CERN[1] in March 1989 (Berners-Lee 1989), subsequently gaining support and finally creating the system with Belgian computer scientist Robert Cailliau (Fig. 1.1).

Two decades was all it took for the Internet to embrace all media and means of communication humanity has created since painting the walls of the Chauvet caves some 32,000 years ago. Within 20 years, the web had become almost ubiquitous in many parts of the world, and it is growing at tremendous rates in the rest. By December 2011, the Internet reached almost 79 % of the North American population and almost 83 % of the total population in Germany,[2] where TÜV NORD has its origins and headquarters. Penetration is highest among younger people: More than 96 % of Germans aged 10–34 had been active users of the Internet by 2010 (Statistisches Bundesamt 2011).

As a result, the way people create and share entertainment, information, and goods evolves rapidly. Real values become virtual, virtual values become real.

[1] Organisation Européenne pour la Recherche Nucléaire, Geneva, Switzerland.
[2] e-mail: http://Internetworldstats.com/stats.htm, accessed Feb 28, 2012.

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Reality itself is being augmented. Transferring money and knowledge, watching a movie, playing a game or planning a journey, organizing work and leisure, establishing relationships, and taking active parts in publishing or politics keep changing profoundly on a daily basis.

Fig. 1.1 Engineers at Exchange of Experience workshop in the TÜV NORD 3D auditorium in Second Life (2008)

1.1.2 The Rise of Social Media and Multi-User Online Games

In January 2004, the blogging tool *WordPress* went public. A month later, the social network *Facebook* started out of Harvard, and *flickr* was launched, an online community built around a free web service for sharing photos and video. *eBay*, *amazon*, mail order giant *OTTO*, and others had overcome the stock market crash which put an end to the first Internet bubble. They had proven that electronic commerce could be highly profitable, some of them incorporating new forms of customer participation, thus fostering the Web 2.0. *Wikipedia*—launched January 15, 2001—had become an epitome of a highly relevant, user-generated service; as a knowledge base, it replaced printed publications like the *Encyclopædia Britannica* or Germany's *Brockhaus* for millions of people. Up came *MySpace*, *Friendster*, and hundreds of other services, among them *YouTube*, which went live in 2005; *Twitter* followed in July 2006.

Another phenomenon started to catch public attention. Digital technology enabled ever more complex, realistic, and immersive types of video games. Usage started to shift from single-player games for consoles and PCs to the social experience of playing in networks on the Internet. In 2004, Richard Bartle published "Designing Virtual Worlds," while Indiana University economist Edward Castronova shared results of his research on online gaming culture in "Synthetic Worlds" (Bartle 2004; Castronova 2004).

Omidyar Network, the investing group of eBay's founder and chairman Pierre Omidyar, started to fund Linden Research Inc., a San Francisco start-up also referred to as Linden Lab. They had publicly launched the *Second Life* software and server technology in 2003. In May 2006, Omidyar stated in a BusinessWeek interview: "This generation that grew up on video games is blurring the lines between games and real life." (Hof 2006). In September 2006, the MMORPG[3] *World of Warcraft* reached seven million subscribers. They paid $10–15 a month or even more to obtain an avatar, team up with others, take challenges, and solve tasks, totally immersing themselves in a 3D fantasy world setting.

1.1.3 Second Life: Virtual World, Real Hype

Also in 2006, Second Life[4] started to make headline news. The physical world became aware of that other reality, based on bits and bytes, evolving from the digital spheres of the Internet: Virtual Worlds. There has been some discussion on how to define the term, but we would agree with Mark Bell, who—building on the thoughts of Bartle, Raph Koster, and Castronova—stressed the essential element of human presence and described virtual worlds as "a synchronous, persistent network of people, represented as avatars, facilitated by networked computers." (Bell 2008).

The number of users registered with Second Life rocketed from 100,072 to 2,251,416 in 2006–an amazing 2,200 % within 12 months. These so-called residents settled on a virtual landmass of 294 million square meters; 18 months later, Second Life would have grown to 1.5 billion square meters (Fig. 1.3). (Manhattan Island, in comparison, covers 60 million.)

Similar services had been there for quite some time. *ActiveWorlds*[5] was released in 1997, 6 years earlier than Second Life. *Whyville*[6] had gone public in 1999, an educational Internet site geared towards children aged 8–15, originally based on Java. As cultural anthropologist Tom Boellstorff pointed out at the Chicago Humanities Festival, virtual worlds had been around as far back as the 1970s: *Videoplace*,[7] created by American computer artist Myron W. Krueger, followed by *Adventure* (1976), *Utopia* (1982), and *Habitat* (1985) (Boellstorff 2010).

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[3] Massively Multiple Online Role Playing Game or MMOG (Massively Multiple Online Game).

[4] http://secondlife.com.

[5] http://www.activeworlds.com.

[6] http://en.wikipedia.org/wiki/Whyville.

[7] http://en.wikipedia.org/wiki/Videoplace.

Fig. 1.2 A window to the 3D world: Second Life login screen (2006)

The *Virtual Reality Modeling Language, VRML*, became an ISO standard in 1997. The International Conference on Virtual Worlds was held in Paris in 1998. But 8 years later, the media world had changed. Driven by the entertainment sector, 3D software had reached new levels. PCs and laptops had the computing power to run the demanding graphics and animations. Digital media literacy had grown, with international audiences absorbing the Internet. Multiuser 3D worlds were not science fiction anymore—they happened live, in real time, with humans creating avatars all over the planet. Academics, institutions, and corporations like TÜV NORD were encouraged to find out about these new ways to interact (Fig. 1.2).

Media attention for Second Life and its attractive avatars was unprecedented, spurred by innovative ideas introduced by Linden Lab. Instead of selling subscriptions to consumers coming for game-play, the Lab sold virtual land to users who generated their own, individual 3D content. The effect was multiplied when the Linden Dollar economy was created—a huge marketplace for virtual land (i.e., web server capacity), virtual goods (e.g., 3D objects, buildings, animations), and resulting services (not only building, scripting, and writing but also hosting, teaching, performing, trading and much more). Linden Lab's Terms of Service granted intellectual property rights for the user-generated content. The virtual economy was connected to the US dollar; in effect, the Linden Dollar was an equivalent to any currency in the physical world, and real money was being made, traded within, into, and out of the system. (As these innovations are being discussed in-depth in other chapters of this book, only aspects with specific relevance for the TÜV NORD IN 3D project will be addressed below.)

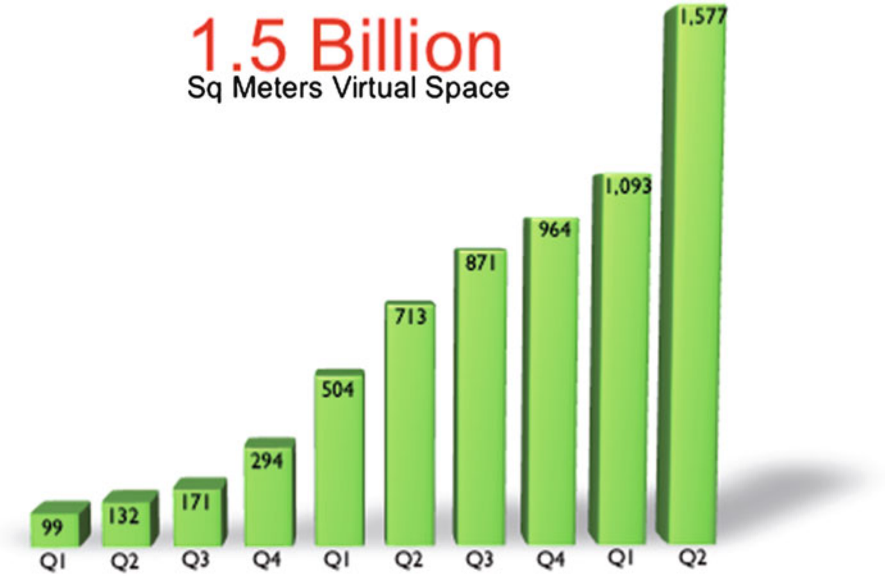

Fig. 1.3 Early growth of Second Life: Q1.2006–Q2.2008 (Source: Linden Lab, July 2008) (Source: http://lindenlab.files.wordpress.com/2008/07/15billionland.png)

In April 2007, the IT consultancy Gartner made a statement that would turn out to be among the most often quoted predictions in the development of multiuser 3D environments: "80 Percent of Active Internet Users Will Have A 'Second Life' in the Virtual World by the End of 2011" (Gartner Inc. 2007); in 2011, a Google search for the quote still produced 9,000 results. It fueled the media hype going on since BusinessWeek had come to the newsstands in May 2006 with a computer-generated picture of virtual land baron *Anshe Chung* on its cover and the headline "Virtual World, Real Money" (Hof 2006). *Anshe Chung* is the avatar and brand name of Ailin Gräf, a teacher with Chinese roots, living in Germany. Buying, developing, renting, and selling virtual land, she is said to have made a million dollars in Second Life (Köver 2007) (Fig. 1.4).

For Gräf, this was only a beginning. While maintaining her business sub-selling virtual land (i.e., server capacity) on the Second Life platform, she invested in related services. This included *ANSHEX*,[8] a virtual banking system in Beta, connecting *IMVU*, Second Life, *Entropia Universe*, and *Frenzoo*. Reportedly, Anshe Chung Studios also acts as an angel investor for Claus Nehmzow's award-winning Hong Kong start-up *3D Avatar School*,[9] using cutting-edge technology to teach Mandarin Chinese in a virtual 3D environment (Perez 2011).

While the *Anshe Chung* brand originated in the virtual world, the physical world saw business opportunities, too. Brands like Adidas, AOL, Axel Springer, Cisco

[8] http://www.anshex.com.

[9] http://3davatarschool.com.

Fig. 1.4 BusinessWeek (USA) May 01, 2006; Capital (Germany) March 01, 2007

Systems, Dell, Mercedes, Reuters, or Toyota set out to gain a head start in the new technology, and add new tools to their marketing and communications. Leading academic institutions like Harvard, Princeton, and the Massachusetts Institute of Technology as well as US Government agencies including the National Oceanic and Atmospheric Administration (NOAA), NASA, and the Department of Defense started to look into the immersive 3D world to improve learning, training, recruiting, innovation processes, simulation, and long-distance collaboration. Among the most active were the US Military and IBM; the first German institution to reach out to 3D audiences via Second Life was the City of Hamburg, represented by the Hamburg Chamber of Commerce and the public/private network for business development, Hamburg@work (Fig. 1.4).

Editors the world over jumped on every bit of news related to Second Life—the more spectacular, the better. Googling "Second Life" in 2007 returned more results than the search for George W. Bush, then president of the United States; media from all over the world commented on the opening of the official 3D embassy of Sweden as well as that of the Hamburg Chamber of Commerce (Techshout 2007).

Little notice was taken of the fact that Gartner had been much more specific in their prognosis. In their 2007 press release, the first paragraph actually read: "By the end of 2011, 80 percent of active Internet users (and Fortune 500 enterprises) *will have a 'second life,' but not necessarily* in Second Life." Gartner vice president Steve Prentice specified: "Do not expect to undertake profitable commercial activities inside most virtual worlds in the next 3 years." But he also encouraged IT leaders to take the initiative and innovate: "The majority of active Internet users and major enterprises will find value in participating in this area. Don't ignore this trend. It will have a significant impact on your enterprise during the next 5 years."

Many journalists did not bother to go into these details. Expectations were raised that the whole world would rush to create 3D avatars in Second Life and participate in its economy. Unbridled exaggeration obscured the benefits and values added. Consequently, many decision makers as well as the general public missed important points during the initial excitement, and were taken by surprise when sentiment changed.

Analysis at BÜRO X of the data provided by Linden Lab had shown as early as March 2007 that Second Life had a problem with user retention. Interest was extraordinary; users registered accounts in the millions. But not many more than one million of them returned to become active on a monthly basis as residents. In all of Germany, there were 100,000 at the most. The Second Life 3D viewer interface was complex and hard to use. Access was a challenge, significant reach in the sense of traditional advertising not provided. A steep learning curve had to be mastered by new users to experience the 3D environment and its benefits.

In July 2007, the "Gartner Hype Cycle of Emerging Technologies," an indicator of trends and developments in information technology, saw virtual worlds at the "Peak of Inflated Expectations": at least 5 years from mainstream adoption, but right before a deep fall into what the analysts call the "Trough of Disillusionment." And so it happened. In mid-2007, the backlash was under full steam. Yellow press reporting as well as quality journalism had changed their stanza. Stories of illegal gambling, virtual banking scandals, and sexual misbehavior came up, damaging the image of Second Life. Millions of marketing dollars were said to have been wasted (Rose 2007). While much of the discussion was as exaggerated and emotional as the preceding media hype, hard facts like low retention and technological deficiencies could not be disputed. In spite of massive expectations and the serious engagement shown by early adopters, Second Life did not grow anywhere near the circulation of popular print publications, the effects of search engine marketing, or TV's mass audiences. Second Life and other public virtual worlds of 2007 failed to deliver either sales or a quantity of awareness measurable by the standards of conventional marketing and media planning.

Disappointment led to negative evaluation, bad press, and the withdrawal of corporate budgets and projects for years to come. But tens of thousands of developers, hundreds of start-ups, and tech corporations like Apple, Cisco, Google, IBM, Intel, Microsoft, or Sony intensified their efforts to enable and improve immersive 3D technologies. Academics and enterprises all over the world followed the results closely, making productive use of what new technology was ready and available.

TÜV NORD was not discouraged, either. The Group had not rushed in-world with the first corporate wave, on the contrary: It had taken most of 2007 analyzing what happened, discussing opportunities and investments with their R&D partners at BÜRO X. There had been plenty of time to adjust ideas and concepts and to finally launch the 3D project with a sustainable approach.

1.2 TÜV NORD IN 3D: Exploring the Future

When TÜV NORD set out to explore the early stages of the 3D Internet, sales to Second Life residents were not in focus. Before virtual doors opened in late 2007, the plan had been set up to find out about the technology's long-term prospects and potential value for interaction and transaction, seizing the opportunity to take a glimpse into the future of the Internet: three-dimensional in design, social and collaborative in function, deeply immersive in character.

The conservative approach was due to the fact that TÜV NORD Group is quite a special enterprise. The company is one of the large technical service providers in Germany, owing a leading market position to its competencies and a broad range of advisory and testing services in fields like mobility, industrial services, natural resources, energy, training, health and human resources. The Group operates in Europe, Asia, Africa, and the Americas. Many of its activities are business to business, but awareness for the "TÜV" brand, which grants quality standards and safety, is almost 99 % in the home market, similar to the world's best-known consumer brands. Obviously, TÜV NORD is a knowledge-driven enterprise: "Making our world safer" is the corporate mission, and slogan. And it is growing fast. When the 3D project started in 2007, the Group had a staff of 6,800, many of them with a background in engineering or science. By 2010, the global workforce had grown to 14,600 and achieved revenue of 922.6 million Euro. International business contributed 21.4 %, up from 19.8 % in 2009 (TÜV NORD Group 2011).

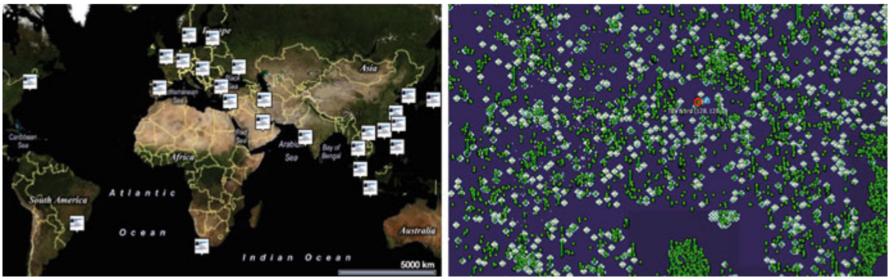

Fig. 1.5 From digital 2D to virtual 3D. Logos mark international TÜV NORD offices on the 2D web site (*left*); the 3D simulator *TUV Nord* is surrounded by thousands of green dots representing avatars on the Second Life world map (*right*). After registration with Second Life, the simulator can be found using SLurl coordinates in any web browser[10]

The 3D project was expected to contribute to this expansion eventually, adding extra value to the Group's communications. But in 2007, the technology was seen in early beta stage, comparable to the 1990s Internet—a testing environment, or Petri dish, as it was labeled by Castronova in a lecture given via "Campus Hamburg" in Second Life for students at the Hamburg University of Applied Sciences (Castronova 2008). The 3D team was assigned to go for new ways to share

[10] TÜV NORD 3D simulator in Second Life: http://slurl.com/secondlife/TUVNord/44/224/27.

knowledge within the Group; learning about immersive branding and engaging potential customers beyond what was possible on the 2D Internet and in the physical world would be welcome as a side effect (Fig. 1.5).

In July 2007, the 3D project was set up within the Strategic Planning department at TÜV NORD. Operative responsibility was with Client Management, the department responsible for the Group's international IT structure. Supporting some 8,000 computers worldwide, one of its tasks is to look into any new media technology expected to bring significant improvements in collaboration efficiency, learning quality, risk reduction, and cost effects. To begin with, TÜV NORD chose to extend its real-life commitment to protecting the climate into the digital space.

A mixed-reality press conference was held in Hamburg, with Dr. Guido Rettig, Chairman of the TÜV NORD Board of Management, laying the virtual foundation stone for the group's first TÜV station in 3D (Fig. 1.6). Journalists participated virtually at company headquarters in Hannover, branch offices in Essen, and the new TÜV NORD space in Second Life. When the simulator *TUV Nord* opened for staff and public on December 7, 2007, the company stated: "We will be operating an important experimental lab here to link up with the knowledge community in the whole of the virtual world, but also to actively involve our own international organization in over 70 countries around the globe." (TÜV NORD Group 2007).

1.2.1 Exploring 3D

In Step One of the project, TÜV NORD set out to explore what was new about digital 3D environments and how to employ the new media technology. The public was invited to visit the simulator *TUV Nord*, open to all residents of Second Life. All it took was to register with the service, create a personal avatar, and install a download of the free client software on a computer with strong graphics. When entering *TUV Nord* in the search field on the World Map in Second Life, the region would show and be accessible from any other point in the virtual world.

1.2.1.1 The Avatar as an Interaction Interface

The most significant distinction between the flat 2D Internet and 3D social environments is marked by the avatar as a figured representative in a digital environment. Avatars provide a new kind of interaction interface; they enable communication and collaboration, touch and transaction, and they help to create a realistic feeling of physical presence. The avatar takes Internet users beyond the limits of physical space and reality, allowing them to go some other place and join others to "be there" in person, without having to physically go "there" in person.

As Jim Blascovich and Jeremy Bailenson found in experiments during their research at the University of California, Santa Barbara, and Stanford: "Reality is a product of our minds. If the mind buys into an experience, it deems it 'real,'

Fig. 1.6 Dr. Guido Rettig, Chairman of the Board of Management, using a personalized avatar in a mixed-reality press conference to lay the virtual cornerstone for the 3D presence in Second Life (2007)

otherwise it judges it to be unreal. We can be in two places—one physically and one mentally—simultaneously, whether awake or asleep" (Blascovich and Bailenson 2011, p. 14f). The virtual is a part of reality, extending and augmenting what can be said, done, and experienced in the physical world. In consequence, TÜV NORD expected avatar interaction to enable communication of a new quality with its stakeholders; presenting content in immersive 3D applications would invite them to relate to TÜV NORD issues with a new quality of engagement.

The first thing the 3D project had to learn about was how avatars acted and what they could do in the multi-user environment. The corporate avatars were sent to work (Fig. 1.6).

1.2.1.2 Interaction with the 3D Space

Arriving in 3D compares much more to walking into a park, shop, or classroom than watching a computer screen load after clicking a button in a web browser. Immediately, there is a spatial experience.

Buildings, exhibits, media, pathways, and other elements of the virtual surroundings are displayed as being close by or in the distance. Using the built-in camera enhances that feeling. Free to choose from a variety of perspectives, one sees avatars moving around in the 3D space and zooms in on them or on any object of interest. Personal view is not determined by the decisions of a game designer or film director, but by individual will: See what you want when you want to, even around corners and through virtual walls. Additionally, the Second Life viewer offers a 3D

Fig. 1.7 3D simulator *TUV Nord* in Second Life (2009)

sound experience, adding to the sense of real presence. In the words of Boellstorff, “a virtual world is a place.”

The Second Life platform provides 3D space on mainland continents and in the form of private islands with sandy beaches, surrounded by waves of virtual water. When creating an immersive environment, the chance and the challenge are to combine the means employed in traditional web design and other 2D media to give orientation or grab attention with the experience and habits developed in the multi-dimensional physical world (Fig. 1.7).

On *TUV Nord* island, visiting avatars land at a high-tech welcome point amidst rocks and woods, close to the open sea and a natural haven. Here, basic instructions and an overview of what to expect are supplied. The function of this spot is similar to that of the homepage on a 2D web-site or a book’s table of contents, but the 3D look and feel are more similar to that of an information center at an airport’s terminal. Posters, animated signposts, and 3D objects give directions to the points of interest. Avatars may walk there on virtual foot; in Second Life, they could also fly or even teleport by clicking on a sign or a landmark in their inventory—the fastest way around, and the closest one can get to science fiction becoming reality. *TUV Nord* visitors may also take a car and drive around, a reference to the group’s important role in securing mobility (Fig. 1.8).

1.2.1.3 Interaction with 3D Technology and Content Creation Tools

All this is made possible by the Second Life viewer software. It provides free, easy-to-learn tools to share information and generate content in 3D. Making use of this

Fig. 1.8 Explore the future: landing point at *TUV Nord* in Second Life in 2009

software to see what could be done with it was an important part of the initial exploration phase.

In the process of terraforming and landscaping, the digital terrain can be designed to resemble anything from Antarctic ice deserts to the extraterrestrial fauna and flora on some foreign planet (or in some ancient past), the vast forests of Central Europe, the fundaments for factories and training grounds, or any real-life city in the physical world. For TÜV NORD IN 3D, we chose to combine the casual feeling of the original island setting with realistic buildings and technology, some of it presented in ways not possible in the physical world.

Objects and animations in the 3D environment of Second Life are created from virtual scratch: from prims, textures, scripts, or a combination of the three. Prims can be thought of as digital LEGO bricks with a neutral wooden structure, provided in 13 geometrical shapes, called into existence with a touch of the mouse to be resized, combined, and textured at will (Fig. 1.9).

A texture could be any image: of ancient tiles, a silver screen, a piece of art, an aluminum surface, or the photo of a roadside accident. Placed on suitable 3D prims, the impression will be created of a Pompeii walk, a movie screen, a roller shutter, or a crashed car, damages to be discussed by insurance experts. Tens of thousands of images are available within the libraries and market places of Second Life, but what is even more important: At the cost of a few cents, anybody can upload any digital image from their hard drive to the Second Life platform, use it there as a texture, and put it on display.

Scripts are programs written in Linden Scripting Language. They animate objects, avatars, and accessories, bringing them to life in the way intended by their creator. Scripts can be a few lines of code, opening and closing that roller shutter,

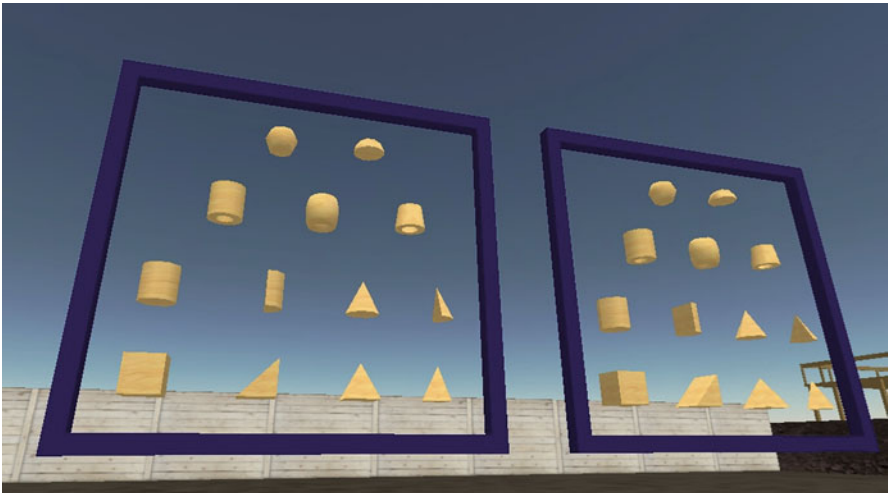

Fig. 1.9 What 3D virtual environments are made off: basic prims provided for building in the Second Life toolkit

for instance, switching on lights, or shadows, or a motor, starting a video or sound file, or loading a 2D web site. They can also be complex programs triggering multi-step interaction, providing data analysis, or employing artificial intelligence.

Content creators have full rights to determine what happens with their creations. Second Life provides its own digital rights management: A certain virtual asset may be created for one-time local display in the 3D environment; other objects are free to be copied, shared, or sold. Almost anything can be created or at least drafted in 3D within Second Life, but it is also encouraged to import assets from outside of the platform, created with more elaborate 3D tools such as Blender, Maya or 3Dsmax.

The rights to display and change content usually are limited to the building team, else anybody could change the environment at any time or even delete parts of it by accident. But in dedicated areas of Second Life, building, scripting, and even collaborative work on 3D objects are enabled for everyone or a selected group. Such a sandbox was created on *TUV Nord* with exclusive access for staff, offering tutorials and encouraging them to experiment with the tools provided.

TUV Nord and most of its 3D applications were created by designers and programmers at BÜRO X Media Lab. Collaboration was close with TÜV NORD subject experts and IT, incorporating assets and items obtained from other members of the Second Life community. Selected members of the 3D workgroups were granted the rights to rez and display pictures, slides, or text files so they could share them in-world in real time with others (Fig. 1.10).

Fig. 1.10 Creating virtual reality: TÜV STATION in Second Life, built in 2007 following design and architecture in the physical world

1.2.1.4 Interaction with Objects and Media

All installations on *TUV Nord* make use of the diverse possibilities to integrate classical media from the physical world with the 3D online setting. Slides are turned into billboards, thumbnail photos into larger-than-life exhibits; music and sound effects add to a natural atmosphere and learning experience. Films are ready to be viewed on demand; the Welcome Point features machinima documentation of the creation process, opening ceremony, and press conference held in 2007. Much of the content is bilingual to make it comprehensible for visitors from around the world, in support of the Group's international expansion. In the more complex installations, the scripting allows avatars to change the whole setting from German to English and back with a mouseclick.

In the first stage of the project, the rebuild of an inspection pit was conceived, recreating a *TÜV STATION* from the physical world (Fig. 1.10). As every car registered in Germany has to go through inspection periodically, the virtual station grants the same kind of brand recognition as the TÜV logo itself. It connects the 3D space to the 2D Internet, with direct access to services and fields of competence on the Group's web site. Outside, flags wave in the virtual winds, connecting "TUV Nord" in 3D to the local web sites of subsidiaries in Spain, Turkey, Korea, Saudi-Arabia, the USA, and others.

TÜV STATION was also meant to be a meeting point and a key visual in classical marketing sense, but other offerings turned out to serve these ends far better (Fig. 1.11).

Fig. 1.11 Bilingual navigation: Interactive guideposts give directions to the public installations. Avatars would walk, fly, or click a sign to be teleported to their destination

Two interactive learning settings had been conceived, building on the outstanding expertise of TÜV NORD engineers in the field of environment and climate protection. The first installation was the magnified recreation of a fuel cell, visualizing how electricity is won bringing hydrogen to react with oxygen, converting its chemical energy with the help of an anode, a cathode, and an electrolyte membrane. Pure water is the only "waste" product, which makes fuel cells an important part of future concepts for mobility and energy supply. The 3D environment basically sets no limits to the size and detail of an object. While the original cell was only 20 cm in size, the 3D model was 60 virtual meters high. It contains a learning path, taking avatars right to the heart of the cell. The chemical process, invisible in the physical world, was both animated and explained, while the avatar, feeling as small as an ion or electron, moved along amidst energy-laden particles. Experts for fuel cell technology and for immersive education collaborated closely to create the 3D installation. From a distance, the visualization turned out to be a spectacular sight, and the true key visual of the TÜV NORD IN 3D representation. From within, it was a totally new learning experience (Fig. 1.12).

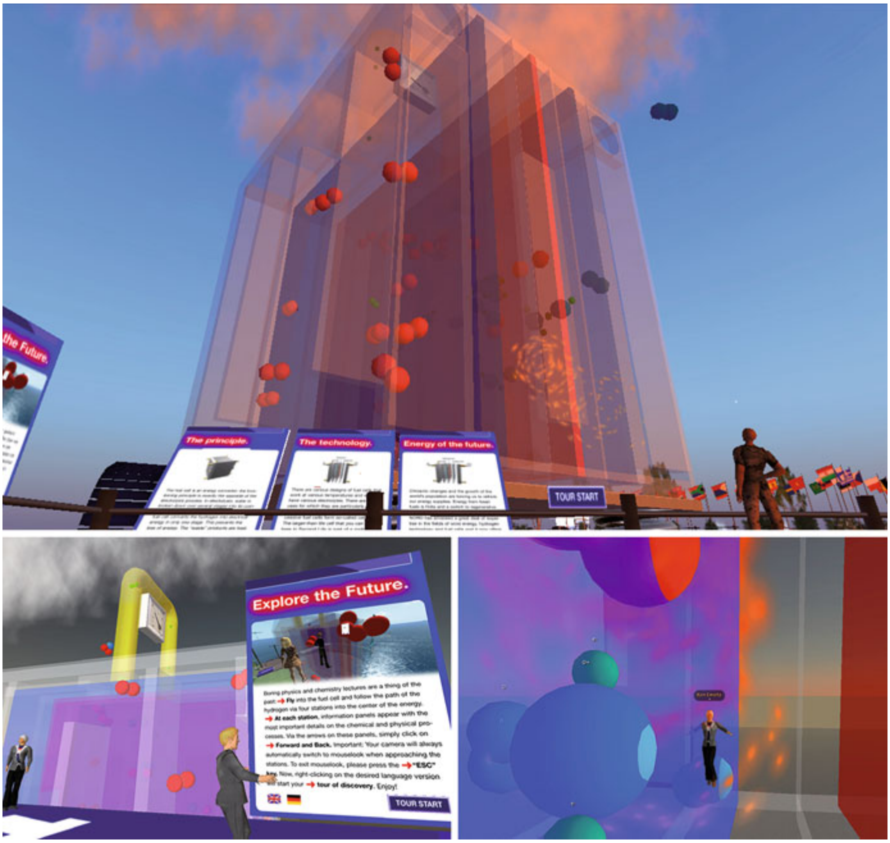

Fig. 1.12 Not possible in real life. Avatars going on a learning path in a 200 ft fuel cell

The second installation invites avatars to carry out surveys and analysis in the role of TÜV NORD experts for ground penetrating radar technology. The *GPR Radar Challenge* adds game-based elements to convey information about environmental risks and their resolution. The 3D scenario is the construction site of a new academy building; hidden in the virtual soil are abandoned oil tanks and cables, roots of old trees, a leaking dike, and other items. The avatar is provided with basic instructions and a 3D GPR device. Taking the tour, she would try to find all items; technically, she would move around until she made contact with invisible touch points, each of them triggering the display of a radar image taken during a survey in the physical world on the screen of her GPR device. Analysis of the image and additional information were supplied in text chat and notecards: The participant learnt what she had found and how the resulting problem would be taken care of. Proceeding to a multiple choice question board, the visitor could apply her newly gained knowledge, get immediate feedback, and receive a symbolic reward for the right answer.

Fig. 1.13 Students of Augsburg University exploring the game-based learning installation *GPR Radar Challenge*, taking the role of TÜV NORD experts using ground-penetrating radar technology to assess construction sites and protect the environment

While many compelling installations of educational content in Second Life lack the public attention they would deserve, the combination of learning, challenge, and reward made the *GPR Radar Challenge* a true meeting point for avatars; some of them even turned out to be regular visitors (Fig. 1.13).

1.2.1.5 Interaction with Others

Avatar-based interaction brings a new quality to the Internet and to social media. An online 3D simulator can be a space full of life. In a region as heavily frequented as *TUV Nord* in Second Life, other users are likely to be there at any given time. While they would be isolated in front of their computers on the old Internet, they will see each other in the spatial 3D environment, and they will start to communicate, in real time.

Part of the attraction of the Second Life software is the range of free communication tools it provides. Visitors of the TÜV NORD simulator can enter local text chat to communicate in their immediate 3D surroundings; they can also “shout” text messages to everybody on the 65,000 m^2 sim. Instant text messages (IMs) can be exchanged exclusively with a selected person or within a group of registered members; notifications may be forwarded to a person’s e-mail account. Groups may involve three or more avatars. In December 2011, the builder’s group *TUV TSN* had 8 members, 154 employees had registered with *TUV Project*, and hundreds of visitors received updates on 3D development and events via *TUV Net*.

Each group member can communicate with all others who are online at the same time. Group chat participants can be situated next to one another on the same simulator—or thousands of virtual regions away. Like in personal or conference phone calls, only those directly invited (or part of the group) can join these exchanges; privacy is ensured.

Animation programs are provided to make it possible to sit down together, touch objects or other avatars and dance in couples or groups. The software offers simple gestures to add to a more natural experience: nodding one's head or applauding for approval, pointing at something of interest, expressing surprise, or lifting the virtual hand to catch attention in a meeting.

In 2007, Second Life added Voice to the platform, a synchronous speech facility with a spatial 3D acoustic appeal. The VoIP solution provided by Vivox enhanced the ambient sound effects already included in the environment. Applicable in the same private or public ways as text chat, Voice increased the immersive potential of the virtual world. A sense of direction and distance was amplified; the feeling of being close to other avatars, moving towards them, or walking away while they talked fostered the experience of real presence in the virtual space.

For professional and educational purposes, Voice held vast improvements on the practical side. It sped up the conversation compared to text chat like the invention of the phone did in succession of the telegraph. In 2008, Vivox released a case study announcing a daily average of 600,000 min of peer-to-peer calls being provided in Second Life, adding up to over 1 billion minutes of voice communications per month; group events were reported to be handled with as many as 400 avatars (Vivox 2008).

In the meantime, text chat has not vanished. In role-play, a natural human voice might hamper an intended learning experience, while text chat is neutral and might be better suited. During lectures, presentations, and teamwork in Voice, text chat is often used as a back channel to supply questions, comments, and additional information without interrupting the speakers. Some virtual meetings deliberately do without Voice and rely completely on text, as the chatlog automatically provides notes of the discussion and information.

Avatars share nonverbal information and objects, adding to the transfer of knowledge. Each avatar has a personal profile others can click and view. Like in other social media networks, that profile contains information about the person—as much or as little as she is willing to share. Each avatar also has a personal inventory, administered in the cloud of the Second Life asset servers. This is likely to contain landmarks of interesting locations within Second Life, similar to bookmark URLs on the 2D Internet. It may also contain images, notecards and audio files, virtual business outfits or complete avatar designs, animated 3D objects like the GPR device or even a complex building full of interactive learning applications. According to the rules set by the content creators for each of these items, they can be shown, copied, shared for free, sold to individual avatars, or distributed to a group. Passing things on in any of these ways is an important part of the social experience. Watching and discussing content together also supports the sense of social interaction.

To get acquainted with the 3D tools and media and learn about the avatar-based interaction, TÜV NORD employees made themselves available to colleagues and visitors from the Second Life world. Users would see when the 3D team was online and contact them.

Fig. 1.14 TÜV NORD staff was ready to help with the Second Life software, take part in discussions, and supply information about the company. In the early stages of the project, a trained member of staff held regular office hours over a period of 6 months. Using a virtual postbox, questions, ideas, and criticism can be sent by e-mail

Interviews with residents were held on an irregular basis; feedback was documented. The project has been accompanied by desk research and virtual field research from the beginning, performed by the staff at BÜRO X Media Lab. International media coverage was monitored as well as academic publication. During virtual excursions to benchmark corporate facilities, the Media Lab obtained first-hand information on other 3D projects. Avatar-based participation in lectures, conferences, meetings, and interviews provided insights to complement the experience gained with TÜV NORD's own audience at *TUV Nord* (Fig. 1.15).

To process and evaluate these data, the core development team of TÜV NORD and BÜRO X held monthly meetings during Step One of the project, many of them in the virtual world. Personal observations, visitor's feedback, and input from professional colleagues were also assessed to prepare for Step Two of the project.

1.2.2 Adding Value in 3D

From the start of the project, corporate media kept the international TÜV NORD organization up to date, informing about the new opportunities to connect and collaborate. A secure portal was created on the company's intranet to provide 3D news and Second Life tutorials. A forum was established for staff and management to

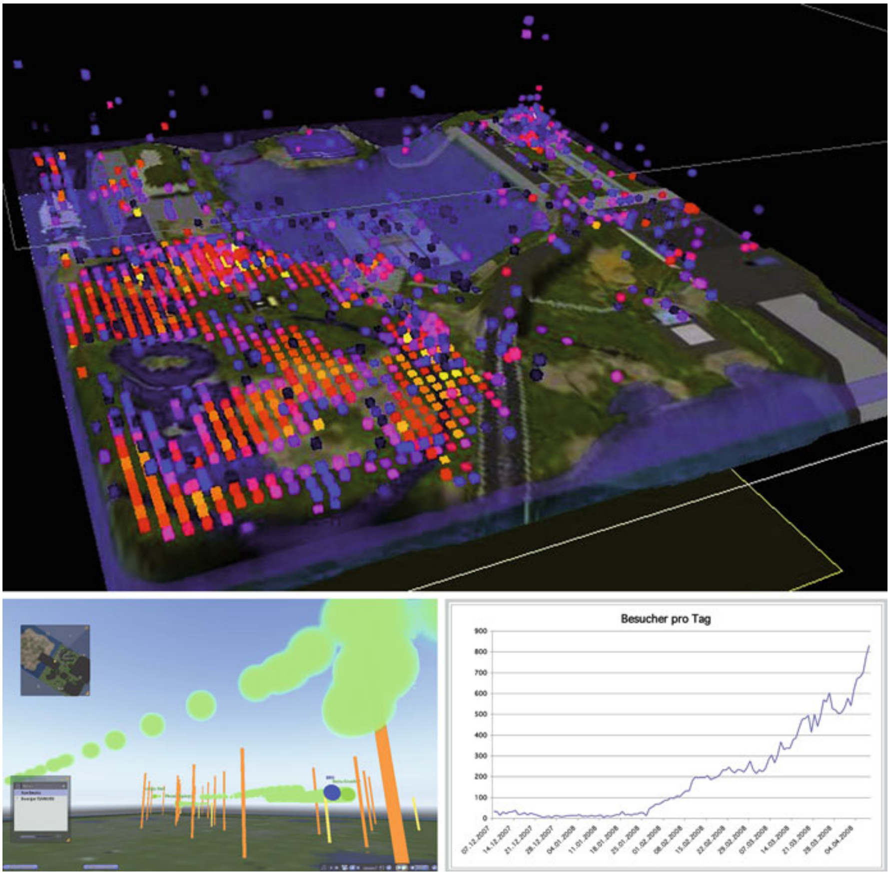

Fig. 1.15 Information and data on visiting avatars and their behavior were collected on a quantitative and a qualitative basis. Innovative applications like a 3D heatmap (*above*) registered and visualized the data and movements of avatars: how many entered the simulator, how long did they stay, and what did they like and dislike? Did they take and solve the GPR challenge? Where did they spend their time and quit? (Image of heatmap: courtesy Cale Flanagan.)

share ideas for additional applications, demand for research, and other suggestions for a productive use of the 3D environment.

Soon, a pool of ideas had evolved. Three areas were selected for further exploration as a part of corporate education, training, and long-distance learning:

- Virtual events and meetings.
- Visualization and simulation in 3D.
- Game-based education.

Several projects were drafted. The approach for each project varied as well as the level of completion needed for evaluation. A simulator named *DMT* was added to

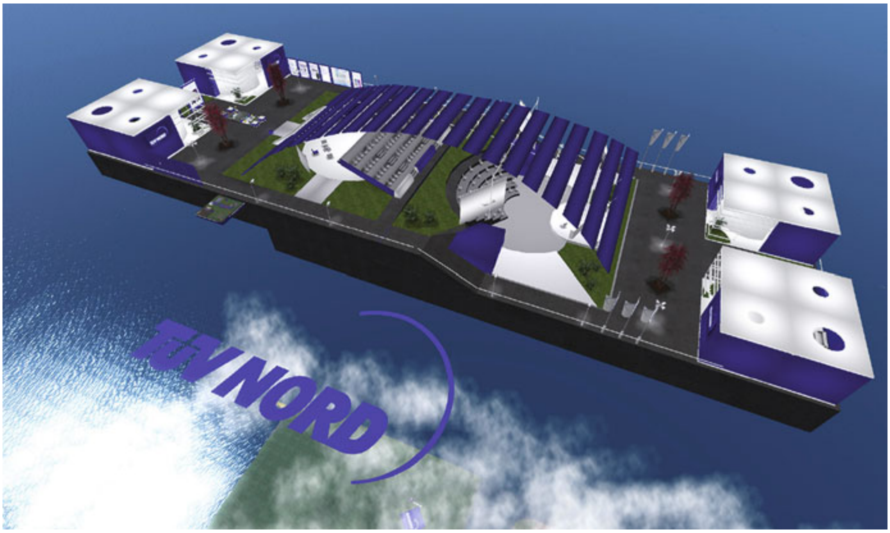

Fig. 1.16 For staff only: TÜV NORD auditorium in a protected area of Second Life

the *TUV Nord* island. It did not allow public entry and provided increased security for developing projects, TÜV NORD staff meetings, and guests.

1.2.2.1 ROI Within 1 Year: Virtual Events at the 3D Auditorium

To make use of the social quality and interactive potential of the young media technology and to enhance global collaboration within the TÜV NORD organization, a 3D auditorium was created in Second Life. Placed in a protected area at 1,500 ft above virtual ground, the venue supplies seating for up to 80 participants. The architecture is open, the design modern, but it is not overtly futuristic; feedback from early research had suggested it might help employees to get assimilated if they would start in familiar surroundings (Fig. 1.16).

Nicole Sohn, Head of Notified Body for Pressure Equipment of TÜV NORD, set up a team of tutors to beta test the environment. IT Services trained two Serviceline employees to assist with the technology. Tutorials were provided in the form of videos and PDF. Workshops were held, with BÜRO X Media Lab helping the team to get acquainted with 3D environment and the interactive tools and collect their feedback for refinement.

The surname "TUVNORD" was registered with Linden Lab to identify corporate avatars. Each employee uses their real-life surname as a first name in Second Life; "Frank Boerger" became "Boerger TUVNORD" in the virtual world. It turned out this simple measure strongly enhanced the feeling of real togetherness in the meetings to follow, enabling colleagues to recognize one another immediately.

Fig. 1.17 Upon registration, each member of the multiethnic staff can choose from one of 15 basic corporate avatars and outfits to get started in the virtual 3D environment

Following a specific wish of the beta testers, 15 corporate avatar designs and basic business outfits were provided for the multiethnic staff. To ensure that only employees can join the project, a simple registration process was created on the intranet. Registration can also be initiated with an e-mail from a person's TÜV NORD account to IT Services; in this case, the avatar will be all set up and equipped, ready to be picked up in the 3D auditorium (Fig. 1.17).

On September 10, 2008, Nicole Sohn and 14 of her colleagues from Hamburg, Bangkok, Katowice, Mumbai, Istanbul, and Hong Kong sat at their desks with a PC or notebook and a headset. Some of them were thousands of miles apart as the TUVNORD avatars logged into Second Life and joined "Sohn TUVNORD" in the 3D auditorium for the first PED Exchange of Experience in the virtual environment, a workshop with high-level updates on Quality Management and the European Pressure Equipment Directive.

Conferencing tools included big screens with laser pointers for slides and video. High usability was a main requirement. In close cooperation of the TÜV NORD team with the scripters and designers of BÜRO X, a lectern with an elaborate interface was created to manage presentations and support exchange with the virtual audiences. Each seat in the auditorium was equipped with its individual small screen and corresponding functionalities (Fig. 1.18).

These facilities are utilized continually. If someone has a remark or a question, she clicks a button; the avatar's name will immediately be placed on the waiting list displayed for the speaker. If someone has a technical problem, another click will call for support. If someone misses a slide, they can click back or forth on their personal monitor for review. If additional information is ready for download or a

2D Internet URL is referenced, another button opens the web pages in a browser. To engage the audiences and collect feedback from the group, polls can be performed and results immediately visualized in larger-than-life graphics. A manual with all details is available for staff in-world and on the Internet.

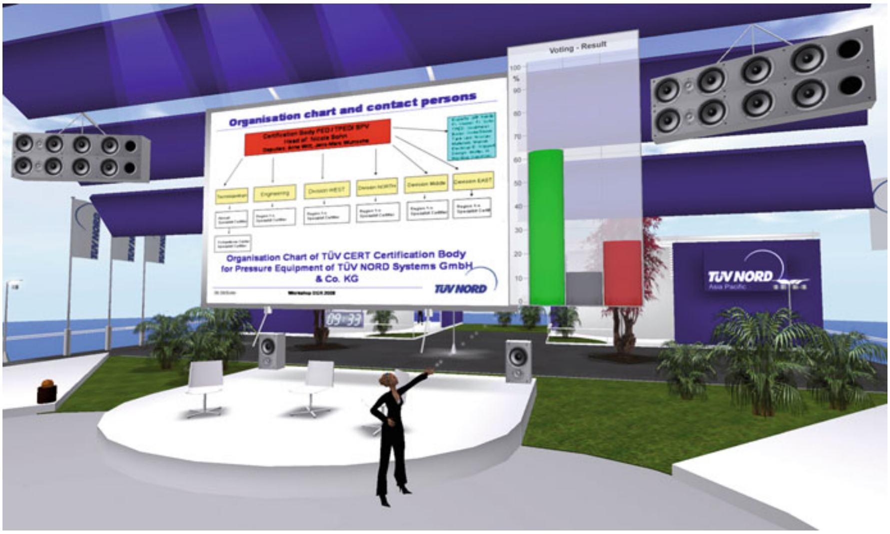

Fig. 1.18 Interactive tools, e.g., a voting board to collect feedback from the group, support conferencing and long-distance learning

Despite minor technical hiccups, the premiere went well. As Sohn would recall later: "We were very content to see how everybody could follow and participate in the lectures once they had adopted the basics of interaction in 3D. Video conferences, on the other hand, demand a huge investment, with access limited to a few people. Our team and the number of experts we need to connect with worldwide is constantly growing. So we have been searching for a less expensive, more flexible method for a long time" (Boerger 2009, p. 16) (Fig. 1.18).

The virtual facility is saving a lot of time, money, and kerosene. Flying in ten people from Poland, Croatia, Turkey, Brazil, Hong Kong, Thailand, and India for one training session can cost as much as US $37,800 for tickets, plus thousands of dollars for hotels, expenses, and food, plus far more than 150 expensive hours spent traveling instead of serving customers. On average, savings added up to $3,126 p.c. for each international trip substituted by long-distance learning in the virtual 3D environment (Linden Lab 2010).

TÜV NORD reached return on investment in less than a year. Savings of more than $140,000 were achieved in the first 10 months, exceeding the initial cost of design, scripting, servers, and support since the start of the project. By 2011, Sohn and her tutors held regular PED workshops for groups of 30–40 employees. In spite of the growing numbers, live support from the IT-Serviceline was hardly requested any more; 3D media literacy was picking up fast among some of the world's leading experts for pressure equipment.

1.2.2.2 Visualization and Simulation in 3D

Creating and assessing content in digital 3D was another area promising a vast potential for improvement of procedures, content exposure, and means of collaboration.

In April 2009, an inspection hall was created with 3D models of trucks to provide an immersive workspace for TÜV NORD traffic experts specialized in the appraisal of damage on vans and heavy vehicles. Experts distributed all over Germany could upload 2D photos of accidents and related incidents, place them on 3D models, and meet with colleagues in avatar form to discuss severity and valuation in real time. Complementing a similar, but costly procedure in the physical world, the experts would be able to meet on a more regular basis (or on short notice) to exchange their experience. This project did not really take off. The benefits of virtual meetings did not make up for the experts' effort to achieve basic 3D interaction skills—and the method of visualization was not convincing. In the physical world, experts create 2D photographic evidence by taking pictures at a 45° angle; textures in virtual worlds work best using pictures taken from a frontal view. To create a natural 3D environment with immersive, larger-than-life illustrations of incidents, a designer would have to manually build high-quality 3D models of crumpled fenders, rusty handles, or smashed headlights for discussion and valuation, which proved far too expensive and time-consuming. To make the idea work for this specific purpose, better and more convenient 3D technology would be needed; what Second Life had to offer at the time was not sufficient.

Another project produced more gratifying results. Stefan Luckmann, then a grad student at the Rostock Warnemünde Department of Maritime Studies of Wismar University, had been a very early adopter of Second Life. After years of absence, Sohn and her team at TÜV NORD Systems had revived his interest in the 3D software. With their support, he dedicated his diploma thesis to the enhancement of expert's inspection capabilities in Second Life. He thoroughly investigated and compared learning content and procedures in the digital space and the physical world. Then he created several 3D learning applications.

An interactive model of valves in a pressure exchange device helped to understand the technology as well as train for its examination; a display of seven larger-than-life welded joints on a kettle provided the challenge to identify those that did not comply with security standards. Finally, Luckmann defended his thesis in a mixed media presentation held live in Rostock and in the TÜV NORD *Sandbox* for his mentors in August 2009. Luckmann's work not only convinced his professors but also led to immediate employment at TÜV NORD (Fig. 1.19).

1.2.2.3 Game-Based Learning

The positive reception of the TÜV NORD *Radar Challenge* and the exploration of STEM-related installations on other 3D simulators encouraged further investigation into the field of game-based learning. Second Life, based on game technology itself, provided many tools to create applications and 3D environments to improve learning, accelerate understanding, and train reliable routines in a playful way, while raising motivation to do so at the same time.

Training something that would potentially be dangerous, prohibited, or even impossible in the physical world was the next case to be explored. In September 2009, *IdeenExpo 2009* was held for a huge audience of kids, educators, and the broader public in Hannover. Corporations and national institutions with a rooting in STEM offered a glimpse into their labs and their human resources development, competing to present innovative technology and training programs for future staff (Fig. 1.19).

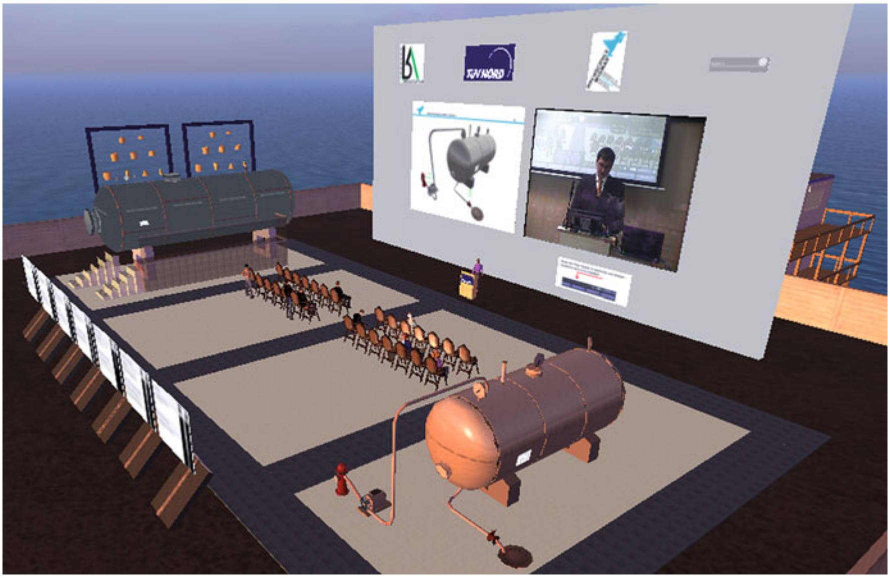

Fig. 1.19 Grad student Stefan Luckmann defending his diploma thesis in a mixed-reality event held live at the Rostock Warnemünde Department of Maritime Studies and in the TÜV NORD *Sandbox* in Second Life in 2009

TÜV NORD trainees had created a booth with exhibits focused on mobility and safety on the roads. This included the premiere of *Training for Traffic*, a 3D installation created by junior employees in collaboration with the Media Lab in Second Life. Within a week, 2,000 young people had taken the virtual parcours. Out of a curriculum of 1,500 rules and regulations, they had to master 11 exemplary traffic situations converted into interactive tasks. No risk or reward was involved, yet the ambition to deliver a faultless performance was strong. TÜV NORD trainee Mario Grauer helped many of the participants with the software, most of them 15 years of age or younger. "The 3D course was a main attraction; kids were standing in line to get a chance to drive," he reported later. It was observed that for this age group using an avatar to interact in 3D held no serious impediments (Fig. 1.20).

These findings correspond with the spread of digital games in general. According to researcher Jane McGonigal, 3 billion minutes were spent all over the planet playing games in 2010—each week. Players invest a lot of engagement, intelligence, and creativity to succeed. Research stated that 97 % of youth in the US play video and computer games, as well as 25 % of those over the age of 50 (McGonigal 2011, p. 6, 11). In Germany, 36 million active gamers were to be counted in 2011, almost 60 % of the Internet population (Newzoo 2011). It is one of the pivotal suggestions of McGonigal in her book *Reality is broken: Why games make us better and how they can change the world* to redirect some of that energy and social skills to learn and work together and solve serious tasks in the physical world: "Games are providing rewards that reality is not. They are teaching and inspiring and engaging us in ways that reality is not. They are bringing us together in ways that reality is not. (…) Game developers know better than anyone else how to inspire extreme effort and reward hard work. They know how to facilitate cooperation and collaboration at previously unimaginable scales. And they are continuously innovating new ways to motivate players to stick with harder challenges, for longer, and in much bigger groups. These crucial twenty-first-century skills can help all of us to find new ways to make a deep and lasting impact on the world around us." (McGonigal 2011, p. 4, 13).

TÜV NORD drafted two scenarios to explore how elements of game-play and the power of intrinsic motivation could improve training and augment courses, especially those requiring high expenditure for tutorship and the provision of learning environments in the physical world.

The first such scenario was "Safety of Loads." Owners and drivers of vans, trucks, and heavy vehicles, shipping agents; and manufacturers have to comply with a multitude of laws and regulations. Equipment and handling expertise have to be assessed on a regular basis. In Germany, 360 million load trips were undertaken in 2010, an average of 41,500 per hour (Kraftfahrt-Bundesamt 2011). Each load has to be checked and approved before going on the road (Fig. 1.21).

In the physical world, the cost for a day's training of some 20 people to fulfill these tasks or train and supervise others easily adds up to $60,000 for rent and personnel. Learning material is originally delivered in books and slides while training involves vehicles, loads, forklifts, plus drivers, workmen, and equipment. Prototyping an immersive learning path, with 2D images, 3D objects, animation, and sound, the *Safety of Loads* 3D scenario in 2009 recreated exemplary parts of that content to explore whether the use of casual games, 3D visualization, and interactive presentations could improve learning progress and complement (or even replace) the expensive real-world learning facilities (Fig. 1.22–1.23).

Yacht Crew Academy was another example. Crew such as stewards and deckhands are prepared for the demanding tasks awaiting them on private luxury yachts.

Fig. 1.20 *Training for Traffic* in 3D. simple rules, unexpected obstacles, and instant feedback made the game-based learning installation a success with young visitors of *IdeenExpo 2009*

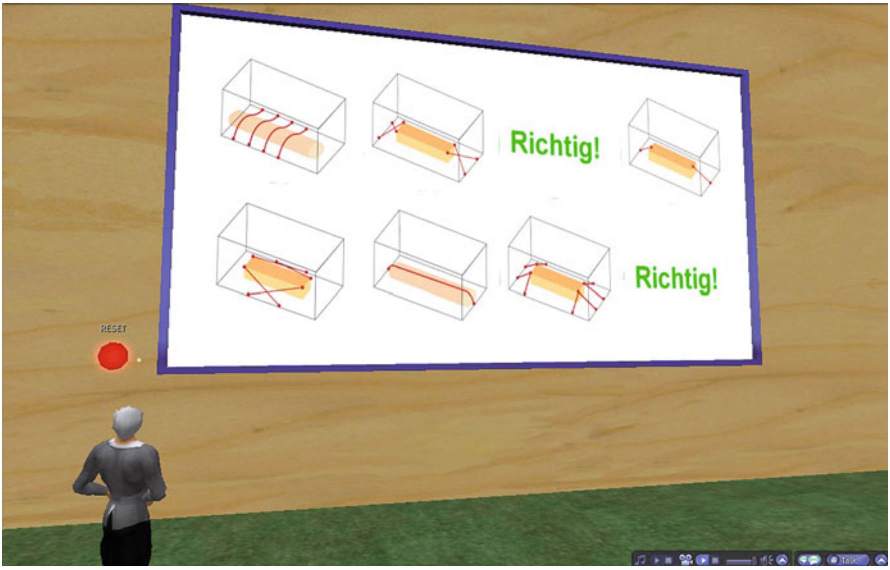

Fig. 1.21 *Safety of Loads*. Draft of an interactive scripted click-board for self-teachers, aiming to speed up visual recognition of potential danger by faulty fixation of load on a truck

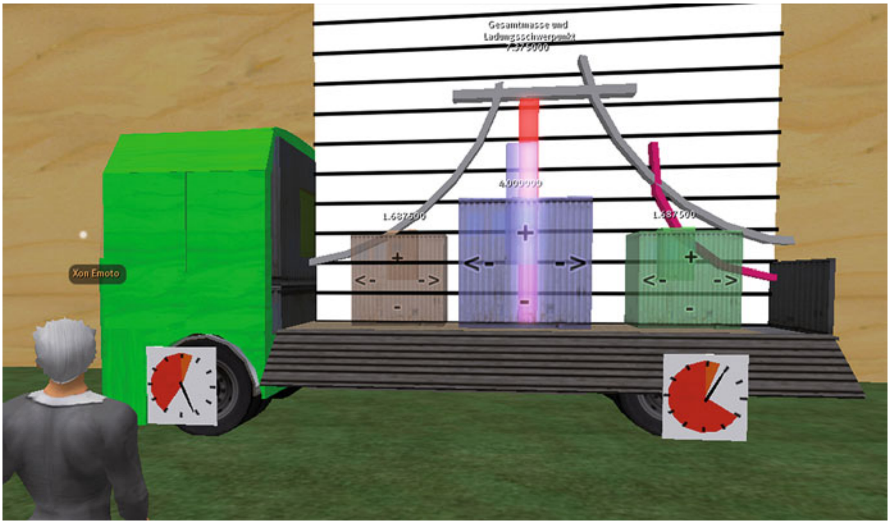

Fig. 1.22 *Center of gravity*. Conceptual draft and scripted demo of an interactive training simulation for truck drivers and inspectors. Using data from the physical world, it visualizes how load must be placed on a truck to ensure a safe drive

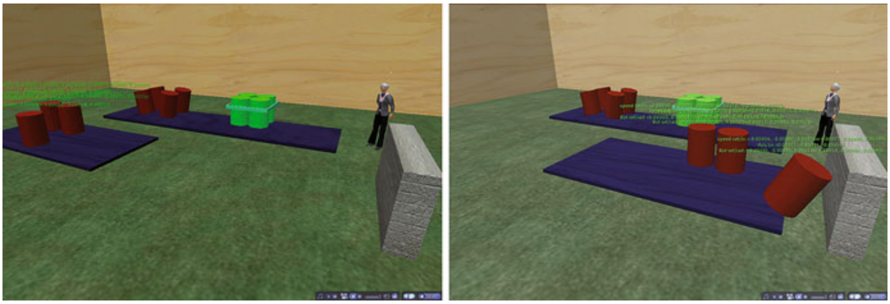

Fig. 1.23 *Crash test*. Early prototype of a learning module visualizing how to secure barrels and demonstrating the forces at work in a sudden stop

Training environment and instruction in the physical world are no less demanding and expensive to provide. Concepts were drafted in 2010 to transfer parts of the existing curriculum and procedures into virtual 3D environments (Fig. 1.24).

The project for the first time combined the 3D experience accumulated during the TÜV NORD projects in Second Life with the expertise of professional game design. Drafts and prototypes included elements such as role-play. "Being Someone Else" has been identified as an effective educational method to change perspectives or adopt new skills; virtual reality takes it into a new dimension. In the words of visionary researcher and VR pioneer Jaron Lanier at the London *Learning Without Frontiers* Conference: "If you are the molecule, that molecule is interesting, because it's you." (Lanier 2012; Guttenplan 2012).

Fig. 1.24 *Yacht Crew Academy*. Providing an exclusive 3D environment to improve learner's experience and reduce training costs (2010)

Participants in the *Yacht Crew Academy* scenario would enter the interactive 3D screenplay in the role of a crewmember. They would work towards a score, cope with unexpected challenges, acquire rewards for tasks well taken care of, and upgrade on a level system, created in a team led by Micha Becker at BÜRO X Media Lab (Fig. 1.25).

Level 1, named *Welcome Aboard*, was conceived so that participants would acquire basic yacht crew knowledge while at the same time being taken through a tutorial teaching them the media skills needed to master the virtual course. Almost without noticing, they were introduced to 3D technology and avatar interaction; an animated map would help them know their way around the ship. (Both advocates and deniers of virtual reality had called for this kind of usability before.)

Level 2 would use animated 3D objects, media, and sound effects to deepen maritime knowledge, letting participants take their time to find and take care of irregularities, untidiness, and defects.

Level 3 would randomly change the familiar setting and introduce a timer; participants would now work against the clock. On Level 4, nonplaying characters (NPC bots or agents) entered the scene. Adding artificial intelligence, they would act as the ship's owner, other crew members, or guests, confronting learners with requests and unexpected situations to test and enhance social skills such as politeness, flexibility, and responsibility. Level 5 would demand perfect orientation on the yacht, high social competence, stress resilience, and fast decision-making in an atmosphere of peril, under bad weather conditions, confronted with NPCs and limited time. In assessment mode, participant's adoption of knowledge and skills would be recorded.

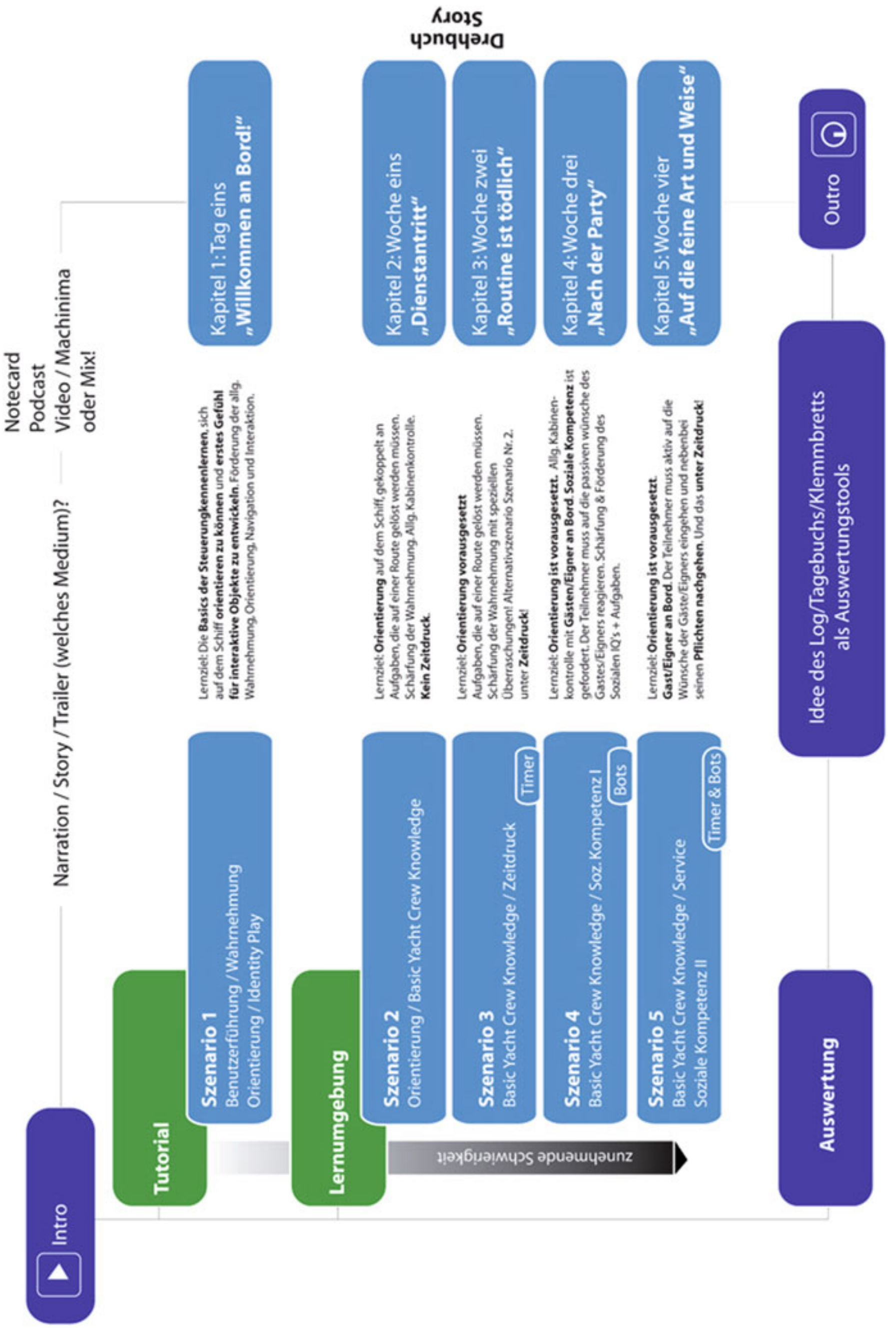

Fig. 1.25 Draft of the game-based level scenario, basis of the interactive screenplay

TÜV NORD IT specialists were involved to incorporate data created during the participants' virtual careers on the 3D yacht with documentation of their overall progress in the physical course. The virtual *Yacht Crew Academy* was conceived as a single-player application, enabling asynchronous learning and flexible use of the 3D installation. This would also reduce complexity, cost of creation, and the need for live support compared to a multiuser online application (Fig. 1.26).

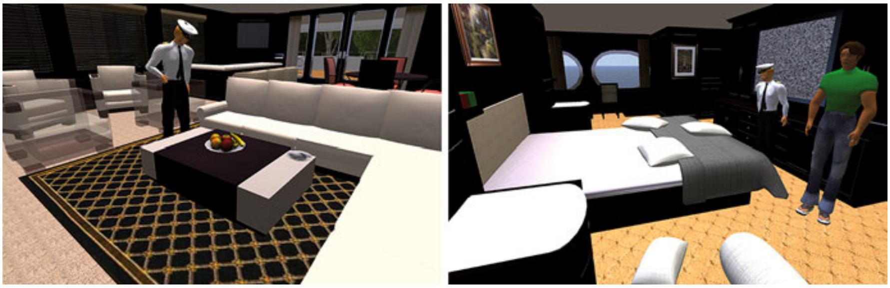

Fig. 1.26 Following checklists, meeting unexpected challenges, and being confronted with non playing characters, participants would acquire knowledge, routine, and social skills

1.2.2.4 Positive Feedback, Serious Doubts

The TÜV NORD team performed the first explorations into game-based learning from mid-2009 to the end of 2010. Creative concepts and didactic benefits of *Training for Traffic*, *Safety of Loads*, and *Yacht Crew Academy* met positive response on all levels. This included the staff involved, beta testers of various ages and backgrounds, and TÜV NORD management.

Each of the projects included the calculation of a full-scale realization of the entire curriculum relevant for the virtual learning environment. With regards to the effort it would take to make best use of Second Life technology, realization would have required budgets between 80,000 and 450,000 US$. Requirements included assessment, automated recording, and external storage of the participant's results.

Would Second Life be apt to deliver the performance expected in return for this kind of investment? With 3D experience growing, and more elaborate ideas evolving, questions arose. Linden Lab and its policies had undergone severe changes. The team had established personal contacts with CEO and founder Philip Rosedale, his successor Mark Kingdon, and many of their management and staff in the first 3 years of the project. But transparency decreased with most of them leaving Linden Lab and Second Life. In 2009, *Second Life Enterprise* had been introduced, a promising product aimed at corporate projects like TÜV NORD IN 3D; in mid-2010, the offer was terminated without much explanation. Benefits for educators were cut, driving many institutions to other platforms. The future of Second Life had become vague. Would the service be available next year— or even next month?

Another fact had to be taken into account. Adoption of the Second Life software by TÜV NORD employees beyond the 3D team and the successful group using the 3D Auditorium had been so slow that some of the projects mentioned above could not take off—at least not in 2009 and 2010, and not in the world of Second Life. At the same time, development of 3D technology outside of Second Life had made significant progress. Would other applications make it easier to engage staff, or even customers at some point? Could learner's success be achieved more effectively?

More and more options were available. Building on information collected and contacts made since 2007, the TÜV NORD IN 3D project set out for a systematic evaluation to provide safe grounds for future investment.

1.2.3 Expanding Expertise: Beyond Second Life

As stated before, TÜV NORD regarded Second Life as a laboratory in which to explore the characteristics and potential of a social 3D Internet, expected to emerge from the 2D predecessor. Hence the interest in the software, the tools, and the platform, where thousands of simulators form a virtual world, visited by more than a million individuals on a regular basis—a small size Web 3D, enclosed in a walled garden created by one visionary start-up.

Now the project set out to see what was beyond those walls, looking for:

- Higher scalability and a much better 3D user experience
- Easier access, ideally in the web browser
- Total ownership of original 3D content
- Freedom of content distribution for learning, branding, and collaboration in 3D
- Control over technical provision and user's safe access to the 3D content.
- Seamless integration of existing data and content.
- Seamless integration or even replacement of existing 2D tools
- Avatar interoperability between various 3D environments

What was to be had, what was to be expected—and at what cost? The 3D team examined:

- Other 3D virtual world platforms
- Online tools for collaboration and education in 2D
- Offline simulations for training, therapy, etc.
- Software and applications for digital 3D design and visualization
- Animation, special effects, and 3D technology for TV and movies
- Development of 3D game technology
- Development of Web 3D technology
- Development of 3D standards

We can only scratch the surface of the findings we owe to our visits and talks with many inspiring 3D spaces, toolkits, and their skilled creators, and we can only mention a few in the section below; it would be going beyond the scope of this chapter to give even an abridged report on each of the platforms we examined.

But we hope the selection we had to make will give an overview of the dynamic development as a whole, and we included resources we expect to be useful for those who wish to undertake more research or gain a more detailed picture. These include the URLs for many of the services we mention, such as the *Daden World Finder*,[11] a web-based app to match corporate requirements with 3D technologies, created by Daden Ltd. from the UK; Maria Korolov's well-kept list of OpenSim providers and statistics, a part of her work at the HyperGrid Business blog; Wagner James Au's *New World Notes*; and John Lester's *Be Cunning and Full of Tricks* blog and his growing list of OpenSim landmarks.

We also watched the skyrocketing increase in the use of 2D avatars such as user nicknames, portrait photos, or self-recorded video images in web conferences as well as social and mobile media, with a focus on their interactions in these 2D digital worlds, and their increasing integration with 3D technology.

1.2.3.1 Other Virtual World Platforms and Toolkits

OpenSim

Having started TÜV NORD IN 3D in Second Life, the first alternative to look at was OpenSimulator or OpenSim. OpenSim supports the core of Second Life technology, open-sourced by Linden Lab early in 2007 (Kerner 2007). Standalone sims and grids of multiple OpenSim regions are accessible with the Second Life viewer or third-party viewers, created by independent developers. In the words of the initiators, "OpenSimulator allows virtual world developers to customize their worlds using the technologies they feel work best—we've designed the framework to be easily extensible. OpenSimulator lacks support for many of the game-specific features of Second Life (on purpose), while pursuing innovative directions towards becoming the bare bones, but extensible, server of the 3D Web. OpenSimulator is getting more stable as it approaches release 1.0, but we still consider it alpha software; so should you."[12]

OpenSim environments can be set up behind corporate firewalls or on private servers. This would guarantee maximum control and security, but at the same time, all maintenance would have to be provided by individual IT administrators; with regular updates on the software, this can be quite a challenge. Also, many of Second Life's high-quality features like Voice from Vivox or Havok physics are not automatically included in the OpenSim toolset. If these are needed, licenses have to be obtained, which Vivox has been encouraging and supporting (Korolov 2011a), or other applications used. Individual regions can be connected to larger grids such as the *New World Grid*.

A growing number of companies like *Dreamland Metaverse*, *Kitely*, *spotON3D*, *TalentRaspel*, or *Virtyou* offer rental of 3D server space and maintenance services;

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[11] http://www.daden.co.uk/pages/virtual_world_finder.html, last accessed Feb 26, 2012.

[12] http://www.opensimulator.org, last accessed Feb 26, 2012.

some also deliver creative work.[13] *InWorldz* focuses on social and gaming communities; *Avination* (run by German developer Melanie Thielker) offers voice and physics in Second Life like quality. *JokaydiaGrid* is known to encourage and support educational activities. Others just host cheap 3D web space for their tenants to make use of the creative potential of a virtual world by themselves.

Many of Second Life's creative and innovative solution providers, developers, and educators contribute to OpenSim. Corporations and institutions also stimulate the development, offering virtual land and technical support. Intel runs almost 2,000 regions on the ScienceSim grid[14] (Winkler 2011). In cooperation with Sandia National Laboratories and the Fashion Research Institute, engineers Mic Bowman, Dan Lake, and John Hurliman of Intel Lab[15] have developed the *Distributed Scene Graph* architecture, or DSG, boosting capacity of a single OpenSim region from less than a hundred to more than a thousand avatars active at the same time (Lake 2010) (Fig. 1.27).

The US Army, with its high safety standards, on one hand, and its long tradition of adopting new technology early, on the other, set up 200 regions in less than a year at MOSES.[16] The admission-only Military OpenSimulator Enterprise Strategy grid started by Douglas Maxwell at the Simulation and Training Technology Center in Orlando is a platform for researchers and developers from within and beyond the military (Neville 2011). Maxwell and many colleagues at the Army, Navy, and Air Force had done groundbreaking work in the semipublic MiLands regions of Second Life and were strong supporters of the protected *Second Life Enterprise* Beta. Seeing their investment in content at risk when Linden Lab pulled the plug on *Enterprise* in 2010, Maxwell took another look at OpenSimulator: "It had matured significantly since 2008: it was more stable, feature rich, even allowed for backups." (Panganiban 2011). OpenSim and MOSES are part of the activities the Department of Defense devotes to 3D virtual environments and game technology, also including the Federal Virtual Worlds Challenge,[17] and the Federal Consortium for Virtual Worlds' conference held at the National Defense University in Washington,[18] chaired by Paulette Robinson (Fig. 1.28).

Developers are working hard to add functionality and overcome limitations. While OpenSims are somewhat compatible with one another and with Second Life, an individual account and avatar had to be created to access each grid. Friends, groups, and virtual inventory obtained in Second Life or on a specific OpenSim would be lost and have to be reestablished on each new grid, including avatar appearance and outfits. In 2008, Crista Lopes of the University of California, Irvine, a key figure in OpenSim development, created a patch called the Hypergrid, "an architecture and protocol for securely decentralizing multiuser virtual environments

[13] http://www.hypergridbusiness.com/opensim-hosting-providers, accessed Feb 26, 2012.

[14] http://www.sciencesim.com/wiki/doku.php, last accessed Feb 27, 2012.

[15] http://www.intel.com/content/www/us/en/research/intel-labs-scalable-virtual-worlds.html.

[16] http://fvwc.army.mil/moses.

[17] http://fvwc.army.mil initiated by Tami Griffith, accessed Mar 28, 2012.

[18] http://www.ndu.edu/icollege/fcvw, accessed Feb 26, 2012

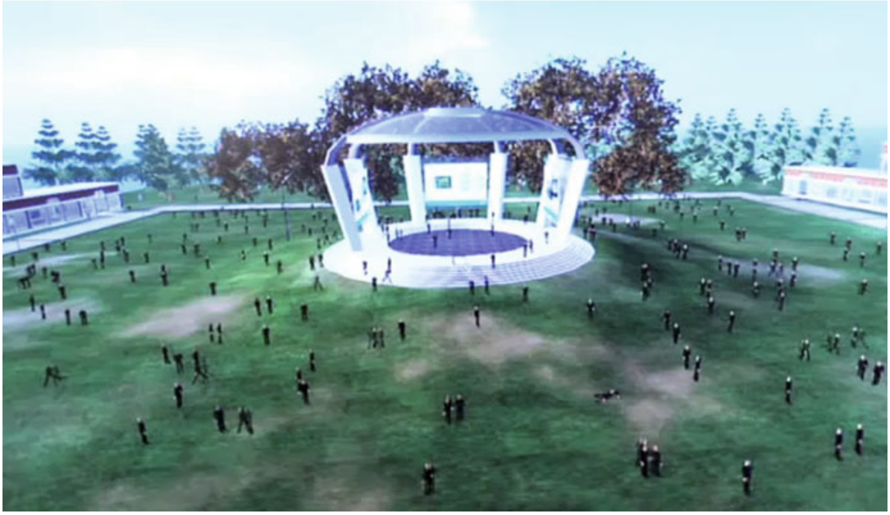

Fig. 1.27 Expanding capacity: Intel's *Distributed Scene Graph* enables virtual mass events, live meetings with hundreds of participants, and a new dimension of training simulations (*image courtesy of* Intel Labs 2010)

Fig. 1.28 Supporting development in a safe environment: MOSES map and STTC Welcome Area of the Military OpenSim Enterprise Strategy grid provided by the US Army (2012)

at all scales" (Lopes 2011). With the help of Thielker and others in the open source community, Hypergrid has constantly been improved and refined. Now it is interconnecting more and more OpenSims, and there is a growing network of HyperGates,[19] enabling the transfer of avatars and assets, a promising step towards a larger virtual world—and more ease of use.

John "Pathfinder" Lester, Chief Learning Officer at ReactionGrid and JIBE, has started the *Hypergrid Adventurers Club*, taking guests on virtual tours to selected OpenSim locations,[20] while the 3D ecosystem is growing. "The top 40 public

[19] http://thehypergates.com, accessed Feb 26, 2012.

[20] http://becunningandfulloftricks.com/hypergrid-landmarks, accessed Feb 26, 2012.

OpenSim grids passed the 20,000-region milestone," Hypergrid Business reported in November 2011[21] (Korolov 2011b) (Fig. 1.29).

Fig. 1.29 Connecting 3D servers: educators and 3D developers using HyperGates to visit various OpenSim regions on a tour with the Hypergrid Adventurers Club (*Image courtesy of* BÜRO X 2012)

Initiatives and publications like those of Lester, Korolov, and core developer Justin Clark-Casey[22] have proven very helpful in keeping up with the rapid development of OpenSim technology and other 3D options available or coming up.

Open Wonderland

One approach consistently improved is *Open Wonderland*, a JAVA-based open source toolkit for creating collaborative 3D virtual worlds.[23] "We were inspired by Second Life to build something more geared towards business collaboration," Nicole Yankelovich reported in 2007, when she used the original *Project Wonderland* engine and the *Project Darkstar* server to demo *MPK20*, a 3D virtual workspace for *Sun Microsystems*' highly distributed workforce (Yankelovich 2007).

The toolkit further evolved after Oracle bought Sun and stopped *Project Wonderland* in 2010. Immediately, a strong community formed to further develop the engine and its adjunct open source warehouse. Like OpenSim, *Wonderland* is an important

[21] http://www.hypergridbusiness.com/statistics, accessed Feb 26, 2012.

[22] Justincc's OpenSimulator blog http://justincc.org/blog, accessed Feb 26, 2012.

[23] http://openwonderland.org, accessed Feb 26, 2012.

part of iED, the Immersive Education Initiative based in Boston.[24] Recently, new funding and a lot of progress has been seen, including bringing up one 3D object synchronously in several virtual environments, having collaborators join meetings from out-of-world by phone, or adding modules to support game-based learning in Singapore. Yet, *Open Wonderland* still takes extensive technological skills to set up and handle. It could not replace Second Life to serve the purposes of TÜV NORD at the present stage, but the potential is obvious (Fig. 1.30).

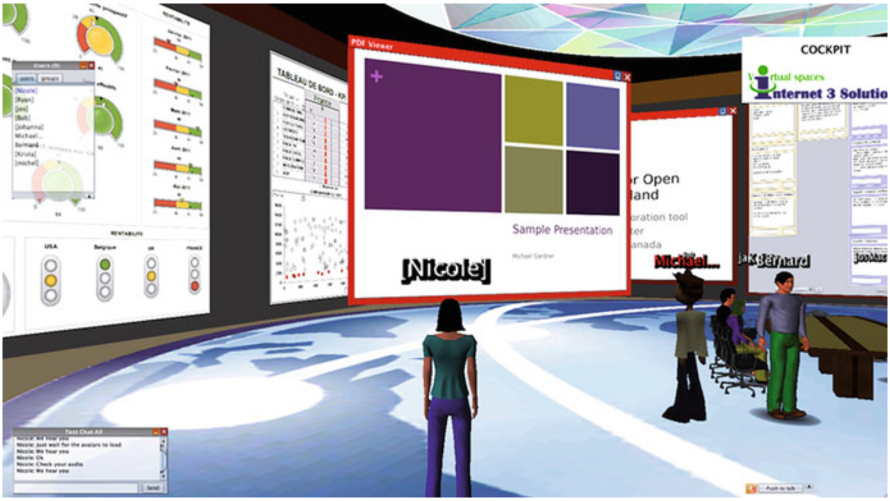

Fig. 1.30 Improving collaboration. Created in the +Spaces project, a new module in the Open Wonderland Module Warehouse allows drag-and-drop presentation of existing 2D content such as text documents, spreadsheets, or presentations in a virtual 3D workspace (*image courtesy of* Open Wonderland Foundation 2011)

VastPark

VastPark from Australia, contracted by the US Government in 2010 (Anderson 2010), was also closely examined. Founder Bruce Joy has been pursuing the convergence of game design, virtual worlds, and Internet technology since 1999. His team is able to provide individual solutions, but VastPark also enables software developers to create virtual worlds and community solutions. VastWorlds supports 3D worlds with a unique architecture built with a view towards the future of communication platforms.[25] The company has launched the developer kit *OpenAvatar* in 2011, facilitating character design and animation (Joy 2011); they also pay a lot of attention on collaborative tools for teamwork in immersive 3D environments.

[24] http://immersiveeducation.org.

[25] http://www.vastpark.org.

VastPark has been described as “a virtual content platform that enables you to create and deploy your own 3D virtual world within minutes. Play with ideas, add physics, trial concepts and publish them online. You might not have used 3D before, but you can do this!” (Alhadeff 2007) (Fig. 1.31).

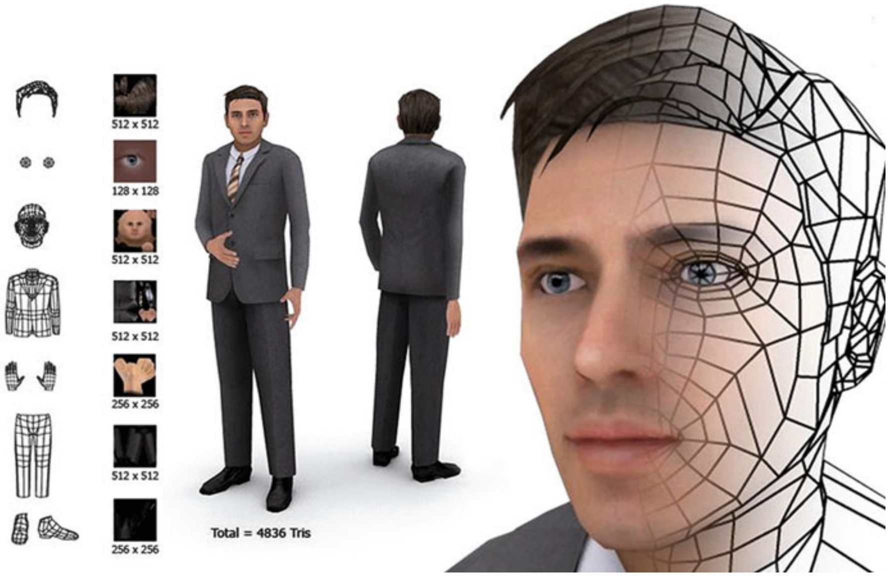

Fig. 1.31 Improving the avatar: *OpenAvatar* SDK created by VastPark (VastPark 2011)

Worlds Based on Games

Any avatar-based video game in multiplayer mode constitutes a virtual world, and many public 3D worlds, workspaces, and learning environments are based on game technology. Middleware such as EPIC’s *Unreal Engine 3* features professional software development kits with powerful authoring tools, robust physics, advanced AI, and high-end graphics. CryTek offers the *CryENGINE3* SDK free of charge for non-commercial purposes (Handrahan 2011).[26] Serious games like *Moonbase Alpha*,[27] the FBI Academy, the British Military, or the recruiting tool *America’s Army*[28] make use of these benefits for engagement, practical and leadership training; they are also applied with significant success in architecture, healthcare, advertising, and other fields. These toolkits enable the delivery of an experience conceived for the user by

[26] http://mycryengine.com.

[27] NASA Moonbase Alpha Game and Manuals for Players and Educators: http://www.nasa.gov/offices/education/programs/national/ltp/games/moonbasealpha/index.html.

[28] http://www.americasarmy.com.

storytellers, programmers, and designers; creating content in-world (as in Second Life and OpenSim) usually is not a part of the game.

Blue Mars

In October 2009, *Blue Mars* went public in Open Beta. Created on *CryENGINE*, early machinima showed fascinating graphics far beyond those to be seen in Second Life; builders and bloggers welcomed Blue Mars as a potential successor to Linden Lab's service. Blue Mars tried to attract virtual world developers who would create content offline and offer it in-world, building social communities. The business model was somewhat similar to that of Second Life, but the requirements were much higher. It takes professional skills to create for Blue Mars and hardware equipped for high-end games to run it smoothly. Initially, it did not run on Macs, excluding many pioneering users and content creators. Despite its potential, the platform failed to gain traction with professionals and the public; management changed, and focus shifted to mobile and other new forms of Avatar-based interaction. But IDIA Lab Director John Fillwalk of Ball State University had successfully adopted Blue Mars for education (Spearing 2010). Early in 2012, the world's provider Avatar Reality granted extensive rights for noncommercial use of the 3D platform to Ball State. "Blue Mars greatly advanced the graphic fidelity, functionality and scalability of virtual worlds—well beyond current standards," Fillwalk said. "Its strategy connected social spaces across devices, from high-performance desktops to mobile phones. Our goal is to build upon both its technology and vision for the future of virtual worlds" (Werner 2012) (Fig. 1.32).

Worlds Going, Worlds Gone

Research included quite a few 3D worlds and toolkits that stalled at some point or were surprisingly short-lived. *Lively* was Google's first public attempt at a virtual space with avatars creating content, after much speculation about secret projects, or plans to merge Google Earth and Second Life, creating "Second Earth" (Roush 2007). Lively was finally launched in July 2008, only to be closed again a few months later (Google Inc. 2008). It remained unclear what Google was really looking for in the endeavor, and what they learnt, but it remains a fact well observed that the Internet company—like Apple, Intel, Microsoft, and Sony—is heavily engaged in various 3D development projects (Fig. 1.33).

The peer-to-peer approach of *OPEN COBALT*[29] also caught attention. Julian Lombardi, his team at Duke University, and international open source contributors aimed to make it easy to incorporate 3D content and connect independent 3D places—but by 2010, stability and usability were still far from mainstream adoption, and there has not been much information on progress since. *There.com*, a pioneer

[29] http://www.opencobalt.org.

Fig. 1.32 Elaborate game technology like the *CryENGINE* behind *Blue Mars* brings a new quality of detail, lighting, physics, avatars, bots, and AI to projects such as Ball State's recreation of a historic glass factory (*image courtesy of* IDIA Lab, Ball State University 2011)

of public virtual worlds since 2003, popular for some time with brands like Coca-Cola, closed its virtual doors after 7 years in public. A plan to reopen was announced a year later (Wilson 2011), and recent blog activity points to progress being made (Fig. 1.33).

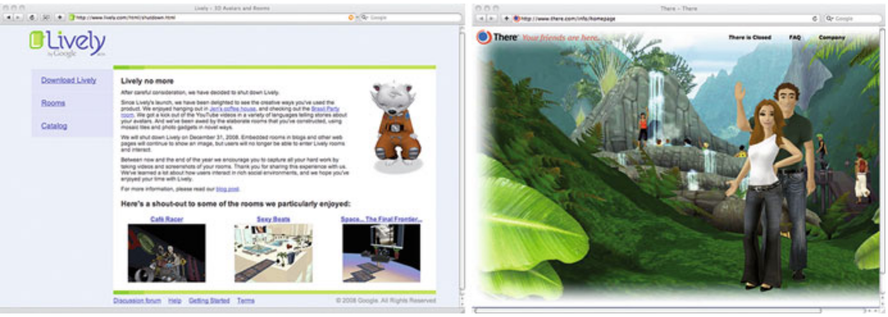

Fig. 1.33 Farewell notes on the community blogs: Google Lively, There.com

twinity,[30] a German-based service mirroring major cities from the real world, had been marketed in 2007 as a potential successor of Second Life; BÜRO X set up an experimental Lab in its virtual 3D Berlin. But the service failed to attract large audiences, despite initial offers from brands and entertainment companies.

30 http://www.twinity.com/en/choose-your-free-avatar.

The technology did not convince educators, due in part to stability issues, but also for lack of user-friendly creation tools. And while coders and designers manually recreated and textured small parts of Berlin, London, Singapore, and Miami, true mirror worlds grew at rapid speed within Google Earth, Maps, and Street View and to some extent in Microsoft's Virtual Earth. Reportedly, 2011 has been a break-even year for twinity (von Hardenberg 2012), but as with *There.com*, it remains unclear what will become of the service.

Also in 2007, Raph Koster had started to alpha test *Metaplace*. Metaplace was a toolkit for users to create social spaces and casual games, and it was web-based. Graphics and avatars were 2.5 rather than 3D, but this was a major step. Koster envisioned a platform accessible through Flash-apps, 3D clients, cell phones (Au 2007)—a world with multiple attractions, incorporating other digital media such as video, embedded in web sites or connected to Google Earth. Metaplace went open beta in 2009. A learning game was drafted for TÜV NORD in the field of energy consumption when word arrived the service would be taken offline within days: "Unfortunately, over the last few months it has become apparent that Metaplace as a consumer UGC service is not gaining enough traction to be a viable product, requiring a strategic shift for our company" (Metaplace Team 2009).

1.2.3.2 Digital 3D: Old Questions, New Answers

Some of the developments above caused irritation, adding to immanent questions regarding the potential of virtual 3D media technology and the safety of future investment. But more and more answers were to be found.

User-Generated 3D Content

Would users really create 3D content on a larger scale? Possible, if it was made easy enough for them. This would be suggested by the success of *Minecraft*,[31] a sandbox-building independent video game written in Java originally by Swedish creator Markus "Notch" Persson and now by his company, Mojang.

An alpha was released in 2009; the full version of the PC game was available in November 2011. By February 18, 2012, Minecraft had sold more than 5 million units (Wikipedia 2012). A total of 20 million users had registered, and 4 million fan videos were showing off Minecraft creations on YouTube (Bradshaw 2012). Support for teachers has been set up at MinecraftEdu,[32] building on the simplistic 8-bit cube aesthetics and animations. Joel Levin in the USA, Liam O'Donnell in Canada, Jo Kay from Australia, and many others explore the inspiring toolset for education. LEGO—its plastic bricks enjoying employment as facilitators of corporate

[31] http://www.minecraft.net.

[32] http://minecraftedu.com/index.php.

creativity—collaborates with Mojang on the *LEGO Minecraft Micro World*, taking the digital game and its 3D content to the physical world (Jensen 2012).

Virtual Trainings, Meetings, Collaboration

Would teachers and learners, corporate staff, and public service personnel really adopt avatar-based interaction for teamwork and education? The success of those using TÜV NORD's 3D auditorium in Second Life points to a positive answer, and so do a growing number of specialized services offering more security, more usability, and a better integration of existing tools and data.

AvayaLive Engage,[33] originally created by Nortel engineers as *web.alive*, is one of them. Based on the *Unreal Engine*, it is used by IBM Global Business Service for their "*Virtual Center*" a voice-enabled and web-based collaboration complex. The MIT Sloan School of Management, according to its Executive Director Peter Hirst, employs AvayaLive Engage in their Executive Education program, exploring "how we can harness technology to create learning solutions that match the characteristics of the world we live in, that support the way we truly learn and allow employees and students to access learning when and where they prefer" (Kline 2012). More and more 3D content and collaborative environments are created by independent developers, while Avaya has made the virtual facilities an integral part of its AvayaLive Suite of Solutions strategy (Fig. 1.34).

Olive is another enterprise-grade, real-time 3D interactive environment for collaboration, training, analysis, and decision-making. Built on the virtual reality engine originally created for *There.com*, Olive was acquired by SAIC[34] in 2010 from Forterra Systems. It brings virtual environments to industry-standard PC servers and client hardware, within existing IT and network security systems; productive use is being made in the fields of energy, environment, national security, health and critical infrastructure (Henderson 2011).

ProtoSphere[35] from Proton Media features VoIP conferencing, real-time text chat, video streaming, application sharing, and Web 2.0 tools like social networks, blogs, and wikis, with value added by avatar-based presence awareness. Made for telecommuters, global meetings, and distance learning, it is built as an enterprise software platform, powered by Microsoft technology, offering enterprise-grade security featuring AES 256 data encryption. In the words of CEO Ron Burns: "We view Lync and Sharepoint together as the operating system of the enterprise. And we're building on top of that OS. So you know the investment you've already made in the Microsoft stack can be enhanced by our product" (Burns 2010). According to experts like Paulette Robinson, Vice Dean at the National Defense University, Washington, and Chair of the annual Federal Consortium of Virtual Worlds' confer-

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[33] Avaya http://www.avaya.com/usa/product/avayalive-engage.

[34] Science Applications International Corporation, USA http://www.saic.com.

[35] ProtonMedia http://protonmedia.com.

ence, both Proton Media and Microsoft are very serious about the cooperation and its progress (Robinson 2012).

Providers like *InXPO* or *VenueGen* specialize in the creation and support of virtual event solutions. The annual *Virtual Edge Summit* sees audiences participating both physically in California and virtually from all over the world. At the same time, rising use of 2D applications like *Adobe Connect*, *Blackboard Collaborate*, or *Citrix GoToMeeting*, which combine familiar user interfaces, web-based video-conferences, and collaborative tools like shared documents or desktops, rapidly adds to digital media literacy.

Fig. 1.34 *AvayaLive* (*left*), *Olive* (*right*), ProtoSphere, and others offer immersive workspaces and training environments, including more and more data and content from the physical world

3D in Your Pocket: Mobile Avatars

Could 3D avatars interact with others on mobile devices and join friends, colleagues, or students engaged in virtual 3D worlds? The answer is simple: They do already. The quest has produced early results with applications like *Kimidora* from Japan or *Pocket Metaverse*, an app to connect with Second Life on an iPhone. The user interaction has been very limited, but with the increasing relevance of mobile computing, this is changing. Each new generation of smart phones (such as the LG Optimus or the Samsung Epic 4G), tablet computers (like the Acer Iconia), or handheld consoles (like the Nintendo 3Ds) has made it easier and more rewarding to connect to virtual environments and other 3D content. In 2011, things were picking up. *Blue Mars Mobile* was introduced in February, an iOS app for the presentation of avatars and the exchange of virtual accessories, interconnecting their creators via social media like Twitter. Using the built-in camera and the app's augmented reality function, an avatar could also be placed and moved in real-life surroundings. In July, Chris Hart of ReactionGrid brought a demo of the avatar-based *JIBE* environment to devices on the Android platform (Hart 2011). *WonderSchool* presented a virtual classroom based on *Open Wonderland* live on the iPad (Sassen 2011). *Minecraft* presented a *Pocket Edition*, first for Android, later for iOS—it has multiplayer mode. In early 2012, more than 100,000 games made up the most popular category on the iTunes

App Store,[36] many using avatars of one kind or another. There were also more than 60,000 educational apps. Some analysts view the HD Retina screen introduced in 2012 for the iPad as a swift move in the direction of the console markets, and it did not go unnoticed that Apple has been registering patents for 3D motion control, 3D display and imaging, 3D multi touch, 3D avatar creation, and more for mobile devices in the course of the past years.[37] Adding things up, it is not a daring assumption to expect a veritable boost in mobile 3D technology and content, soon.

3D on the Web: Avatars in the Browser

Would virtual 3D environments as complex as Second Life be fully accessible on the open Internet? No one solution has achieved this by the end of 2011, but impressive progress has been made to offer 3D content and facilitate access.

One option has become apparent with the creation of cloud gaming platforms like *OnLive*, *OTOY*, or *Gaikai*,[38], letting users participate in game environments not deployed on their consoles or computers, but rendered server-side and streamed to them from the cloud (Thompson and Writer 2010). Thanks to today's bandwidths, transmission feels almost like real time under favorable conditions, with suitable hardware and a performing Internet connection.

Second Life took a public test for a limited time using the Gaikai service in 2010. This allowed instant creation of a default guest avatar who could then choose where to log in and join the perpetual world of Second Life. She would see and be seen by other avatars, some also visiting from the Internet, others logged into the full, viewer-based version of the 3D virtual world. Interaction was limited, though. Text chatting beyond the frontiers was possible, but Voice would not work. 3D content could be seen from the browser, but not animated nor created. But the case was proven: The 2D browser would serve as a viewer for the 3D world, and avatars could interact. The wall was coming down.

In a test performed by the TÜV NORD IN 3D team in Hamburg, an auditor in the Second Life Auditorium would share his desktop and avatar via *Join.Me*[39] with a guest. The guest would then be able to operate the avatar and interact with others, with limitations, but without the need to download the 190-MB viewer of Second Life (Fig. 1.35).

The most promising development, though, included Unity3D, a new game engine, launched at Apple's *WWDC* Conference in 2005 by *Unity Technologies* from San Francisco, USA. In 2007, Unity Technologies started the annual Developer Conference *Unite*, where in 2009 a free version of the toolkit was introduced.

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36 http://148apps.biz/app-store-metrics.

37 http://www.patentlyapple.com/patently-apple.

38 http://www.onlive.com, http://www.otoy.com http://www.gaikai.com.

39 https://join.me.

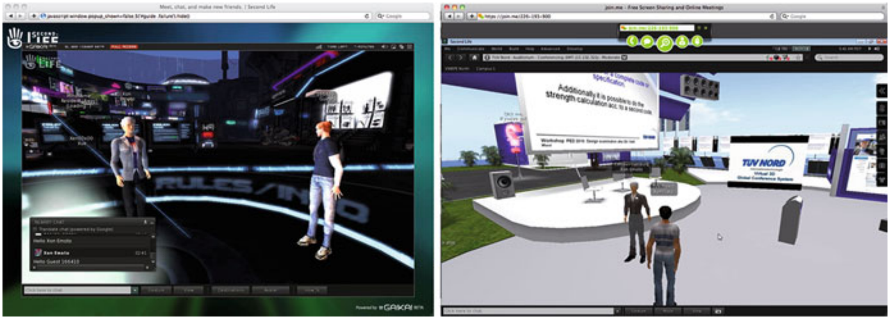

Fig. 1.35 Avatars meeting live in 3D on the web, without the download of a client: *Gaikai* streaming test performed by Second Life (2010), sharing desktops with *Join.Me* (2011)

Changing the Game: Unity3D

Unity is a development platform for creating games, virtual worlds, and interactive 3D environments like training simulations and medical and architectural visualizations. It is free to a large proportion of developers and claims to be affordable for the rest; the Pro licenses and high-end features for mobile publishing and team work in total would add up to $5,000, based on 2012 prices.[40]

Other than Second Life, OpenSim, or Minecraft, Unity does not enable in-world creation of objects and characters; this—as well as terraforming and landscaping—takes place before a user enters the environment. As a result, Unity lacks the potential of designing, building, and changing things together in real time. Creation happens externally, using professional 3D software such as Blender, Maya, Cinema4D, and 3Ds Max as well as Photoshop and others to create and refine textures. Unity then serves to assemble the 3D world from art and assets and bring it to life, adding interactivity and finesse with lighting, shadows, etc. in high visual quality. This can be done with *CryEngine*, *UE3*, and other game engines as well.

What put Unity in a separate category was the fact the result could be deployed to any target all over the digital world: The *Unity Web Player* works as a free plug-in to any browser, enabling users with or without avatars to enter 3D virtual reality and interact with the content and with other users. Unity-based applications can be accessed on iOS and Android mobile devices, on standalone Mac or Windows PCs and on the current generation of game consoles.

In 2010, Unity Technologies won the Wall Street Journal Technology Innovation Award, was "Best of Show" at the Game Developers Conference GDC, a winner in the US Army's Federal Virtual Worlds Challenge in the "AI Assisted Training" category, and more (Unity 2012).

Impressive growth resulted. Within 2 years, more than 1,000,000 developers registered with Unity, among them Bigpoint, Coca-Cola, Disney, Electronic Arts,

40 https://store.unity3d.com.

LEGO, Microsoft, NASA, Nickelodeon, Ubisoft, the US Army, Warner Bros., large and small studios, independent professionals, students, and hobbyists.

By 2011, this included many of the pioneering and most creative contributors to the Second Life and OpenSim platforms. In mid-2010, Rezzable Productions from Britain were the first to use Unity3D for a browser-based preview of Heritage Key,[41] their educative OpenSim experiences of Ancient Egypt, the Tutankhamun excavations, Stonehenge, and the Terracotta Army. In June 2010, Orlando-based ReactionGrid premiered *JIBE*, a middleware working to bring the best of OpenSim and Unity together to make it even more accessible, especially for educational purposes.[42] TÜV NORD started to work with Unity3D at the end of 2010.

In April 2011, OpenSim developer Lopes reported on her discovery and assessment of the potential of Unity on the Metaverse Ink Blog:

"The bottom line, if you don't care to read more, is this: The Unity3D ecosystem feels like Second Life for grown ups. In SL, building is a large part of the SL 'game', of its entertaining user experience; in Unity3D building is a serious matter, it's the activity with which entertainment is produced for others to experience. As such, Unity3D provides a much larger spectrum of options than SL. And, as a consequence, the learning curve is much steeper than SL's. For every 100 people who can build in SL, there are possibly 1 who can build in Unity3D." Answering comments, she elaborated: "It's a different paradigm—and one that I think will be the dominant one in the future. They separate building from experiencing. I can't stress enough how relevant Unity3D is for the community interested in interactive 3D, networked or not" (Lopes and Canto 2011).

A week before, Andrew Hughes of Designing Digitally had announced a partnership with the US Air Force Academy to develop a virtual campus tour[43] for the browser, based on Unity3D. Unity CEO David Helgason noted this was "an impressive example of market leading game technology being used for very serious uses." (Designing Digitally 2011) (Fig. 1.36).

Jon Himoff, Founder of Rezzable, announced that the company's 20 regions in OpenSim would be closing down by December 2011. "We are moving focus to Unity3D," he said, due to a number of factors, including problems with getting new users into OpenSim. In addition, he said, the grid was expensive to run, and a challenge to monetize (Korolov 2011b).

At the FCVW Conference 2011, Eric Hackathorn demoed an interactive oil rig, to become a part of the NOAA ReGenesis learning experience, plus drafts of other immersive learning environments, such as Rock Creek Park developed in partnership with the Department of Energy, and elaborate 3D data visualization.[44]

41 http://rezzable.com/projects.

42 http://reactiongrid.blogspot.de.

43 http://www.3dvirtualcampus.com/3dvctdemo.

44 http://fragileearthstudios.com/category/projects/unity-project.

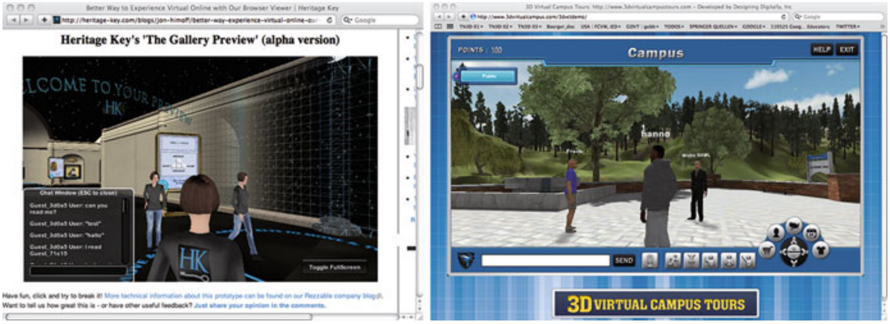

Fig. 1.36 TÜV NORD IN 3D teams exploring Rezzable's *Heritage Key* demo in the web browser in 2010 (*left*); Designing Digitally's *3D Virtual Campus Tour* in 2011 (*right*)

1.2.3.3 TÜV NORD: Backup in 3D

While taking the Second Life toolkit to its 2010 limits in the "Yacht Crew Academy" scenario (see Sect. 1.2.2.3), the possibilities of moving 3D content to other platforms such as OpenSim and creating a backup outside of Second Life were pursued.

It was found that Second Life only allowed the export of content created and owned 100 % by one avatar. Workarounds were found to facilitate the technical export of objects with the consent of the original creators, and an avatar was created to collect all the original content and inventory. But as the *TUV Nord* sims were the result of collaborative work and included many objects obtained from third-party vendors and the Second Life *Marketplace*, it was time-consuming and costly to collect or even rebuild with permission some 85 % of the assets, and impossible to obtain the remaining 12–15 %.

Second Life's system to protect Intellectual Property of 3D content creators has restrictive side effects that even creators willing to go beyond Second Life cannot change or eliminate at will. Also, as there is no "one" OpenSimulator, and each OpenSim creator is free to define their own set of rights, IP is not technically protected on some OpenSims, deterring renowned Second Life content creators to grant rights of use for OpenSim.

On a stand-alone server, a version of the *TUV Nord* sim was created without public access, serving as a backup repository. For test purposes, this OpenSim was temporarily connected to the New World Grid; avatars could come and visit, and interaction with the population of New World Grid was possible. This included the landscape of the 3D simulator, but none of the scripts running the learning installations and sophisticated conferencing tools described above, a major setback. Original scripts could be saved in the form of text files, but it would take significant manual effort to recover the full functionality of the Second Life 3D presence. Selected teleports, triggers and animations were exported or rebuilt to test their functionality in OpenSim; generally, this worked, with minor glitches.

The whole region—as far as it had been reconstructed—was saved in one piece in the form of an OAR (OpenSim Archive) file. It could then be recreated with little effort on a different server, something the developers had long been asking for.

Even a custom USB stick could serve as a backup repository (Lester 2010). Equipped with the software to run OpenSim, a 3D viewer and the OAR file of "TN3D Island," this offered an interesting new option: A 3D learning environment could be duplicated with full functionality and distributed as a Sim-on-a-Stick to learners or collaborators for offline work on any PC.[45] Another option that came up was *Kitely*,[46] a new service and business model. *Kitely* enables the upload of OAR files and their delivery on demand from the Amazon server cloud, whenever a single user or a group of users want to login with avatars, gaining legitimate access with Facebook ID.

At the end of the process, TÜV NORD had saved much of the original 3D content created for Second Life and discovered interesting new options. Beyond that, there was no need to spend a significant amount of money to restore the full design and functionality of the Second Life installations on OpenSim, as public exposure would be reduced there, and browser-based access was an open question.

1.2.3.4 3D Standards: Being Set

In the meantime, standards were being agreed on for digital 3D on the Internet. The Khronos Group has settled for WebGL, German developers joint forces in the Emergent project funded by the government to make the best of X3DOM and XML3D. Collada's *.kmz* is about to become a ubiquitous 3D file format, similar to *.jpg* or *.tiff* for 2D images. This adds tremendously to the safety and sustainability of investments in 3D content, as Collada files can be used in Unity and most game engines, on OpenSim, in Wonderland, and even Second Life. As a result, more and more high-quality, professional 3D content is created and distributed via asset stores and 3D warehouses like those of Second Life, Google, and Unity; consequently, content prices will drop.

1.2.3.5 TÜV NORD: Expansion in 3D

TÜV NORD had started examination of tools available to bring its 3D project to the web in 2009. Now the 3D auditorium and *Training for Traffic* were chosen as a suitable basis to compare production costs, usability, and performance.

Simplified versions of the auditorium were created in Blender, Wings, and SketchUp, then brought to 3D environments including Unity3D—and even Google Earth (Fig. 1.37).

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45 http://simonastick.com.

46 http://www.kitely.com/-!home.

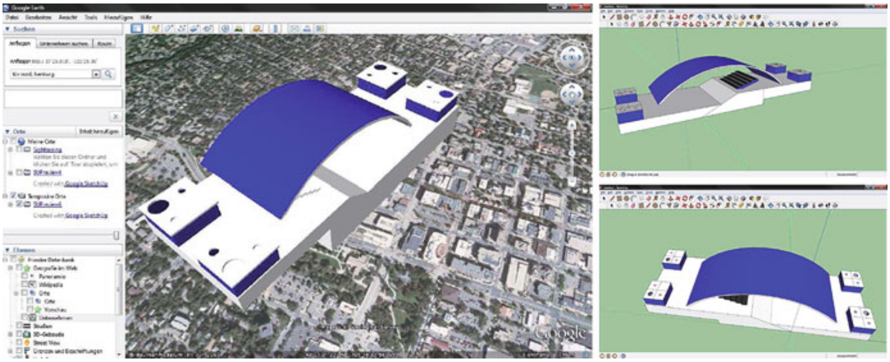

Fig. 1.37 Proof of concept 1: 3D auditorium demo created in SketchUp (*right*) and then placed in the virtual skies of Google Earth above the TÜV NORD offices in Hamburg, Germany (2009)

Local game professionals helped to draft a *Training for Traffic* adaptation in Unity3D. John Lester of ReactionGrid demonstrated how easy it would be to bring that up and present it in JIBE, and via JIBE, on the web. This was in single-player mode; but multiplayer would be no problem. Using an early version of BuiltBuyMe from *Tipodean*, a static version of the training environment could be brought directly to the web browser, but without scripts running.

Finally, BÜRO X Media Lab conducted a demo during which the Unity version was deployed and accessible on a page on *Facebook*; the case was made. The Internet was ready to incorporate virtual 3D environments and avatar-based, multiuser learning games. And the next innovation rush had only just begun (Fig. 1.38).

1.2.3.6 Overcoming Limitations

While Second Life's prim limit of 15,000 per region also limited its visual quality and immersive potential, 25–60,000 prims could now be had on many OpenSims, and the developers of Euclideon from Brisbane, Australia, having updated their "Unlimited Detail" 3D engine, presented a video demo with a single sculpted statue of an elephant featuring 530,000 polygons in unprecedented graphic detail.

While Second Life had made it hard to bring 100 avatars to one region without crashing, Intel Labs now ran the DSG stress tests with up to 1,000 avatars (Fig. 1.29).

Artificial intelligence has reached levels known from the science fiction movies of only a few years ago. IBM's Watson winning at "Jeopardy" is the tip of an iceberg on the verge of changing the way we play, learn, and interact forever.

A digital avatar that looks like one's self is something many professionals prefer at the virtual workplace. Creating such an avatar takes a lot of time, effort, and skills in an environment like Second Life. To add gestures and body language to a virtual representative, commands have to be entered on the keyboard, and the result is a laugh, a clap, and an expression of discontent in the form of a preprogrammed

Fig. 1.38 Proof of concept 2: *Training for Traffic* in web-based applications *Facebook* (*top*), *JIBE* (*bottom left*), and *Tipodean* (*bottom right*)

animation—many quite comicky, some close to ridiculous. Using voice chat, viewers could be set up so that the avatar's lips move, somewhat randomly, in Second Life. True lip-synching would look different—far more natural. But achieving this was miles down the digital 3D developer's road. Or was it?

Tremendous progress has been made creating and controlling personal avatars for work, play, and entertainment. From Cisco's elaborate 2D *Telepresence* videoconferencing and the transmission of 3D hologram projections in real time via Microsoft's record-breaking innovation of *Kinect* (a 3D camera for the Xbox 360), to the wireless *EPOC* headset from Emotiv—a brain-computer interface letting users control their avatar with the power of their minds, sensors picking up electric impulses generated when thinking (Eisenberg 2008). This is to further empower access and seamless navigation of 3D content. Steep learning curves and the usability of 3D virtual environments likely will not be a subject of discussion anymore. The special effects and games industries add to this development.

On top, Big Data and Open Data are about to bring strong demand for 3D visualization tools making it easy to see what is really important and support decision-making. 3D printers can be assembled for a few hundred dollars; with their help, digital content created in virtual spaces literally materializes in the physical world.

1.2.4 Going Public: Sharing Results

As TÜV NORD chairman Dr. Rettig had announced from the beginning, interaction with colleagues and knowledge-driven communities exploring virtual 3D environments was an important goal.

The TÜV NORD IN 3D project received invitations to numerous national and international conferences and events. Results were presented and discussed in various forms in the physical world, for instance, at the Queen Elizabeth II Conference Center (at Virtual Worlds London 2008), the Hamburg Chamber of Commerce (3D Web Information Day 2008), the Hamburg Business Club (Mobile Monday "E-Learning" 2010), TÜV NORD Academy Frankfurt (Opening 2010), or the University of Hamburg (EduCamp 2010).

An even wider audience was reached by means of new online media and at 3D virtual events. Master students at Argentine's Universidad de Córdoba learnt about the project in a web-based seminar using *Elluminate Live!*. German teachers were informed at a workshop session held simultaneously at the State Institute for Teacher Education and School Development in Hamburg and in Second Life. Participants of *Fernstudientag 2010*, dedicated to distance learning, joined a live tour of the virtual TÜV NORD fuel cell in Second Life.

Colleagues learnt about *TUV Nord* at VWBPE 2010, the *Virtual Worlds Best Practices in Education* Conference (Boerger and Tietgens 2010), at *The Virtual World Conference 2010*, held by the British Serious Games Institute on Open University's 3D facilities, or during the mixed-reality session "Avatars in Class," connecting audiences at Hamburg's University of Applied Sciences HAW and on the virtual *Campus Hamburg* during VWBPE 2011 (Tietgens 2011).

TÜV NORD was invited to be a part of the panel discussion "Virtual Worlds as Green Workplaces," hosted by the US Department of State's Office of Innovative Engagement (Fig. 1.39); a machinima documentation by Bernhard Drax recorded more than 5,000 views in its original and a German version on YouTube (Drax 2009). "Brennstoffzelle—Exploration Second Life—TUEV Nord," posted by master student Torsten Lex in preparation of his thesis at the University of Duisburg-Essen, had been viewed more than 3,000 times by the end of 2011 (Lex 2007).

Fig. 1.39 Presenting TÜV NORD IN 3D to international audiences in virtual and mixed-reality events, here: panel discussion hosted by the US Department of State (2009)

Corporate media such as TÜV NORD's own print publications *Explore* (for clients) and *Internord* (for staff) or *HSH Nordbank's Nordstern* contained information on the progress in the virtual worlds of the 3D Internet. In 2009, Linden Lab had started a series of success stories covering the international 3D projects of IBM, Intel, Northrop Grumman, Cigna, Loyalist College, Open University, NMC, NOAA, and others. Linden Lab chose TÜV NORD IN 3D to be their first success story from continental Europe. "Making the Real World Safer: TÜV NORD Group in Second Life" presented concepts, content, and results to media and the public in six languages all over the world (Linden Lab 2010) (Fig. 1.40).

CEO Mark Kingdon presented the case at CeBIT Global Conferences 2010 in Hannover, and Linden Lab arranged a round table with representatives of Goethe-Institut, Bayerische Staatsbibliothek, TÜV NORD, BÜRO X, and journalists in Munich. After 2 years with the press overly critical of virtual worlds and their potential, this was a turning point in media coverage and public reception. Media ranging from PR Report to Heise iX to national newspapers like Stuttgarter Zeitung and Die Welt reported on the productive use case of TÜV NORD IN 3D: "The hype is over, applications for business move in: TÜV NORD uses a secluded part of its Second Life presence for internal trainings and instructions." (Die Welt 2010).

As described in the introduction, the TÜV NORD project had gone public only after the media hype of 2006/2007 had turned negative. Still, the innovative character of the project was widely acknowledged by journalists who took a serious interest in the 3D technology and followed the development. In the German press, the TÜV NORD case soon became an example of a productive use of 3D Web environments, contributing to the image of the group as an innovative provider of technical services and STEM expertise.

CASE STUDY

Linden Lab

Making the Real World Safer:
TÜV NORD Group in Second Life

"Flying in ten people from Poland, Croatia, Turkey, Brazil, Hong Kong, Thailand and India for one training session can cost as much as US $37,800 for tickets, plus thousands of dollars for hotels, expenses and food, plus far more than 150 expensive hours spent traveling instead of serving customers."
– Frank Boerger, Head of Client Management, TÜV NORD

"As the number of experts we need to connect with worldwide is constantly growing, we've been searching for a less expensive and more flexible method for a long time."
– Nicole Sahn, Head of Notified Body for Pressure Equipment, TÜV NORD

Executive Summary:

Since 1869, when the company was founded in Germany to inspect boilers, TÜV NORD Group's unwavering mission has been to "make the world safer." Today, TÜV NORD Group has over 8,500 employees in more than 70 countries and a broad international client base for its unique consulting, service and inspection portfolio and management of complex safety solutions. The company's 3D presence can be found in Second Life by the region name of "TUV Nord". Since 2007, the region has been used for recruiting, meetings, game based education and other new ways to share knowledge. An ambitious long-distance training project produced a complete return on investment within a year. Now the company is ready to share the benefits of its extensive virtual development with clients.

1

Ausgabe 3 März 2010 www.prreport.de

PR REPORT

CeBIT & Co.
Deutschland ist Messeland. Die verschiedenen Standorte positionieren sich, der Wettbewerb um neue Themen hat sich verschärft

Controlling
Fast alle sind sich einig: Wirkungsmessung für Kommunikation muss her. Doch von konsequenter Umsetzung kann noch keine Rede sein

Computer
Umwerfend war für Apple-Sprecher Georg Albrecht das Medieninteresse am iPad

Zurück aus der Zukunft

Die Parallelwelt in 3D lebt doch noch – und will mit neuen Applikationen Unternehmen und deren Kommunikation beeindrucken

Fig. 1.40 TÜV NORD's own press releases, Linden Lab's case study (*left*), and other PR activities (*right*) lead to coverage of the 3D project in online, business, and mass media

1.3 Lessons Learnt

For TÜV NORD Group, the sincere exploration of the young 3D online media technology has produced a number of valuable results.

1.3.1 Evaluation

Second Life lived up to the initial expectation that it would provide a high-quality lab environment, at surprisingly low cost. One of the key projects—the 3D auditorium for virtual meetings and long-distance learning—led to savings on travel time and expenses which had already made up for a significant part of the total investment into the 3D project within the first year; ROI keeps improving with each workshop held in the virtual environment.

Prototyping interactive 3D simulations, larger-than-life visualizations, and game-based learning applications unveiled a vast potential to develop skills and share knowledge, in ways more engaging and effective than all media and methods known so far. The tremendous impact this will have on future marketing could be deducted from interaction with the residents' communities of Second Life.

At the same time, the Second Life experience made obvious the massive barriers to overcome before the benefits of immersive 3D technology can fully unfold. Second Life brought up the questions and helped to assess the answers, many of which were found during explorations beyond Linden Lab's platform; we have shared our findings in detail in this chapter.

Generally speaking, in early 2012 we find the virtual 3D ecosystems of Second Life and OpenSim to be strongly interdependent, more so than Linden Lab and the open source community seem to acknowledge. For TÜV NORD IN 3D, they provide a stable conferencing environment and a platform to create and test low-cost prototypes. There is still no single software available which offers as many possibilities as the Second Life 3D viewer and its third-Party derivates, including the tools for users to generate content.

In a corporate context, though, many of these features are too complex and time-consuming compared to traditional media and to other 3D online options. Recent game technology such as Unity3D alleviates these problems, enabling productive use of immersive 3D. Apple, Facebook, Google, Intel, Microsoft, and other large tech companies are pushing the development.

In the wake of the Second Life backlash, Gartner's forecast that 80 % of active Internet users would have a "second life" by 2011 was heavily debated; but at the end of 2011, it does not seem so far off. More than a billion accounts have been created in social media such as Facebook, Twitter, MySpace, and Google+. Most of them use some sort of 2D digital representative to support interaction, such as a photo or video images. Many are static, and some are not visual at all, but we still would consider them to be avatars. At the same time, 2.5 or 3D avatars, serving as interaction interfaces in virtual environments, have become ubiquitous among the young generation. In 2010, the New York Times—based on research by KZero[47]—reported: "Number of Virtual World Users Breaks 1 Billion, Roughly Half Under Age 15" (Watters 2010). Already, these are an important group of consumers—growing up to be the students and TÜV NORD customers of tomorrow.

A growing number of researchers and developers recognize the potential of game techniques and technology for education, training, collaboration, and communications. The *Horizon Report K12* predicts adoption of game-based learning in pre-college education will take place by 2014 (Johnson et al. 2011), and Gartner expects more than 50 % of organizations that manage innovation processes to gamify those processes by 2015 (Burke 2011).

1.3.2 Outlook

With entry hurdles coming down and digital media literacy on a dynamic rise, TÜV NORD sets out to further expand its 3D expertise. Some major learnings will have strong influence on future projects coming forth:

1. Corporate users come for content and collaboration; they have no time or interest to acquire complex media skills as a prerequisite to access a 3D environment. The 3D interface and navigation will have to be user-friendly, intuitive, and stripped

[47] http://www.kzero.co.uk.

of unnecessary features. Different toolkits fulfill different requirements; the right tool for the right job grants an immense potential for ROI.

2. As of today, the idea of avatar-based interaction is disconcerting for many people, especially in a working or learning context. Benefits compared to other media must be strong, convincing, and clearly communicated; trial of avatars must be well prepared and actively supported to help staff master the initial learning curve fast. But technology is rapidly facilitating the creation and control of digital 3D representatives, and their pervasion will hardly slow down: "Our brain is designed to thrive in a 3D environment full of embodied people and places. What we experience in a virtual environment feels real because our brain fills in the gaps" (Lester 2012).
3. Just like producing a TV ad or photography for an annual report, creation of high-quality 3D applications and learning content is costly. With technological standards being agreed on, investment can now be calculated against tangible business potential. Use cases can be identified, 3D benefits named. Existing data, 2D applications, and content can be incorporated, budgets set, and binding targets defined to measure success in comparison to traditional practice.

TÜV NORD Group will pursue the 3D project to build and bank on the extensive experience it has acquired and grow the competitive edge it has achieved. Corporate collaboration, trainings, and long-distance learning are in focus.

Web 3D technology is basically here. Its components are visible in beta applications, demos, conference talks, and patents granted, some of them distributed between competing tech corporations, others even within those corporations. We are witnessing heavy investment and 3D-related innovation in the ICT and entertainment industries, the general adoption of web-based interaction, and the spread of games and avatars fueled by social networks and mobile devices; it will not be long before the pieces fall together. The 3D Internet and interconnected mobile apps will serve as an open, augmented space for work and learning.

TÜV NORD Group is ready to be at the forefront of this development.

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Biographies

Frank Boerger (aka Boerger TUVNORD)

Frank Boerger has graduated in 1995 as an electrical engineer from Fachhochschule Dieburg (University of Applied Sciences), specializing in communications engineering. In September of the same year, he started working for TÜV NORD Group as a network and PC administrator. Since 2006, he holds responsibility for the Client Management Department with a staff of more than 40 employees, taking care of some 10,000 PCs and mobile devices in the group's international organization. Boerger had his first avatar in Second Life early in 2007 and has been Head of TÜV NORD Group's Web 3D projects from day one.

Hanno Tietgens (aka Xon Emoto)

Tietgens has been in publishing, advertising, and corporate communications since 1976, co-founding *Journal Frankfurt*, consulting multinationals like reinsurer Munich Re, the German Chambers of Commerce and public broadcaster ARD for *Das Erste*. Tietgens has won awards as a copywriter and creative director with TBWA, McCann and Baader, Lang, Behnken in the 1980s and with Büro X since 1990. In 2006, he started the Media Lab to explore the convergence of classical and digital media, focusing on social media, 3D learning environments, and avatar-based interaction. Supported by the City of Hamburg and the Hamburg Chamber of Commerce, Tietgens initiated *Campus Hamburg in 3D*, a collaborative space used by the University of Hamburg, HCU, HAW University of the Applied Sciences, MHMK, and others as a starting point in virtual worlds and for joint efforts of academia and enterprise in new forms of R&D. BÜRO X Media Lab has been consulting TÜV NORD on their knowledge-drivenWeb 3D project since 2007 and on their 2D Internet relaunch in 2009.

Chapter 2
How Linden Lab Built a Virtual World for Business and Education

Jean Miller

2.1 How Linden Lab Built a Virtual World for Business and Education

Many people wonder whether the initial development of Second Life included its impact on business and education. Did the visionaries know from the start that this new communications medium would influence how human beings could interact with each other worldwide? Science fiction literature has been cited time and again as the best description of a seamless virtual world with futuristic pizza delivery service (Stephenson 1992). Science fiction literature does not discuss corporate training programs or education within a virtual world. With the release of Second Life in 2003, an eccentric group of gamers, entrepreneurs, and academics broke ground and surprised its developers by pushing usage model boundaries. Linden Lab, the creators of Second Life, made a series of decisions around user[1]-created content and intellectual property law that turned the development of a virtual environment into the development of a virtual platform. The ability to exchange US dollars for the Linden dollar, the limited license object used to exchange virtual goods, would open up a new method of conducting online business. The relatively inexpensive ability to have a 3D space that did not require specialty software or extensive training provided a teaching and development medium for daring educators. These examples

[1] For the purposes of this chapter, I intentionally use the term "user" instead of the Linden Lab preferred term of "resident" because I feel the term "user" is easier to parse for the reader that is new to virtual worlds but has an understanding of online communities.

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illustrate the marriage between Second Life platform development, and businesses' interests and educators worldwide.

In this chapter we will discuss the early development decisions, whether intentional or reactionary, that supported education, internal development of businesses inside Second Life, and external businesses entry into Second Life. We will take a closer look at the notable examples in business and education that influenced development decisions and how organizational structure influenced business and education. We will discuss the evolution from the idyllic metaphor "building a country" to the more literal, "building a core platform." Between my own experience at Linden Lab,[2] integrating organizational literature, as well as interviews with several stakeholders that were part of the decision-making process during the last 12 years of development, we will have a greater understanding as to what led to the focus on business and education on the Second Life platform and what led to the change in focus.

Listing all the steps that Linden Lab took in relation to business and education so that they may be replicated or ignored in a new company would not be as useful as understanding why management took certain steps in development and why these steps were seen as important. I conducted nine recorded, semi-structured interviews (lasting 30–60 min) with former and current Linden Lab employees. I asked every interviewee one primary question: what are some of your memorable business and education decisions? I supplement this case study's timeline with the help of two authors, Thomas Malaby and Wagner James Au, and their invaluable commentary.

Linden Lab's decisions around business and education were weaved into its organizational culture. In order to understand the course of decisions that have been made from Second Life's inception, I believe its organizational culture played a role. Organizational culture is directly influenced by technology, markets and is defined by its founding leaders. There are three components of organizational culture: the relationship between the employee and the organization, the vertical or hierarchical system of authority, and the organization's vision from the perspective of the employees (Trompenaars 1998). Linden Lab was not only building a very different product with Second Life, but was also trying to build a very different type of company.

2.2 To Build a World

In 1999, Philip Rosedale decided to turn an idea into a reality, an idea deemed by many impossible from a technical perspective, lacking an audience if it was not a game, and that no one would ever use it. Mitch Kapor, one of Linden Lab's initial investors noted:

> So in the history of Second Life, I've been through multiple waves of skepticism about it. 'It will never work.' Philip had this radical idea that hadn't been done before about having an

[2] Full disclosure: I retain a financial interest in Linden Lab to date due to my employment. For this reason, I rely primarily on my interviews to give perspective and endeavor to present my observations analytically and fairly.

> infinitely scalable virtual world by centralizing the backend. [I]t had just not been done that way. Technical people said, well this isn't going to work. But that hurdle was overcome, and an existence proof was built in six months. Then there's the business argument, that people have tried these virtual worlds and they've failed. And it was true that at that point the roadside of the information highway was littered with the corpses of failed start ups in this space, [...] the preconditions of success were not there. The next thing we heard was that there's no market for online games. [...] this is not for regular people. 'I'd never use this.' It reminds me of other things I've heard people say. In 1995 I was showing people Amazon, and they would say I will never put my credit card information on the Internet. Well, we got over that one. (Wallace 2006)

As the story goes, what we know to be Second Life was not created from the beginning. In fact Rosedale had originally set up to build virtual reality hardware—but he needed a virtual world for the hardware. Building the virtual world was the secondary goal. By summer 2001, Linden Lab released the Alpha version of Second Life, which was originally called Linden World (Terangreal 2010). It was around this time that Philip Rosedale and Cory Ondrejka presented Linden World to a group of investors. During their presentation, a couple Linden staffers were in Linden World, as Wagner James Au describes in his book, *The Making of Second Life: Notes from the New World*, "... one Linden staffer was building a giant, evil snowman, while another was busy creating a mass of little snowmen, gathered around their titan Frosty to worship him. *This* everyone realized, was what made their online world unique" (Au 2008).

This investor meeting was a very important transition in Second Life's development. Thomas Malaby, a professor in Anthropology at the University of Wisconsin-Milwaukee and the author of the book, *Making Virtual Worlds: Linden Lab and Second Life*, points out, it was in this moment where Linden Lab went from building a complex self-organizing system where one could venture through in a natural landscape to building a platform for individual creation (Malaby 2009).

Closed Beta of Second Life began in November 2002 and went public in April 2003 (Terangreal 2010). In Beta, Second Life first started the beginnings of an in-world (in Second Life) economy, or more specifically, a flat tax around the development of objects "in-world" (inside Second Life). Linden Lab had also decided on a subscription based revenue model.

Subscription models were typical to in-game economies of the time. Everquest and Ultima Online had shown that online gaming with market economies could be very profitable when based around a subscription service. However these games were extensive and pre-built. Second Life depended on its users to create the content and there was no pre-existing game element in the world. In fact, for many employees, it was the platform for building games *on*. In 2005, Malaby observed first hand as an ethnographer that the developers at Linden Lab were working with Bedazzled, an inside Second Life developer, to make Unreal Second Life Chinatown, a first-person shooter game in Second Life. They felt the product would take off and that Linden employees felt that "[Second Life could] be a platform of both development and distribution of online multiplayer games" (Malaby 2011). What actually did take off around the same time, was a game called Tringo, developed by a user named Kermitt Quirk. Malaby could almost hear the creaking of the ship as Linden Lab switched gears in order to capitalize on Tringo (Malaby 2011).

By October 2003, Linden Lab had grown to a team of 30 employees that were highly involved in responding to the community. Though the users that participated in the tax revolt in Second Life felt that they helped cause the economic structural change, Second Life's user growth was flat. With flat user growth, the company realized that their subscription model was not sustainable without having to raise a huge amount of money (R. Harper 2010). Linden Lab subsequently laid off one third of their work force (11 employees) and decided that they needed to rethink Second Life's business model (R. Harper 2010). As with much of technological development, innovative ideas spawn out of other types of existing technology. As Robin Harper, former Vice President of Marketing and Community Development, points out:

> We started out thinking that Second Life was largely going to be populated by gamers. And so the early business model reflected the gaming business model, so the assumption was set, people would pay a monthly subscription. And then we would maybe layer in over that. (R. Harper 2010).

Many of the new employees came to Linden Lab from the video game industry, which provided a natural bias towards the initial business model assumption. Disc-based games, especially massively multiplayer online games at the time, relied primarily on subscription based revenue models. Additionally, the only products in the market that resembled what they were trying to build at all were video games.

First, they wanted to build a game, next they realized they wanted to build a platform to build games on, and then they realized they didn't necessarily need games.

2.3 To Build a Nation

Since they needed a unique business strategy, the leadership at Linden Lab decided to reach out and ask people for advice. Cory Ondrejka, former Chief Technology Officer, noticed early on:

> While building Second Life, there was a tremendous amount of knowledge that we didn't necessarily have in-house, from economics to urban planning, [...] monetary policy and fiscal policy. And so, in a lot of cases, it made sense for us to be reaching out to academics [...]. [I]t makes for a much richer collaboration when you're [not only] reaching out to the academy, schools, and individual professors because you have questions, but that the answers are going to have meaningful impact on a business, and then, conversely, that the project that you're working is something that is potentially useful to the academics involved (Ondrejka 2010).

In late 2003, when Second Life was in Beta, Linden decided to gather a group of "big thinkers" from outside of the company to discuss how to maximize economic growth for the company. Harper remembers:

> The people who came to this meeting were: Ted Castranova, Julian Dibbell, [...] (who moderated,) Lawrence Lessig, Mitch Kapor, Jed Smith, Philip, Cory, and myself from Linden

> Lab, Mark Louis from EA, and Bob Trager who was originally from EA. [W]e spent the whole day talking about what we should do and out of that meeting came this idea that what we were really trying to build here is a new country. Like you may have heard Philip quoted as saying, "I'm building a country." [I]f you look at a developing country, for example, there are four pillars that need to be in place that will drive economic growth. [Those] four pillars are the right to own land, the right to do whatever you want on that land and retain the ownership of it, the ability to monetize whatever you create and the ability to keep the reward. [They're] [. . .] the core of how capitalism and free societies work. [. . .] It's what the Internet is all about. Self-expression, creativity and ownership.

This was a pivotal moment for Linden Lab. They went against what every game company at the time was doing, which was suing consumers that created things and tried to sell them on their respective platform. In fact it is directly in opposition to where Sony was at the time with Everquest and where they continue to be with anything that is developed without expressed permission on their platforms (Torrone 2011). (Though more recently they have supported user-generated levels in their product Little Big Planet.) It was out of this "big thinkers" meeting that the tax system got repealed and a new economic system came into place. It was also the beginning of a long relationship with the academic community. In fact, even though the meeting of "big thinkers" of 2003 was an intentional meeting, Linden reacted to their comments in a very profound way.

Malaby's analysis as to how the new internal model was brought into fruition may have sounded well thought out in hindsight, but in reality it was a lot more reactionary (Malaby 2011).

Mark Ferlatte, former Executive Director of Web Software Engineering, saw the copyright decision and the creation of the Linden Dollar, as logical decisions, that were very intentional, very controversial, and supported business and education directly (Ferlatte 2011).

> Internally there was a lot of discussion around the copyright issue, because it put us under significant unknown risk. Because nobody had done it, so nobody knew what [. . .] was going to happen. The Linden Dollar, for the same reason, also had us under significant unknown risks, because [. . .] governments don't like things that look like competition for printing money. [We had] to be very careful about that. [E]ven though the Linden Dollar was not money [. . .]. Policy makers, seem to be a lot more comfortable with the concept [of] digital economics [as we've seen in our recent economic history]. (Ferlatte 2011)

For others, like Chris Collins, former General Manager Enterprise, a nation was exactly what Linden was building:

> With the Linden dollar, being a single transaction mechanism, [the fact that it] could go across borders really allowed for that. When you're in Second Life, you're in another country or another nation, and therefore, the ability to commerce with anyone is very easy to do. I ran the currency exchange for a year, and the fascinating thing with that is that I would equate that to running an actual real economy in that the one interesting economic difference that we had is that we were a country that had [. . .] an [uncontrollable immigration policy], because the population growth was the equivalent of people getting on a boat and arriving in the tens of thousands every day, which drove a lot of the economic activity and increased the economy. (Collins 2011)

In May 2004, Philip Rosedale said to reporter, Daniel Terdiman, that he was "building a new country" (Terdiman 2004). However, Malaby would argue that the notion of building a nation was not mentioned at Linden Lab during his ethnographic research from December 2004 to January 2006 and would not take hold in the company's philosophy until later. He explains:

> [Linden Lab was not] really coming from a place where they wanted to make a society. This idea that it's a nation, [. . .] I really [. . .] didn't hear that metaphor while I was there. I think that's very much a post hoc type thing. They made that shift to user creation, and then when it wasn't working, they made the shift to intellectual property rights. (Malaby 2011).

He suspects that building a nation-state or country became an organizational metaphor when Wells Fargo developed Stagecoach Island in September 2005 (Malaby 2011; Staff 2007). Wells Fargo wanted to be separate from the main grid or the common space that was Second Life. Malaby further explains:

> [T]hey had a very important decision to make. Did they want to let Second Life, [. . .] in pursuing these [. . .] corporate interests, did they want to let Second Life cleaved and shard, effectively, into all these leased out Second Life architecture domains, or did they want to keep everything in one world? [. . .] And it was at that moment where, as Philip at least described to me, he decided everything had to be on the grid. So that was where it did become one entity, and that sealed [everything] a bit more like boundaries of a nation, state or a country.

Part of this decision was due to a severe lack of resources at the time to build and sustain such an area. Additionally, this decision supported the "building a nation" ethos that everyone would reside in one contiguous nation. Linden Lab was already feeling severe technological pain points around supporting a separated Teen area and did not want to replicate them. The teen area (also known as the teen grid) presented legal concerns around the protection of children from adult content and the main area (also known as the main grid). Additionally, Second Life did not have the technical ability to implement those protections without making Second Life a terrible experience in the process.

2.4 To Build a Democracy

In the midst of exploring how to build the Second Life platform, Linden Lab was also exploring how to build a different kind of company. In Thomas Malone's book, The *Future of Work*, which was suggested to all Linden Lab new hires by 2006, Malone postulated that just as society has moved from centralized hierarchy to democratic decentralized systems with the increase in network technology, businesses also fall along the same continuum and were moving from traditional centralized systems to more democratic decentralized structures (Malone 2004). This fell in line with existing theories that organizational success would depend "less on the authority of the few and more on the judgment of many; less on compulsion and more on motivation; less on external control of people and more on internal discipline" (Hock 1999). There are very few studies on notable organizations that had attempted a truly decentralized democratic organizational system. Mondragon Cooperative Cooperation in Spain and Goretex are but a few examples.

In November 2000, years before Malone's book, Rosedale and Ondrejka provided the management foundation for Linden Lab. "We wanted a short-term, transparent progress towards tasks, flexibility, and participation of the whole team" (Ondrejka 2011). Employees were held publicly accountable for their projects by sending out a weekly list of Achievements and Objectives to the entire company. In February 2005, Linden Lab implemented a project management application called JIRA.[3] Through JIRA, employees were encouraged to vote on each other's projects to help determine priorities within the company. Though democratic process, such as this one, helps resolve conflicts of interest Malone also noted they tend to be very inefficient and this proved to be true as the organization grew (Malone 2004; Ondrejka 2011).

The second goal was to make interrupting and asking questions part of the organizational culture. Instead of isolating employees in offices, every employee sat in pods with several other employees, who more often than not were on another team or project. It allowed fellow employees to ask each other questions, which incited cross-functional learning about various projects within the company (in addition to reading everyone's Achievements and Objectives list). It created a culture of interdepartmental communication.

Glenn Fisher, former Director of Developer Relations, describes how interdepartmental communication provided a big win:

> I found, the more people I talked to, the better, internally at Linden Lab. In the old management, walking around style, I'd find somebody who was working on something arcane and I could say, "Gee, that's something that matters to developers, would you mind talking to developers about it?" And we'd set up a seminar and the [engineer] would discover that the way they wanted to implement it actually made it a totally useless function, but if they did something just a little bit differently then that suddenly made it really useful for people. [...] [There was one engineer who] was working on something for scripting and I happened to sit across from her one day at a rotating desk when I was [in town] and I was grousing about the developers and she said, "I'm working on that." And we went [...] and spent some time in the conference room drawing on the [whiteboard] and she ended up changing just a little bit and what she did ended up being – something that made a big difference to people. (R. Fisher 2010)

The third goal was that the key tasks were all up on a whiteboard and everyone would gather once a week to discuss and update the list (Ondrejka 2011). This bred a sense of responsibility to the tasks and to the rest of the company. Ondrejka further describes:

> [T]his system was completely transparent and gave everyone a voice, it was never "everyone just does what they want." [...] "Do what you want" didn't show up until the Tao of

[3] http://www.atlassian.com/software/jira/.

> Linden was written in 2006. [W]ithin this model, what you get is a many-to-many communication model, where everyone is talking to everyone. Those discussions were shaped by the global direction, and the clarity of direction and small total employee count meant that the communication overhead was manageable. (Ondrejka 2011)

The unique nature of Linden Lab's internal structure was an experiment in and of itself. Part of having a decentralized management structure is to allow for the voices of each employee, whether around a specific decision or the workings of the structure itself (Miller 2007).

Similar to Mondragon's Ten Official Principles, in 2006, Linden Lab codified a list of company principles that they designated as the Tao of Linden (Linden Lab 2006; Cheney 1999). The company principles were: work together choose wisely, execute well, be transparent and open, make weekly progress, no politics, have a sense of humility, have fun, call out inconsistency in principles when you see it, and do it with style (Linden Lab 2006).

The term "reporting" in this instance is "loose," while someone may be a supervisor or lead on a project, they did not give direct orders but rather recommendations. Linden Lab's aspiring flat management structure shared characteristics similar to that of "loose" hierarchies: dense communication, lack of centralized control, and freedom of choice (Malone 2004).

From previous interviews that I conducted with Lindens, one interviewee had this to say:

> Give people the opportunity to make informed choices about what they should be working on and then execute on those choices with as few people as necessary tasked with monitoring those choices. (Miller 2007)

In this sense, Linden attempted to build a direct democracy within the company where every employee/citizen was capable of making a substantial contribution with as little overhead as possible, an entity very much like the virtual world they were trying to build.

Part of building a nation includes building a government and in this vein, in 2004, Linden Lab asked its users if they were interested in self-governance. The users were less than enthusiastic. In 2005, the company introduced a voting system in which a very small fraction of the Second Life population participated (Au 2008). Au describes the events in greater detail and compares the users to Americans:

> [The user's] collective sense of Second Life is reminiscent of Americans' relationship with their country: deeply patriotic to its ideals on an emotional level, eager to rally in its defense when threatened by external forces – but come most election days, still not likely to show up at the polls. (Au 2008).

In this sense, many users wanted Second Life to be something behind the scenes that kept the servers running and interfered as little as possible.

In late 2007, Rosedale referred to Linden Lab as a public utility, which fell perfectly in line with the “building a nation” metaphor. At the time, Linden Lab was frantically trying to keep up with its rapidly growing user base so the self-perception of being a public utility for this greater world was appropriate. Malaby, however, explains that it was indicative of a deeper issue:

> That was a way to try and resolve this paradox of authority that Linden Lab was inevitably caught in, where they wanted the world to organize itself, they wanted to tell people they have all the agency they ever need, but yet they could not get away from their own enormous and incontrovertible control. [...] When central authority is a problem, you start casting about for metaphors, and that one of the public utility is something like that, something that is needed by everybody, provided by a central source, but is not a competing interest. All it does is facilitate creativity on the part of individuals and groups. So yes, that was [...] consistent with that sort of struggle.

Linden Lab struggled with it’s own internal pulls for decentralized management and centralized control. Decentralized leadership assumes that everyone can be a leader if they have enough information to make educated decisions. However not everyone has the ability or the authority to make certain decisions and even if they did, they don’t always want to (Malone 2004).

The challenge was allowing those who could manage to be able to work optimally while providing structures that leveraged strengths and capabilities of those who did not. One employee noted in 2006 that, “we need middle management, but we need to do it in a way that works with Linden culture” (Miller 2007). Linden Lab struggled between allowing good leaders to lead and good followers to follow and yet not fall under the expressed concern that Linden Lab was centralizing it’s structure. However, as another employee observed in 2006, “we definitely have a hierarchy at Linden Lab, whether we really acknowledge it or not” (Miller 2007). Some decisions, such as opening registration to the public in 2005 and no longer requiring credit cards, were seen by some employees as a top-down decision. Other decisions, such as open sourcing the Second Life client, went through extensive discussions which became an "example of how [Linden Lab] brought the whole company into the process of [making] a decision that impacts the whole company (Miller 2007).

2.5 To Support Education

After the meeting of the “big thinkers,” Linden Lab announced at the academic State of Play conference in 2003, that any Second Life user could retain their intellectual property rights on the objects they created in-world. Ondrejka remembers the turning point:

> That series of announcements was really the first tip for Second Life. [...] We went from a couple thousand users to many thousands very quickly after that conference and generated a lot of great early users, both in the academic and non-academic communities from that. (Ondrejka 2010)

The Linden Dollar decision and ecosystem of in-world developers, that came from that decision had a secondary effect on education as Ferlatte noted:

> Second Life for educators would be significantly less rich if they had to [build] all the content and experiences that they wanted their students to have on their own. [T]he fact that there's a seamless and inexpensive way for an educator to get access to content that supports the lesson that they're trying to teach is [. . .] an important feature.

When Harper came to Linden Lab in 2002 from Maxis, the creators of Sim City, she spearheaded the foray into education based on her previous experience:

> [At Maxis] we noticed that we were getting requests from teachers for black line masters they could use in their classes. So after exploring that a little, we created school editions of Sim City and then of several other games that were also simulations that were used in the schools. [W]e sold them for grades five through college. People wanted to use the simulation as a way to teach all kinds of things. And so I knew that with the right sort of game you could build a market, a very lucrative market in education. [After speaking to Anne Beamish], I knew education was going to love Second Life. (R. Harper 2010)

After Mitch Kapor spoke at a conference at MIT, he introduced Anne Beamish, a professor at the University of Texas to Harper, and when Second Life was still in Alpha, Professor Beamish brought ten students from her architecture and urban planning class into Second Life for the summer. Ondrejka remembers it fondly:

> When the UT Austin architecture and urban planning students staged their "flying is bad for the social fabric of Second Life" protests and were writing long diatribes on the forums and building walking paths and making the argument that if you just had to walk everywhere, Second Life would be a better place. It was this first great moment of taking a bunch of bright, energetic students who have a whole bunch of theoretical opinions about urban planning and give them this amazing chance to actually run with those ideas and take them to a logical conclusion in a different environment than reality.

From this spawned the beginnings of Campus Second Life in 2004 (Linden Lab 2004). Campus Second Life provided free access to islands for educators. Free access drove a number of educators to experiment and push the boundaries of the classroom, which caused a proliferation of early education stories at academic conferences that brought in dozens of universities' involvements.

Linden Lab started to take their relationship with educators seriously. Seriously did not mean, "Hey, we'd love for you to advertise Second Life, but we're not going to work with you. We're not going listen to you. We're not going to do anything with you or for you" (Ondrejka 2010). Linden Lab dedicated a significant amount of resources and manpower to education and in retrospect why would they not support the community that brought them the business-changing ideas that made Second Life what it is today and brought in its first influx of users. Malaby observed:

> They were sending people to all kinds of conferences, random conferences, and small conferences, GLS, State of Play, sending people everywhere! They were sending someone else to all industry conferences. [They were] carpet-bombing the landscape, not just the industry landscape, but the scholarly landscape and the educational landscape and all these things, just to see if anything [would] stick! (Malaby 2011)

Linden Lab made an unprecedented decision when they switched to selling land instead of subscriptions and thereafter instituted a 50 % discount on land for educators and non-profits. John Lester joined Linden Lab and started the Second Life Educators List (SLED) where educators had their own listserv where they were able to share best practices and support each other.

In the following years Linden Lab provided a platform for educators to showcase their projects especially during the Second Life Community Conferences. Linden Lab also highlighted their work in case studies, on blogs, and in the news-letter, which in some cases brought global attention to their academic project in Second Life. They also had dedicated staff specifically focused on the educational community. By 2007, there were over 5,000 educators worldwide in Second Life.

2.6 To Support Business

"There was no viable way to have a business inside of a virtual environment, without building your own environment, which I think was the key bit" (Ferlatte 2011), Ferlatte observed. One aspect of Second Life that was inherent from the beginning was that Linden Lab relied on their users to create content, and they needed to provide incentive for the user to create. As previously stated, the incentives were the rules around intellectual property as well as the creation of the Linden Dollar. Ferlatte felt that one very important decision was mapping the Linden Dollar to the United States Dollar. He states:

> [T]he thing that we did that was important was map it to the U.S. dollar at a market rate instead of at a fixed rate, which meant that we were taking the risk along with the businesses operating inside of the platform. When we succeeded, they would succeed. And if we failed, or if they failed, we would fail. (Ferlatte 2011)

Many of the tools within Second Life that inherently supported in-world or in Second Life-only business development were not obvious when they were implemented. At least, they were not obvious to the ethnographer who was working at Linden Lab at the time but would probably be referenced by any Linden employee in hindsight as completely intentional.

> The fact that streaming music and the importation of poser animations, scripting of animations, both were added in the same patch long ago – those things were randomly in the same patch! No one at Linden Lab saw them as having any relationship to each other, but the fact that they come in together and someone [could] stream, and people [could] post, create[d] the dance clubs that were such a feature and still are a feature of Second Life landscape. So all of that was very unplanned, very accidental, and that's really more of the story in my opinion about the development of Second Life as a business and its application, than anything else. (Malaby 2011)

Some decisions were much more obvious, like the acquisition of the XStreetSL marketplace in January 2009, as Chris Colosi, former Monetization Manager at Linden Lab, describes it:

> At the time [Virtual Trade LLC (before it was acquired)] was doing maybe around $100,000 a month in business and I'm proud to say that over the next couple of years we grew that to where it's doing about $1.5 million USD a month. And that was truly just enabling businesses in world. It is a business to business and a business to consumer marketplace. (Colosi 2011)

Another side of the business ecosystem is the developers. Some exist primarily in Second Life but others include marketing firms doing work in Second Life. Linden Lab developed a strong relationship with the developer community, through personal interaction as well as showcasing their projects. Fisher described working with developers:

> The two sides of the job were trying to recruit and direct the external audience [to developers] and making sure the right things happened inside [Second Life] to further what the audience was trying to do. Ranging from little things like knowing what happens when two prims[4] intersect, because that occasionally would change and then it would break things that people would build or God knows what else would happen. [. . .] The large part of it was spent in the early days trying to find the right engineer who knew the right thing to try and twist his arm to get him to do it.

The other side of business was business from outside of Second Life coming in to use Second Life, like the Wells Fargo example mentioned earlier. Private sector businesses or government institutions had very different sets of requirements than your based in Second Life only business. Linden Lab started to call external organizations coming into Second Life "Enterprise." One Linden reflected:

> [S]o many big people were walking through the door wanting to do a special relationship, and those special relationships came with [. . .] cash, and Linden being able to really stand by their principle of what they were trying to achieve [. . .] frustrated a lot of people, and maybe looking back you may think, "Well, we should've done something with that person and not with that person," but [instead] it meant that anyone had the same opportunity to do something that someone else did, which really created [its] diversity. (Linden 2011)

Some of the complaints from Enterprise were:

> "You guys aren't helping us enough," and [. . .] well, we don't. We specialize in the technology, but [. . .] for a lot of organizations and educators the firewall had been an issue, but that [is] compound[ed] by 100, [. . .] for the [government], because there's no opening ports. So, being able to work with them and work out ways that we could get the technology in their hands was really cool. (Linden 2011)

Linden Lab dedicated a team of 22 employees and resources to supporting the development of Enterprise.

[4] A prim is a single part object in Second Life that you can attach to other prims in order to create different kinds of objects. It is like a building block.

2.7 To Support Direction

The organizational changes from 2008 to date are reflected in the decisions around business and education. In early 2008, leadership at Linden Lab suffered decision paralysis. This could be attributed to many different reasons but the biggest complaint from Linden employees at the time was that there wasn't any direction. Now, up until this point, Malaby observed that Linden Lab was:

> [M]ore responding and reacting to what's happening in the world than leading the way. Instead, the company knowing that and deeply aware of that, were casting about with enormous amounts of connections, enormous amount of energy in all-different directions. (Malaby 2009)

At that time, Linden Lab was under the weight of all the directions they had created and had a very difficult time deciding on what to prioritize. Like many democratic institutions this caused a gridlock in productivity.

In the summer of 2008, Philip Rosedale stepped down as CEO and Mark Kingdon stepped in. Kingdon was CEO for 2 years in which time the organization changed dramatically in method, scope, and in composition. The most public change was the 30 % layoff that occurred in summer of 2010, which did not account for the 20 %–30 % reorganization that occurred the year before.

For many employees who had worked at Linden Lab before and after the regime change at Linden Lab, this marked a definitive changed in the organizational ethos. The Tao of Linden was changed in 2008 to reflect the renewed organization. Most notably, "Your Choice is Your Responsibility" was changed to "Good People make Good Choices... and vice versa" (Nino 2008). In the 2 years that followed, Linden Lab moved into a centralized hierarchical structure. In hindsight, it was an intentional reaction to the gridlock in direction, which instigated a move to a more centralized leadership structure. In this reformed organization, being "intentionally reactionary" was no longer rewarded and neither was "failing fast or failing publicly" (Malaby 2009). The organization found that it needed to focus on getting things done instead of trying to get everything done. Malaby observed:

> It was a very high-cost strategy early on, in terms of [keeping] your ear to the ground like that, and to be looking, and to be expending all that manpower and time to sort of be out there and see what people are doing that's interesting that you could promote. Yeah, that's expensive, so the bureaucratic response is to say, "Well, we can't justify that, we can't justify letting 1000 flowers bloom anymore, so let's do it differently. Let's retreat." (Malaby 2011)

Linden Lab made very specific strategic decisions. One major decision was that instead of releasing updated versions of Second Life on a regular basis, they would follow a more traditional software model and scheduled a major release one year later, called Viewer 2. This was the first time in Linden Lab's history that a version release had taken a year.

Internally, a product team was built and instead of judging the needs by how loud people yelled, the product team said, "these are our list of priorities." Fisher would then go to the developers to get feedback on the list (R. Fisher 2010).

In 2008 the leadership decided to direct some of their focus to developing "SL Enterprise." They were, in a way, revising Rosedale's "Everyone's got to be on the grid" decision for Wells Fargo in 2007, but at this point in time, they had more resources and more technological ability to make it happen. It was a product that could reside behind a firewall, which had been a stumbling block for years as organizations around the world only started to understand cloud computing. However, what made SL Enterprise more valuable than that was that it was a way an organization could have a more official relationship with Linden Lab. This project would provide tools for educators such as the ability to integrate with their internal directories and provide administrative accounts, as well as providing the support and privacy that government institutions and certain private enterprises need (Nino 2009).

Claudia L'Amoreaux, former Director of Education Programs, describes the development of SL Enterprise for educators:

> What was really exciting about that was that there was this incredible effort going on into creating a next generation product from scratch, which was really hard to hack together in Second Life at the time because there were so many other priorities. [H]ere was this kind of development of a new product where we really looked at what's needed and where education was really seen within business, rather than business is over here and education over here. It really was seen together [. . .] and that they shared needs. (L'Amoreaux 2011)

Collins spoke about the development of SL Enterprise for the Department of Defense:

> [T]hey loved it! They could start to do the things that they could only really experiment with on the public grid, because for them it's – it's not so much can we lock down an island [rather that] they are not allowed to do various training activities unless it's on their network. They can see that the training aspects of a virtual environment are a huge part of what you can do. And to be able to have an immersive training application that can be a shared experience and that a soldier can do from their home is huge, 'cause, one, they can spend more time with their family, and two, they're getting an immersive training experience that could save their life or someone else's life. (Collins 2011)

Another goal for Second Life Enterprise was to develop a marketplace to help ease searching for Enterprise content.

> [W]hen you went into XStreetSL the e-commerce platform, there's a category for business, which if you were an educator and thought I need to go and check out business, it was often not the kind of business that they were looking for. So, we were doing a lot of work around how can we give them a place within the whole ecosystem where you can more easily search for the kind of business that you want (Collins 2011).

In November 2009, Linden Lab launched "SL Enterprise" which was what external business and education had long been waiting for. L'Amoreaux described it as, "the most beautiful thing around at the time" (L'Amoreaux 2011).

2.8 To Support the People

SL Enterprise had a great team that delivered, but it was a constant battle as Collins remembers:

> [T]he challenge was being careful to say we're not doing something that's super special for these individuals, that what we were doing [was] building tools that reflected the principles of expanding the way that people can create things. So, Second Life Enterprise was basically Second Life that could run behind a firewall, so it was just expanding who and where people can grow content. (Collins 2011)

In August 2010, it quietly came out through the community that Linden Lab was going to officially end SL Enterprise. There has not been any official press release. Based on my interviews, there were mixed explanations internally, "you talk to a few other people and Enterprise was profitable and was going to be profitable. If you talk to other folks they'd give you the exact opposite" (Linden 2011).

Or others felt that it was a missed opportunity:

> For me I always actually wanted to go after Education and Enterprise even if it didn't make sense monetarily, as an introduction of Second Life, in a way that commerce [. . .] couldn't take hold. And I felt like we had a lot of people who saw that and understood that vision for a long time. Then we kind of lost that and all of a sudden Enterprise and Education became strictly a monetary benefit versus loss question. (Linden 2011)

Or that the decision was made without taking into account the process:

> [O]ne of the things I've seen is that the grant process is often a two year process. [A] couple of things, one, it takes you a year just for people to recognize your name and another year before people trust you in that market. And that's basically [the] Enterprise market. So you need to be in the market and at all the conferences for two years before anyone is going to consider licensing from you. It's not because your software might not be great, but basically it's a CYA[5] strategy. If they buy into you and it's your first year and it fails, they're going to be on the chopping block. [. . .] So you know there was also a business estimate and an assessment made at Linden Lab that things weren't profitable and you know it's possible that was the right decision, but it's possible that within six months that would have been a very profitable endeavor. [. . .] The other thing is that by leaving that market after we went into it we probably can't return, certainly not anytime soon. Just like you need to build up your credit over a couple of years they also care about stability. (Colosi 2011)

Most importantly though, it ran counter to the new centralized organizational model whose focus is on "building a core platform" as one interviewee observed:

> [T]hey couldn't continue supporting [the] product because it was splitting the company basically into two companies and there wasn't enough – that the company really couldn't afford that, to split themselves into two completely different models. And it really was a very different model. (Linden 2011)

In October 2010, Linden Lab decided to rescind their 50 % discount to non-profits and educators. Several of my interviewees believed that it was unfortunately

[5] CYA is an acronym for cover-your-ass.

handled poorly: in how it was announced, the reasons behind it, and the lack of any overt tapering off plan. However, the resounding belief was, "[Linden Lab] couldn't really support the education community. So if they charge what they need to charge, well [now] maybe they actually can" (Linden 2011).

And what was often missed in the headlines, "Linden made [some of] them really sweet deals, like really worked with them [...]. If they signed their contract they wouldn't have to pay anything extra for a whole year" (Linden 2011).

This had caused an uproar within the community, in which Linden Lab's response was as follows:

> Ultimately, we made the business decision that as we focus on improving Second Life for all users, we will no longer provide the level of special treatment previously offered to educators and nonprofits, which includes ending the 50 % discount these organizations have received. (Nino 2010)

This harked upon a mantra that existed for many years within Linden Lab and Second Life as well as certain democratic institutions—that everyone would be created equal.

Gwyneth Llewelyn, long-time user and writer, eloquently described how the community won the fight for equal rights in Second Life (Llewelyn 2010). "Those content creators not only survived the 'corporate invasion'—they won the battle" (Llewelyn 2010).

Fisher reflected on the developers and the community:

> [A]s the community tended to fight any efforts to give some people better service or more value than other people, the reality is economics flows downhill and you need to identify your key people and treat them well, because if they stay there then they create a lot of value for everybody else. (R. Fisher 2010)

In spite of the increase, educational land holdings continue to increase. As a new educator joining Second Life today, you would not know that the price was anything else than what it is today. Even with all of the concern, in practice, the increase in price has had no effect so far (Ferlatte 2011; Colosi 2011).

At the end of 2010 into the beginning of 2011, Linden Lab closed Teen Second Life and merged the teens onto the main grid. Sixteen and seventeen year olds will have access to the main grid but have adult content restrictions while 13–15 year-olds are only allowed access if they are affiliated with an organization in world and are restricted to that organization's land (n.n. 2010).

L'Amoreaux and I called this project the Holy Grail since 2006. As L'Amoreaux explained:

> [T]here was [a] tremendous [amount of] work that went into [that]. [F]or the whole time I was at Linden Lab, we were working towards solving the teen issue. Number one: how to make that work. It was such a complicated set of problems and challenges. It had to be done in stages, and [...] opening the adult continent was one very significant stage in that direction. [...] And I don't think people realize outside of the company what those of us inside the company realized, what a tremendously impossible mission that was. You do what you can and it's painful to have to make the choices that companies have to make on what you can realistically throw your weight behind. (L'Amoreaux 2011)

Ferlatte had an entirely different perspective on the teen merger and felt that it was part of a "sequence of trying random things to see if they stuck" echoing Malaby's sentiment (Ferlatte 2011). Depending on the employee, decisions were made either intentionally or reactionary or sometimes even randomly. I disagree that any of the decisions at Linden Lab have ever been random. However, I do believe that the decision to merge the teen grid into the main grid falls under supporting the people.

2.9 To Build, To Support

Building an innovative technological platform for an ecosystem of business developers and educators is not an easy task and that though everyone has 20/20 hindsight, the reality was a lot more hectic, agile, and fluid. We as humans, and particularly a human institution with "interests at stake, will tend to, in hindsight, construct a more coherent narrative of its past than ever really existed (Malaby 2011)."

After sitting down with Lindens, whom experiences span from the moment of launch to the present day, we get a sense of a greater ideological organizational conflict. Linden Lab was trying to build a nation in the form of technology as the company strove to be democratic and decentralized. Just like running a country, Linden faced many of the same challenges. Problems that were in some ways unexpected for a software company were in other ways very well known to those who have built a country.

In many ways, Linden Lab, in "building a country," fought and continues to fight many of the same struggles that plague the reality of actually building a country. Do you help the individuals of your nation, or the consumers of your product, or do you help private organizations in order to promote the economy's health or educational institutions in order to help make your community a better place for your consumers and for future generations? As Linden looked at Google Lively's untimely demise and said that "yes, virtual worlds are much more difficult to build than you think," I suspect that many countries' governments would look at Second Life and say, "yes, building a country is much more difficult than you think."

As citizens of our respective nations, we struggle with the best method for prioritizing our resources. Second Life and Linden Lab mirror many of these same issues, and further study could be conducted to see if the issues correlate from technology to organization to state.

In the course of my interviews, I also wanted to find out whether the decisions around business and education were intentional or reactionary. Malaby and Au agreed in essence, that though hindsight may be clear, whether it be in 2005 or in 2008 respectively, organizational reality proves to be much more chaotic and reactionary due to its organizational ideals and its history, respectively.

Malaby states:

> This practice of architecture embraces an approach to control that trades the promise of total order for a different ethical position, one that attempts, imperfectly, to reject top-down decision-making in favor of embracing the indeterminate outcomes of social complexities. (Malaby 2009)

Au writes:

> It emerged through accident and afterthought, and numerous decisions of blind faith and intellectual daring, many of which went disastrously wrong and most of which still seems, even in retrospect like desperate improvisation. (Au 2008)

Malaby alludes to this concept in our interview and I would rephrase that, Linden Lab operated as an "intentionally reactionary" organization.

As Ondrejka comments:

> When we reinvented the economic system that was clearly in reaction "to". I think that changing the [intellectual property] rules was a decision "for." I think that what nobody outside the company can understand or probably even really believe is how much time was spent inside Linden Lab worrying about how to do things that would be right for the community and right for the residents, which doesn't mean that mistakes aren't made. It doesn't mean that some of the decisions aren't harsh ones, but I think it is the nature of that kind of relationship where you have one company that's a for-profit business building a bunch of features and technologies. (Ondrejka 2010)

I would also further the argument that being "intentionally reactionary" is a symptom of having a decentralized, democratic organizational structure and that when the organization shifted to a more centralized hierarchical model that the side effect was that it could no longer be "intentionally reactionary" in order to be more focused. Additionally, when the organization's ideals shifted from "building a nation," where supporting enterprise, and education was a priority, and moved to "building upon the core platform," it was also indicative of its subsequent refocus to building its user base. The organizational ideological restructuring has dictated Linden Lab's path of decisions.

Was "intentionally reactionary" effective in getting things done? Was it more creative though a lot less focused? Did the later hierarchical software development model get as much done as it had planned? Did it get more done than its decentralized democratic predecessor? And if so, did they get the right things done? Does an organization have to trade innovation for capital efficiency, stability, growth, and focus on the bottom line?

In June 2010, Mark Kingdon stepped down as CEO and Rosedale stepped in as interim CEO. In December 2010, Rod Humble stepped in as CEO. Rod Humble comes from EA, the world-renowned gaming company. What direction will the new CEO Rod Humble take (Linden Lab 2010)? Will Linden return to some of its original inspiration in games and become a game development platform? Will Linden find a new development path between games and software? Are they going to tackle the innovative and the unknown or are they going to focus on known markets and sources of revenue?

Whatever organizational model Linden Lab continues with, the development decisions made in the last 12 years for business and education had its appropriate place and time within Second Life's organizational history. Any institution, whether it is a private technological start up or a government entity, with goals to innovate find themselves in search of a new organizational paradigm. As Malone aptly observed, "Figuring out how to combine decentralization and centralization is still more of an art than a science" (Malone 2004). Linden Lab experienced this first hand. Linden Lab uniquely attempted to build a nation with their technology, Second Life. Though we are left with many more questions, Linden Lab continues to proves to be a valuable research case for organizational development, software development, as well as being the notable creators of Second Life.

2.10 Afterword

The one thing that was consistent through all of my interviews was how at one point each employee at Linden Lab was inspired by Second Life, and I leave you with some of their stories:

> For me one of the things that really sealed it for seeing the potential for education was [during an event at Linden Lab]. [...] Someone who was involved with astronomy at Linden Lab actually set up a presentation. [W]e walked in and we went through the explosion of a star essentially, what occurs in the different phases. And the minute he started, he went from describing it, to putting it in a three dimensional sphere that you could circle your camera around and have it expand and seeing the size difference in 3-D and it just clicked for me how there was just such a different level of understanding that you could gather. But even myself who had read about those things, I [hadn't] quite grasped certain things before, [but in Second Life] it was just instantaneous. So that was pretty neat. (Colosi 2011)

> [The] biggest thing that kind of made me go aha, this is a possibility, was going to visit the Sistine Chapel that Vassar College built, to [...] facilitate their arts education. And that was brilliant. That was, for me, one of the most brilliant uses of unique technology to create a unique experience [...], [that] enhances something that you already know. I think the reason why it was so memorable was I remember looking at art history textbooks and you always got to Sistine Chapel and you open the book and it had it all there, but you always were trying to figure out what's where and how's it work, and because they talked about how it's all this unified experience, but they couldn't represent it on 2D page. So unless you went there, you couldn't have that experience. And this was the closest thing that I ever saw to being able to be there and understand it in context and – so I could imagine teaching that class in Second Life. (E. Harper 2011)

> [A]nother great thing that I saw out of the DOD is that they have a conference called GameTech [...] every year. [They hold a contest, called] the Virtual World Federal Challenge. Anyone can enter it. They pick a topic. I think this year is artificial intelligence. I think last year was training and simulation. It's in Second Life, and because it's in Second Life, anyone can get involved. Because of the way the development tools work, it's quite easy to build or collaboratively build with people maybe not in the same physical location. And when I was there two years ago, while I was still at Linden, the finalists were all in a room, showing off what they created, and one of the finalists was a 15-year-old kid that had been on the Teen grid that was one of these classic stories where had built out this amazing training simulation for firefighters where he made the building, he could set it up so the building would catch fire, that you had a hose, and you had to move in with people. And it's one of those stories where what's incredible about this technology is that it really promotes such

> amazing entrepreneurialism, because you can just go in there and have a go. And I remember talking to the organizer of the event who was telling me the story about this individual, saying that they didn't initially know how old he was, because you see this thing and you think, "Wow, that's amazing." They'd flown him down and his mom came with him. And it was one of those [moments] for her as well, she was thinking, "He's just spending a lot of time on the computer." I don't know if she actually knew what he was doing. Then, she says, "next thing I know, I've got the Army calling me up, saying, "This is really great training application for firefighters. Your son's a finalist," so it's that kind of community that I think that was quite incredible to see [...] when I was there. (Collins 2011)

> [One training] story about the importance of perspective on what's being negotiated was about baseball. Where a $3 million shortstop, in the context of most baseball owners was ridiculous, because shortstops weren't seen as very valuable players. And what [this trainer] did was turn it around and say from the perspective of a player when pitchers are earning $15 million, here's what the shortstop does for a team and therefore they're worth more than the half million that they're currently being paid. And so he's telling you this story and you're standing in a baseball box up above a baseball field and down below there are the players on the field and in the real world you see a slide of that and it's a very sort of distant thing that serves to provide a visual reminder but that's it. [In Second Life] you're in the environment and there's almost a physical sense of being present in the baseball field. This was two and a half or three years ago when I saw this training. And I can still tell you what the first three steps are of his training. I can't remember any real world meeting or training I've been to in the last four years even in the last three months but I remember that one! And I think it's not an accident I think it very much speaks to the power of being in a virtual environment where you can create an environment that helps tell the story and engage people. (R. Fisher 2010)

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Biography

Jean Miller (aka Jean Linden)

Jean Miller holds a bachelor's degree in Foreign Service from Georgetown University and dual master's degrees in Global Media and Communications from the London School of Economics and the University of Southern California, Annenberg School for Communication. She was the former head of German Market Development for Linden Lab and led the initial development of International initiatives. She is currently founding a mobile software company when she isn't consulting on digital organizational strategy.

Chapter 3
3D3C Real Virtual Worlds 2010: Definition and Visions for Researchers

Yesha Sivan

Dr. Grace Augustine: Is the avatar safe?
Jake Sully: Yeah it's safe. You are not gonna believe where I am!
From the movie Avatar (J. 2009)

3.1 Motivation: Preparing for a Long-Term Paradigm Shift

Around 1990, a disruptive technology—the Internet—emerged. New businesses like eBay, Amazon, and Google that embraced the Internet in innovative ways thrived. However, companies like Tower Records, Barnes & Noble, and Rand McNally, who failed to embrace the Internet early, were less fortunate (Tower folded, Barnes & Noble missed the online business that now belongs to Amazon, and Rand McNally failed to capture the online mapping business).

Circa 2008, another disruptive technology—smart phones—emerged. A new generation of mobile phones, led by the iPhone and Android brands, changed the communication and application markets. Apple, the leader of the field, and Motorola, leader in embracing the Android operating system, are winning. Nokia and Microsoft are losing. Thousands of application developers are harnessing the value of the new market of smart phones.

Every 10–20 years we witness a technology shift, comparable in magnitude to that of the Internet or smart phones. Such paradigmatic shifts can break older firms, reshape entire industries, and create enormous value and wealth. Missing such a shift, however, could be detrimental to businesses and IT suppliers alike. Consider the shift from mainframe computers to mini computers (which IBM missed and

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Digital captured), from mini-computers to PCs (which Digital missed, and Compaq captured), and from PCs to the network computer (which Microsoft missed and Google captured).

I maintain that Real Virtual Worlds will—in due course—offer such a paradigm shift. What we see now (2010), with Second Life, World of Warcraft (WOW), Club Penguin, and more than 100 other worlds, is just a beginning. In comparison to the Internet age, we are at the "Gopher" stage (Gopher was a pre-browser method to view hyperlinked materials).

I use the adjective "Real" to distance virtual worlds from the gaming worlds. "Real" hints at a much far-reaching potential. While clearly, today virtual worlds are used mostly for games and fun—Real Virtual Worlds (which I will formally define later) have the potential to alter our lives. (Note: for the sake of brevity, I will use virtual worlds or simply worlds.)

The timing of full impact of virtual worlds in not yet set. We observed a spike of interest in 2006–2007. 2008–2009 were more social in nature, with Facebook-like technologies catching our attention. The years 2009–2010 (now) seem to be more mobile in nature with smart phone technologies at the center of the public's focus. The release of the movie Avatar in 3D, the growth of 3D TVs, and the emergence of phone-based augmented reality seem to re-push the field of virtual reality. In any event, time is ripe for research to explore the field and suggest policies, technologies, and applications that can make use of the field and/or advance it.

3.2 Background: Second Life as a Case of a Real Virtual World

The young field of Real Virtual Worlds has its roots in two fields: virtual reality (Burdea and Coiffet 2003), for a review of augmented reality see Bimber and R. (2005) and for gaming worlds see Bartle (2004), Alexander (2003, 2005), and Taylor (2006). Other related fields are also affecting the virtual worlds ranging from economy (e.g., of virtual goods), sociology (nature of communities), and law (copyrights and ownership) to biology (new brain-based human–computer interfaces), computer science (performance, reliability, and scalability), and mathematics (algorithms for 3D rendering and animation).

Second Life (SL) is the first World that fully demonstrates the potential of Real Virtual Worlds. During the last 3 years, I have explored this world, visited places, made friends, reviewed technologies, and used it as a research ground. In short, I confess to being biased by my own experience [see, e.g.,Sivan (2008a)].

SL was conceived in 1999 by Linden Lab as an implementation of the Metaverse[1] (this term is often used in professional circles to denote Real Virtual Worlds). Any user may install the software and create a three-dimensional character for

[1] The term "Metaverse" first appeared in 1992 in a science-fiction book named Snow Crash by Neal Stephenson. The Metaverse was described as a three-dimensional world in which human characters spent their time, played, worked, and lived. In Stephenson's words, "the Metaverse [is] my invention, which I came up with when I decided that existing words (such as 'virtual reality') were simply too awkward to use" (Wikipedia 2007).

him/herself (aka “avatar”), adjusting features such as the shape of his body, skin, hair, and lips. (Note: “he” and “she” may both be used hereafter to denote both genders,) He may select to wear a hat, shirt, or skirt, and add rings, earrings or nose rings. After the body is constructed, the user may purchase a car, a plane or a yacht; he may build a room, an apartment, or a castle. He can meet people, robots, or dragons.

At first glance, many view SL as a game—a direct descendant of games such as Sims, WOW, and Doom. Veteran users will probably recall the worlds of Dungeons & Dragons and other paper-based fantasy games. Indeed, many of the action patterns and techniques of SL resemble these games. This is a good starting point. But the rest is far more profound and meaningful, exciting, and scary. The interaction of avatars, the believability of what you see, and the fact that everything is connected with real money all create a new level of experience, a kind of parallel world, a different world—a Real Virtual World. This is a world where anyone can choose his/her own life-style and actions: from a life of hedonistic leisure and entertainment to a life of lucrative work and creativity (in the real world).

Pepe is one of these avatars. She is a dancer at a nightclub. Her figure, her blonde hair, and her fluent speech (with a Spanish accent) make her very popular among visitors to the club where she works. Pepe hired a fashion consultant, who matched her looks and clothing to her career. Thus, her blonde hair was matched with her police shirt, which bears the letters “SLPD”—an internal joke that means Second Life Police Department.

Pepe is in the center of a human, social, and commercial enterprise, which also includes dancers of both sexes, DJs, club owners (who rent out private rooms to visitors), landowners, landscape designers, building contractors, architects, lighting experts, and musicians (Fig. 3.1).

What, in fact, makes SL a Real Virtual World? Let’s consider Pepe’s story (as an example):

- Pepe and the club she works in have a three-dimensional representation (**3D**). The users can zoom in and out, pan, and explore everything from the texture of her shirt to the coil in the lamp that is located 10 m above her. While Pepe moves herself, other users can roam around the room.
- Pepe can dance on the stage, because she belongs to a group of dancers of the club (**community**). Groups allow several users to act together in the Real Virtual Worlds, to buy land, to work, to get certain permissions, etc. While at work she uses the group of the club; when she shops at the Canimal fashion store, she uses the Canimal group ; while she studies English, she is part of a small group called English as a Second Language (ESL) for Spanish-speaking people.
- Pepe is both a creator and a beneficiary of other creations (**creation**). She creates by mixing and matching her outfit, the color of her skin and her hair, her jewelry, and her shoes–all of which were created by others. She can also buy furniture for her small county house and arrange it. With the right permissions, she can also create a garden for herself. With adequate programming skills, she can program the flowers in her garden to grow, or just buy the growing flowers from someone who has those skills (Table 3.1).

Fig. 3.1 Pepe—policewoman or dancer? (sample avatar)

Table 3.1 Different worlds viewed by the 3D3C Prism

	Sample worlds	3D	Community	Creation	Commerce
1.	ActiveWorlds	***	*	***	(per case)
2.	Club Penguin	*	*	*	*
3.	Google Earth	***	*?	*** (SketchUp)	?
4.	IMVU	***	***	**	***
5.	Second Life	***	*****	*****	*****
6.	Sony Home	*****	**?	**?	**?
7.	WOW	*****	***	*	*

Key: * = very low ** = Low *** = moderate **** = high ***** = very high

- All of her actions for work, fun, learning, or relations rely upon an economy that connects the virtual world to the real world (**commerce**). She can make money by working at the club, she can pay for her house, she can make money by selling flowers, and she can pay her English teacher.

The claim of this example is two staged: first, the combination of 3D, and 3C (community, creation, and commerce) defines a new medium. Second, as Real Virtual Worlds become more 3D and more 3C, we will fulfill the immense potential of the medium.

3.3 A Formal Definition: 3D + Community, Creation, and Commerce

Let's formally define Real Virtual Worlds as an aggregate of four factors: a **3D World**, **community**, **creation** and **commerce**. [For a longer review of 3D3C see Sivan (2008b)].

3D world: This is a dynamic world where viewers see objects like avatars, houses, and cars. The world has land, a sky, a sun (or maybe more than one sun), wind, gravity, water, and fire. Avatars move around freely (e.g., in SL you may fly up to a height of 200 m). The user can further examine the world from different points of view (roaming camera).

Community: Man is a social animal. Unfortunately, during the past century we gradually distanced ourselves from socializing—mainly through the advent of television. We sat alone in front of the screen, watching passively and without much interaction. We did not react, we didn't create and we couldn't see how others felt or reacted. The web actually enhanced this feeling of "isolation" (in a manner of speaking). Then emails emerged, followed by the "chat," the cellular phone, SMS,—and multiplayer worlds. So we are now actually returning to the community, to friends to people. Amazon began this trend by allowing readers to review and recommend books. Later, companies like YouTube allowed users to upload video contents. Moreover, of course, we have blogs (which include comments), social sites such as Facebook and MySpace—the ultimate in this genre where anyone may create a personal site to communicate with his friends. (Please note—all avatars in SL represent real users. There are no computerized avatars as in regular computer games such as WOW.)

Creation: Second Life's greatest invention and technological achievement was in giving users the capability to develop their own "things" (or in SL jargon: objects). In fact, the entire contents of SL (barring a few sample and demo objects) were created by users. Constructing objects may be done at several levels—first, by moving pre-constructed objects from one place to another (i.e., rearranging furniture in a home, or setting up a nightclub). Second, an object (i.e., a house) may be assembled from basic components such as walls and ceilings, followed by "painting" them with various textures. These basic components, called primitives, allow the construction of complex objects at a very high level of precision (see the SL example of Suzzane Vega's guitar, which is made out of more than a hundred primitives). Linden hit the nail on the head when they built a programming language (LSL—Linden Script Language) into the world. LSL allows users with programming abilities to endow their objects with behavioral attributes. As a result, we can see fish swimming in schools, a game of golf, pistols that shoot, and even Pepe's dancing. Largely, these are expansions of the capabilities found in worlds such as Sims, combined with industrial CAD software packages.

Commerce: Linden has created a new currency—the Linden dollar (or L$, for short). There is a defined exchange rate between the Linden dollar and the US dollar—in 2008 one US$ was worth about L$265. The entire economics of the SL world is based on this currency. The credibility of this economy is built on two levels—one conceptual and the other technical. At the conceptual level, Linden established and operates its own exchange. Within it, Linden guarantees the exchanging of L$ to US$ immediately and at any time. For instance, if Pepe earned L$2,600 from tips, she could access the Linden web site and exchange them for about US$10 which would be immediately transferred to her real account. Going the other way, if Pepe needed L$6,000 for a new hairdo, she could immediately buy them for about US$20. At the technical level, Linden has currency and commerce integrated into the game. For example, every object can have purchase ability and price.

Ultimately Real Virtual Worlds stem from the **integration** of the **3D**, **community**, **creation** and **commerce**. Second Life reveals the emergence of this integration. In SL you'll find a price for objects, permissions (i.e., an object may be restricted from being sold), and ownerships. The commerce is structured into the world itself. For example, let us assume that we enjoyed Pepe's dancing (and her Spanish accent) and wish to tip her. We point to her and transfer money to her by clicking a button. If Pepe wants to buy a new blouse, she goes to the shop, points to the blouse of her choice, and buys it for L$2,000. The blouse is defined as a unique object in this world, and Pepe will not be able to copy it. The shopkeeper will receive L$500 for the blouse, and the blouse manufacturer will receive L$1,500 (in accordance with a previously defined business agreement between them). At the end of the month, the shopkeeper will pay rent to the landowners, also based on a predetermined agreement.

This integration of a 3D world–organized and managed communities, immediate creation capabilities of objects and services, and a virtual commerce which actually becomes real—is the basic allure of SL in particular and of Real Virtual Worlds in general.

Next, using the 3D3C framework, let's examine typical worlds. These worlds represent a spectrum of worlds; they were selected to highlight various aspects of the 3D3C definition and not because of their impact on the field. [An earlier version of this table was first presented in Metanomics, a virtual broadcast, hosted by Bloomfield in 2007 (Sivan 2007; Metanomics 2011).]

- WOW is the most popular multi-user game with more than 10 million users. WOW has relatively good 3D graphics. Since it is centrally created, the graphics delivery can be optimized. Creation, is relatively limited, (you can select your avatar and dress it, but you cannot change the environment). Real commerce is limited. I noted one star ("*") because while users cannot buy WOW gold for real money in the game, they can buy it on the Internet by paying another player to send them money in-world.
- IMVU is a chat world merged with MySpace-like personal pages (acronym can be read like Instant Message with a View). It does not allow your avatar to walk

around; you move from one scene to another. In many ways it is a limited world compared to WOW or SL. Still, it is 3D (only 3 stars)and has a strong community infrastructure (with groups, group chat, friends, and people who visited my page capacity albeit without permissions) and real money commerce—where you can buy and sell money; to buy and sell IMVU cash, see, for example, Anshex.com (2011).

- Club Penguin, now part of Disney (it was purchased for US$700m in 2007) is a kids' world. It does not have 3D representation, but rather employs a 2D approach. It has no ability to use currency. Club Penguin is included here to demonstrate that you do not have to be a 3D3C real world in order to be successful (Eldon 2007; Disney Corporate 2007).
- Second Life is a prime example of a full 3D3C world. It now has "full" (more than 3) stars in all the factors. Graphically it is less powerful than WOW, although the addition of reflective water and amazing skies in mid 2008 brings it a step closer to four stars. (Note: new Graphical Processor Units emerge from the likes of Nvidia and AMD-ATI, coupled with better 3D algorithms. We should expect the graphics to improve continuously. The number of stars should be adjusted to the relative market conditions.)
- ActiveWorlds is a platform for worlds and not a specific world. ActiveWorlds is used to build worlds, so the "rule" of each world is determined by its owner. It supports 3D and some of the features needed for community, creation, and commerce. It is really for the world owner to make a decision as to how to use the various factors in their world. ActiveWorlds is active since 1998 in this field (Active Worlds 2008).
- Sony Home for the Sony PlayStation 3 is a relatively new addition to the realm of virtual worlds. I am unsure about the ability to program objects and commerce. Note that if Sony Home turns into merely an arena for playing games (as some of the previews suggest) it will lose its ability to "play" in the area of virtual worlds.
- Google Earth is here because—in theory—it can become a virtual world or an infrastructure to build and run worlds. With SketchUp, Google's simple and free editing tool, one could easily create 3D objects. We are still missing structured community and commerce, but third party tools as well as Google tools like "Open Social" (for community) or Checkout (for commerce) may close that gap. (Google's latest foray into the field was Lively—an avatar-based 3D chat system that looked like IMVU. Lively was subsequently discontinued.)

In this initial and cursory analysis, I have outlined some of the intended qualities of the 3D3C factors. The factors are designed to be comparative (i.e., how the 3D of WOW is compared to the one of IMVU), *relative* (i.e., IMVU did not have many social features when it started; as it progressed it gained more stars), and explorative (i.e., Google SketchUp is an option for creation).

This analysis also reveals some of the limits of the 3D3C factors, as they do not fully uncover the intricate nature of the field. We did not cover physics (the inherent ability of the world to support physics which, e.g., means that objects can fall to the floor—yes for SL, no for ActiveWorlds); voice communication/interface; and so much more. The 3D3C definition is designed to be a top-level starting point.

3.4 What Will Drive Virtual Worlds into the Future?

From the economical perspective, Real Virtual Worlds enjoy both a growing *supply* and a growing *demand*. The supply side stems from a more affordable and powerful technology. New advances in graphics processor units (GPUs) coupled with new interfaces like the Nintendo Wii, 3D engines like Havok Physics, and abundant high bandwidth, are bringing Real Virtual Worlds closer to the personal and enterprise user. At the same time, the demand is growing from both the young and the old. On one hand, we have younger, messenger-crazed users, who crave the interaction, and on the other hand—perhaps more importantly—we have the older folks who have more time, more money, and a need to express themselves.

The supply and demand forces will bring Real Virtual Worlds to the masses in terms of acceptance, cost, and value. At that point, the combination of 3D, community, creation and commerce will continue to boost the innovation within the industry. The immersion of the 3D world, the engagement of the community, the ability to express and innovate that stems from creation, and—most critically—the ability to gain from it economically (read: with real money) is what will propel Real Virtual Worlds ahead (Fig. 3.2).

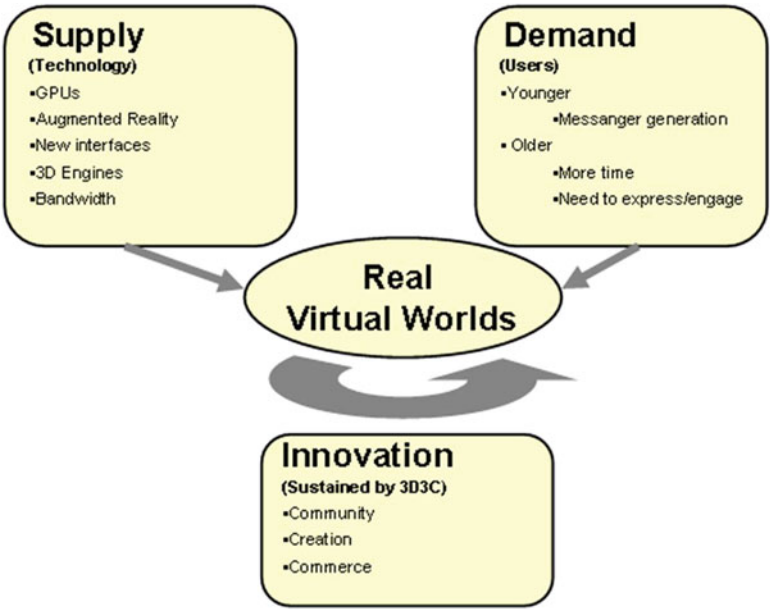

Fig. 3.2 Supply, demand, and sustained innovation for Real Virtual Worlds

With technology acceptance and advancement, we will enjoy a constant stream of innovations, creations, services, and products. Things like art, medicine, learning, and shopping will be enhanced by virtual galleries, home treatment clinics, learning kiosks, and family-owned stores.

However, there is one major roadblock to this vision: lack of standards. On the Internet, we were able to overcome this block with a well-oiled open system of standards that facilitates innovation and growth. We were unable to overcome this block in the gaming world where major game companies have their own systems. There are several open-source projects aimed at creating open virtual worlds (OpenSim, Croquet, Sun's virtual worlds). Linden, the maker of Second Life, is working with IBM and other firms to allow open worlds. I am personally involved with a Philips-led project to develop MPEG-V, a more formal approach to a standard for connecting real and virtual worlds (Gelissen 2008).

3.5 Visions

Let's examine a few examples and study the 3D3C factors in action, and highlight some of the IT dimensions of the scenario.

Virtual Physical Therapy: John is a 75 year old male who had a stroke 5 years ago. Since then, he has been using his virtual home as a starting point for rehabilitation, fun, creation, and productive work. Initially, John was devastated. He could barely move his left arm and left leg. After 2 weeks of intense physical therapy, he continued his therapeutic regime at home. Using remote sensors and actuators (much like the Wii remote, and the Wii fit system), he was able to exercise his body. When he started visiting a local virtual club, treatment became fun—exercise turned into dancing to Trance music.

What We Need: To fulfill this vision we will need Nintendo Wii like sensors and actuators. We will also need better interfaces that do not involve a keyboard or a mouse. Something more direct that will be able to capture our input directly from our minds would greatly enhance the experience. We will also need recognition of the value embodied within the virtual healthcare community. A key factor is allowing people to think about virtual worlds as a place to be and not as a game.

Virtual Schools: A few months later, John met Jane. Together they developed the J&J English school. John and Jane designed an immersive virtual school for English language. Each object in the school can "talk" in English. They designed various student-student and teacher-student experiences. They have three regular classrooms where students can sit and watch their teacher on a video screen. They also have a special testing room for SAT (they had to buy that room). Each student who takes the SAT in the J&J school has to pay them (John in turn pays back the College Board, the owners of SAT). With full tuition, students get their own room that includes various items they have learned about. These rooms are often a place for conversation between students and alums of the school. In fact, there are more than 20 different J&J English schools. They all act the same, but are managed by different schoolmasters from all over the world. John has learned that hiring teachers is a key factor. Each teacher turns the school into his or her own. John and Jane focus on the infrastructure; the teachers focus on the actual teaching. They share the revenues from the students.

What We Need: Today learning is one of the top industries in Second Life. For the first time, educational institutions of all sizes can enjoy a common place of learning and allow synchronized learning. I have personally used SL to teach Executive MBA courses at Bar-Ilan University in Tel Aviv. Students use virtual worlds as a simulation to start small businesses, to work with technology developers and to feel almost real. Note that the commerce factor is critical for the J&J school system. The ability to run a franchise, where the firm maintains quality and standards and the local managers own the customers, is still missing. Classic ERP firms like SAP and Oracle will need to fill this gap.

Virtual Concerts: Once every 2–3 months John and Jane enjoy virtual concerts. In February, Live Nation Vcon hosted Madonna. John had to wait in line, for 2 h to get the ticket. Of course "wait" has a different meaning—"experience" is more like it. The line included meeting old friends and viewing clips of previous concerts. The unique thing about Live Nation Vcons is the fact that you get to experience the concerts with your friends. In essence, a Vcon allows up to a 100 people to "assemble" in the same place. The concert lasts 8 h. It starts with a couple of movies, a few earlier shows, and a simple get-together party. The concert itself is streamed to various virtual halls. Each visitor gets to pick one song (as part of the ticket). Together John and Jane have already accumulated 24 Madonna songs. John has traded old Bee Gees songs for some of Madonna's old songs that he missed. His collection is proudly exhibited in his summer home in Vir Italy, Toscana Island.

What We Need: This vision seems like the next step for Apple iTunes to take. We are still missing many technologies here. First the ability to have more than 20 people in one place today is a major problem in all worlds. This critical problem is a very difficult one because each attending avatar means that its data need to be streamed to all the other avatars. This causes exponential growth in bandwidth and, with growing attendance, becomes a major computation challenge. While there are some theoretical techniques to solve this (like turning crowds into flat backgrounds and calculating their look and feel once in the server) these are all theoretical solutions. Another set of challenges stem from linking mirror worlds (like virtual Italy) and fantasy worlds (the place with the school resides). Both Google and Microsoft's efforts in this direction are quite impressive.

Virtual Shopping: Dan, John's older son, is about to turn 50. It is a good time to buy him a present. John is eager to buy his son something special: a car. John teleports to the nearest Toyota dealership (nearest to his son's residence). While all showrooms are similar, John wants to connect early with the service provider that will maintain the car he intends to buy for Dan. Using the virtual showroom, he builds an initial version of the car. He calls it "Dan's Eagle." He selects the various options. The initial design of "Dan's Eagle" is almost done. John can now view the virtual car. It is delivered to him seconds later. John invites Dan for a preview. Dan is excited; he reviews the design and modifies it a bit. The price changes according to the features he selects. When all is done, Dan approves the order. John and Dan both get a virtual copy of the car. The actual car will take a week to ship.

What we need: The ability to produce a joint design in 3D is already in place. An Israeli company allows you to post your picture on the web and design your own Yogurt cup. However, such efforts are sporadic and tend to be marketing-oriented. We need a full scalable system that involves many aspects—mostly human ones—to allow for this joint car design scenario.

Virtual Races: The monthly trip is about to start. John is ready. He has the maps set up, the goals, and the targets. John and Dan are ready for the game. Vrace, is a monthly competition that connects Dan (in the real world), and John (in his virtual home). Together they are given quests. They will win if they combine real and virtual know-how. Dan's Eagle is equipped with four cameras—one for each side. At any given moments, John can see exactly where Dan is. Using his GPS, John can tell Dan where to go. Jane helps with cracking the clues. She is using 3Dpedia.

What We Need: Vrace is a totally new product. A participatory sport that allows people to merge real and virtual worlds. This is not only a game but also an entire culture that will connect people of all ages. Today, most heavy users of Second Life are in for fun. They build, dance, and tour because it pleases them—this is a "lifestyle" trend that could use Real Virtual Worlds.

Conclusion: You will notice that many of the scenes presented here can be done today. In fact, some companies are already doing it. The challenge lies in the cost of integration. To accomplish the above scenes today, one would need heavy investments in infrastructure, servers, clients, user training, partner training, etc., all of which will probably make the effort a theoretical experiment.

However, assuming the infrastructure is already there: the 3D world, the community tools, the creation ability, and the built-in commerce—the cost vs. value equation starts to make sense. The key is the integration of 3D, community, creation and commerce—all under the same system. When we accomplish this standard level of integration, opening up businesses, setting up services, and enjoying the virtual worlds will be as easy as setting up a blog site today.

3.6 Conclusion for Research

Lastly, I want to point out five key challenges for research. These challenges, which I consider critical to the future of virtual worlds, stem from a preliminary analysis of the Metaverse (Metaverse 2010) ITEA2 EU project.

ITEA2 is an industry-driven, pre-competitive R&D program that brings together partners from industry, universities, and research institutes in strategic projects. The Metaverse1 project was designed to provide "a standardized global framework enabling the interoperability between Virtual worlds (as for example Second Life, WOW, IMVU, ActiveWorlds, Google Earth and many others) and the Real world (sensors, actuators, vision and rendering, social and welfare systems, banking, insurance, travel, real estate, and many others)." (Note: some of the outputs of this project were included in the MPEG-V standard mentioned earlier in the chapter.)

The 3-year project, which started in 2009, created the opportunity to look at virtual worlds from multiple perspectives. The following five research challenges, present my personal take. I believe these five challenges are critical and thus should be tackled by academic and industrial research. By sharing these challenges, I hope to instigate further research:

1. **The interface challenge**: One of the key innovations in personal computers was the invention of the mouse. Together with windows (be it the Xerox, X, Apple, or Microsoft versions), the mouse was the hardware side of the interface. Action like click, double click, and drag (and technically mouseup, mousedown, etc. on the software level) allowed new modes of operation. In a more modern example, iPhone commercialized the touch interface with actions like zoon, pinch, touch, touch, and zoom. Virtual worlds lack a standard method (with or without a device). Each world has a somewhat different combination of commands. Mastering these commands is often difficult and causes a relative long learning curve before the user feels the value. Even worse, moving from one world to another calls for yet another set of commands. The key question is what would be the combination of hardware and software needed for virtual worlds.
2. **The money challenge**: In 2007, I had an opportunity to discuss "money" in virtual worlds in an open-source meeting that took place in a virtual worlds conference. The participates were mostly technical people who develop various parts of the OpenSim project. When I raised the issue of money, I was answered in the following way: "money is a layer that should be added after the system is done." We already had this approach when the Internet was conceived. The combination of pure engineering focus, which does not value commerce, and the somewhat "protective" system of banking that enjoys hefty commissions did not allow—till this day—for a universal and common payment system. Starting a commence Internet site is still complicated. As noted in the 3D3C definition, I believe the full value of virtual worlds will be materialized, if it include commerce. We can clearly see the value of such built-in commerce in the relatively small economy of Second Life, where commerce in the form of products and services both within the virtual worlds and in the real worlds flourishes. Many people who use virtual worlds for educational goals (e.g., for teaching) artistic goals (making movies aka machinima), and therapeutic goals (e.g., for trauma treatments) use subcontractors in the virtual worlds. A true global 24 economy is occurring within Second Life. The money challenge also has to do with taxing issues that may differ from country to country as well as some checks and balances to deal with money laundry and other illegal activities. The key question is: what factors do we need to include and where to enable global the C in the 3D3C virtual world?
3. **The dependency challenge**: One of the key benefits of the Internet is the ability to trust it. As a user, I can go to both Google search and Bing search. I can get my news from CNN or Wall Street Journal; I can use email using outlook or using Gmail. We have choices. Furthermore, we can often "save" our work locally and move it from one supplier to another. We do not have that in virtual worlds. A virtual product or a service is often locked within one world. Often such worlds

simply end (see Google Lively, There.com, or Metaplace). Second Life's content creators are often lamenting the inability to move items from the official Second Life grid to the more open Open-Sim based grids. The key question is how can such a trusted, robust, Internet-like system can be develop that will sustain the 3D3C factors. (Note: there are several examples to closed trusted system including Microsoft XBox, WOW, and—of course—the more generic Apple's iPhone ecosystem. Weather the "ultimate" universal virtual world will be more like the Internet or more like Apple iPhone is yet to be seen.)

4. **The identity challenge**: In an earlier work (Sivan 2011), I have lumped together a set of related issues under the term identity. These issues include, for example, privacy, security, authentication, anonymity, adult content, rights, and copyrights. Examples includes how do we balance anonymity, a key value of virtual worlds, with the need to prevent grieving; how do we protect dressmakers from the theft of their textures; how do we allow software code (which is an integral of content) to run without taking too much energies from a particular server; what happens to an avatar when its own die. The gist of this challenge relates to the yet-to-be-solved interaction between these issues. The key question here is to take our real world—less than perfect—identity structures and bring them to the virtual world, then enhance them to match some of the new challenges. Note that such questions are not technical in nature; it has to do with what we value and what do we want to enable. Once we define that, the technical needed components could be developed.
5. **The many avatars challenge**: One of the key technical challenges to virtual worlds can be seen in Second Life "40-avatar-per-island" limit. Say you are a firm that organizes an event; once about 40 people have arrived to your virtual island, it is practically blocked and no other avatars can go in it. For example, a DJ organized a party and could *NOT* get into his own party because there were too many avatars already in his island. The key question here is how to allow for more people to participate in the same event. Contrast this with a web site that allows thousands of people to participate. You will note that in a real world we also have a limit to the number of people we can interact with at the same time, be it a party. In a large stadium, you interact with just a small percentage of the thousands of people you see. The main challenge is to develop the correct mental framework and supporting technology to solve this challenge.

Researchers like us, who tackle such challenges and other ones, are uniquely positioned to shape the future of virtual worlds. Good designs that include long-term considerations—both technical and social—will allow virtual worlds to better our lives. I look forward to much needed research work in this area.

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Biography

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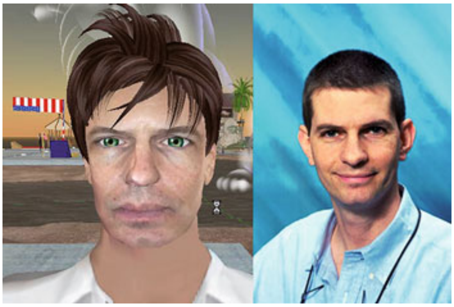

Prof. Yesha Sivan is the head of the Information Systems Program (http://is.mta.ac.il) at the School of Management and Economy at the Tel-Aviv-Yaffo Academic College (http://www.mta.ac.il). He is also the founder of Metaverse Labs (MVL)—a leading think tank focusing on connecting virtual and real worlds. Prof. Sivan professional experience includes developing and deploying innovative solutions for corporate, hi-tech, government, and defense environments (see, e.g.,: the Harvard 9-Keys for Knowledge Infrastructure). He published numerous papers in the areas of strategy and IT, knowledge, 3D3C virtual worlds, and standards. Prof. Sivan received his doctorate from Harvard University. His avatar is Dera Kit, and his blog is http://www.dryesha.com. He has taught EMBA, MBA, engineering and design in the areas of strategic value of IT, the emergence of virtual worlds, and software development in virtual worlds.

Part II
Social Dimension in the Use of Virtual Worlds

Chapter 4
Second Life as a Social Environment

Tanja Adamus, Axel Nattland, and Lars Schlenker

4.1 Introduction: The Social Significance of Virtual Worlds

Up in the first years of the new millennium the third dimension in desktop computing applications was a domain of virtual reality and computer games. Their real-time action and richness of detail was subject to strict requirements. Since a few years three-dimensional online worlds are available via local client and broadband internet connection thereby giving path to the third dimension into online environments for the first time. Early online role-playing games, such as text-based multiuser dungeons (MUDs), have been developed to a vast number of representatives known as multiuser virtual environments (MUVEs) that have their roots also in online games.

The difference from online games, however, is the lack of narrative plots and the associated play goals (Warburton 2008; Poitzmann 2007). In comparison to online games, social interaction in MUVEs is opposed to not inherent objectives aimed at, but will take place independently of it (Schroeder 2008). As a result, persons are involved not as players but as users (Bartle 2003).

Compared to online games MUVEs are referred to as social spaces or social platforms (Schroeder 2008; Warburton 2008; Baker et al. 2009). These online environments include Second Life, Metaplace, Habbo Hotel, Sims Online, and, to the end of 2009, Google Lively. If one focuses on the possibilities of Second Life as a social space, questions arise about the design of this space, the support of social interaction, and the impact of spatial design on social interaction. Three main

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characteristics of virtual worlds seem to pave the way to use it as a social space. Virtual worlds are attributed a high degree of immersion. A deeper immersion in the situation can increase the intensity of social interactions. Furthermore, the improved perception of social presence is a decisive factor. By the representation as an avatar in three-dimensional spaces, signs of spatial and social proximity can be experienced and shown more clearly than in two-dimensional communication tools. Finally, the technical characteristics of Second Life have potential for a shared social space. Since the environment can be created by users themselves, there is the possibility of active influence on this space and thus the cooperative co-construction of the environment.

4.2 Constructing Sociality: Second Life as a Meeting Place for an Online Degree Program

The Duisburg Learning Lab at the University of Duisburg-Essen organizes the online master's program Educational Media. This study program can be completed part-time; it takes four semesters and leads to a Master of Arts. A key feature of Educational Media is that it is an online program. Participants only meet twice a year in Duisburg. The study material is provided through a learning management system.

Students work together in small learning groups and collaborate on group tasks. For each group the learning platform provides an asynchronous, text-based forum and a synchronous virtual class room. Students are encouraged to build up a community and to interconnect through social software. They run blogs or twitter and are connected on Facebook and share links through social bookmarking services such as Delicious or Diigo. As Rutherford (2010) reports, there is a positive correlation between the use of social media, the commitment to study, and the relationship with fellow students and tutors.

In addition, the study groups are supervised by tutors who help in dealing with the group tasks, organize joint meetings, and support in specialist questions. Social interaction in groups and regular – albeit media-mediated – contact with the tutors is a key prerequisite to the success of the study program. Students often report that it is precisely the membership in a group that is an important motivational component. Membership in a learning community relates to positive student engagement (Zhao and Kuh 2004). Group endorsement can help overcome periods of low motivation. Establishment of a functioning community is therefore important for the sustainable success of an online study program.

But not only human resources are necessary, a suitable technical environment has to be established to assist the community. The technical framework of Educational Media provides students with multiple systems for communication and cooperation. However, these have mostly a special focus on learning activities and are rarely used for informal meetings or exchange of more private information. The existing system should be expanded to include a social space, precisely in order to promote social interaction between students. Second Life has been selected for this three-dimensional virtual world. In particular, the immersive nature and the improved perception of social presence speak for Second Life.

Our goal was to create a social space in the first place and not to create topic-specific learning materials. Although the possibility should be given to work on group tasks, but to this extent only sufficient space and the necessary tools are provided. The tasks themselves and the learning materials were still available on the learning platform. Furthermore, a venue had to be created, which simply does not focus on a specific learning process, but provide a community place for informal activities.

The virtual campus Educity (see Fig. 4.1) has been built in Second Life. Educity is part of an island in Second Life and is freely accessible for all students of Educational Media at any time. To support student new to Second Life training sessions were offered.

Fig. 4.1 Educity overview

Educity is divided into several areas:

- Contact point: the Palace Garden
- Central building as a focal point: the Palace
- Group parcels around the Palace Garden
- Recreation area for socializing

The Palace Garden serves as a central meeting point for all incoming visitors; here you can settle down on park benches and talk. The Palace is the central building including the lobby on the ground floor where several information boards are constructed. Visitors can learn about the offered courses and get in touch with the support team of Educity. Expert users in a support team is an key feature to assist student in their first steps in Second Life (Sanchez 2007). On the first floor a conference room with whiteboard and several meeting tools is established. The other floors can be freely used by any visitors as needed. Garden and palace is the common community space to meet and socialize.

Around the Palace Garden individual group parcels are separated. All learning groups can rent these parcels free of charge. To encourage all interested learning groups we provide them with a small amount of Linden dollar (L$) for initial activities on their own land. Although many objects in Second Life – as, for example, clothes or homes – are free of charge, this initial budget motivated the groups to deal with Second Life and their property. Initial construction activities are practiced here and some groups developed their parcel to a group headquarter (see Figs. 4.2 and 4.3). Small houses create a more intimate space and are used for group meetings. As all group parcels use a different voice channel, several groups can meet at the same time and talk privately.

Fig. 4.2 Group headquarter 1

The third major area is the recreation area (see Fig. 4.4). In this imaginatively designed landscape a variety of entertainment spots are set up. There are several games that can be played alone or with others. The jazz club invites for a dance or you can just relax in the spa.

While Second Life is not originally referred to as social software, its use by groups must be regarded as social communication and at least creates new occasions to communicate.

Fig. 4.3 Group headquarter 2

4.3 Constructing Space: Analyzing the Influence of Design on Social Processes

Central concepts of MUVEs differ from other electronic communication environments, e.g., the chat. In addition to the persistence of the internal world they include a relation to real-world examples and elements of symbolic environments. Elements of architecture serving as complex metaphors have a high proportion in them. In MUVEs they serve as a framework for action and combine the various components and functions of the media interface into a logical connection to create a better understanding of the complex working principles between the environmental objects (Dillenbourg et al. 1999).

Early online worlds such as text-based MUDs and systems with additional visual feature like MOOs (multiuser dungeon object oriented) have been called as a result of the consistent application of spatial metaphor space-based system. They are formed by the linkage or combination of rooms. Accordingly, the fictional narratives to build these online games are spatially structured. The internal structure of these games is not set primarily by events but by places linked (Funken and Löw 2002). The results are networks of virtual rooms or clusters of them. With the establishment of MUVEs, the tight game procedures, especially the social interaction between users, changed the role of the spatial metaphor. The situatedness of communication through the metaphor of the space induced a situation of proximity and presence (Beißwenger 1999). Space becomes a certainty of presence and thus the possibility to connect with other users in exchange. In space-based MUVEs this can be achieved by shared symbolic rooms. In text-based MUDs these rooms are not visible but merely constructed by language (Dieberger et al. 2000). Current MUVEs,

Fig. 4.4 Recreation area

such as Second Life, offer their users a high reality-based three-dimensional environment which they can explore with a three-dimensional representation, the avatar. The inner world of Second Life consists of a digital landscape that is expandable in any direction. It is possible to build room structures like buildings in any section of this landscape. A resulting fragmentation is avoided by the concentration of fully compacted built areas in defined Second Life space sections. One variant of these sections are island areas, the so-called Second Life islands. These islands provide individual and independent areas that have no connection with each other. Second Life, in sum, is therefore a disorganized patchwork of space sections of various shapes and uses the user can access via full-text search and a web-based two-dimensional map via direct links (SLurls) which teleport him or her directly to a reference.

Examples of specific references to the architectural space exist in all space-based online worlds, the same in Second Life. They are the expression of a structural and cultural contextualization (Reid 1994; Schiano 1999; Kendall 2002). Their effectiveness is reflected in the perception and use of online worlds. Symbolic rooms of online environments have been named by their socio-spatial characteristics already in MUDs and MOOs to "places" (Dillenbourg et al. 1999; Dieberger 2003). Rooms and areas with social and cultural importance are referred to as "places." Lori Kendall describes in her book "Hanging Out in the Virtual Pub" her impressions and experiences in the text-based MUD BlueSky. She explains how she and other MUDders used the online environment and its special rooms, such as pubs, bars, and other forms of "quasi-private social spaces" (Kendall 2002), targeting at social contacts and mutual exchange. Research at Duisburg Learning Lab, where students at the University Duisburg-Essen, especially study groups of the online master degree program Educational Media, used symbolic rooms for selected tasks in the weekly group assignments, came to similar results in terms of Second Life.

In an experimental setting three group work spaces were created. Each room had the same technical facilities: There were seats for at least eight people installed, a whiteboard could be used to show presentation slides, a pinboard allowed notes to be attached, and in each room a wiki page could be opened for collaborative writing. But the rooms differed significantly in their spatial organization. Room A (Meeting Room, Fig. 4.5) was built as a traditional conference room and meets the real-world experience of a lecture or seminar room.

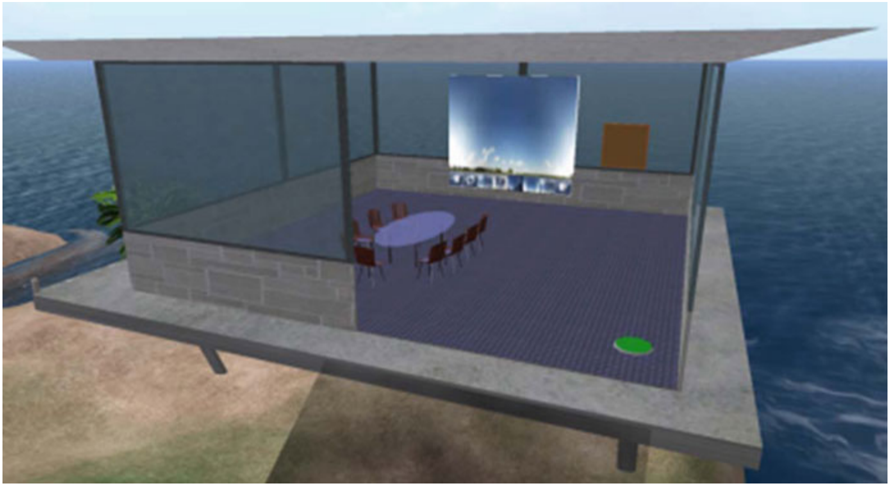

Fig. 4.5 XRoom A (Meeting Room)

Only architectural elements that may also operate in the real world were used.

Room B (Sky Lounge, Fig. 4.6) was designed as a free-floating space in the sky. A futuristic glass structure opens the view – and by that the room – in all directions. Instead of office chairs we used colorful lounge chairs that are not set up around a table but are placed in a semicircle.

Room C (Deep-Water-Lab, Fig. 4.7) was built underwater. Seat cushions were arranged in a circle and free-floating in a kind of transparent pressure chamber.

Several groups of students used these rooms/spaces when working on a group task. All groups were given the same task; after processing, they were asked about their impression of the room. We found out that the design of the rooms had a significant impact on the feelings and atmosphere of the working group. Real-world experiences on room size, proximity to other persons/avatars, colors, and light have been transferred to the virtual spaces. Thus space A has been described as cold and businesslike. This area seems particularly appropriate for factual communication and concentration on the topic. Room B was perceived as far more informal. The

Fig. 4.6 Room B (Sky Lounge)

Fig. 4.7 Room C (Deep-Water-Lab)

spatial width and the color scheme gave rise to a relaxed atmosphere; potential for more creative processes has often been identified as properties. Finally Room C was perceived as relatively intimate. The proximity of the seating positions of the avatars and the architectural frames of the area made this space more pleasant for people who know each other. Some students expressed that they would feel the lack of space as a nuisance if they would be in that room with unknown avatars present.

The differently designed and furnished rooms were selected and used against the backdrop of their social spatiality and their social offers. But the social affordances are read only in the light of its social connotations. Spatial elements of human environments are socialized to different levels and only to understand by their cultural symbolism (Läpple 1991). Their structure is always related to practices that have been learned and normalized in sociocultural processes (Bahrdt 1974). Besides fulfillment of aesthetic and functional requirements, the social-spatial structure supports communication symbols of the society (Hillier 1984). Actors who are socialized accordingly or "culturally competent" can and must read and decrypt these rooms (Willems and Eichholz 2008).

Architecture, as a deliberately designed, semantic, and visible structure of the room, would be a symbol of social arrangement, with the aim to enable space-related activities. Described as social spaces in MUVEs they provide a framework of certain possibilities for action (Rohwder 2007). A "kitchen" refers to other designated symbolic connotations of communication activities than a lecture room. Due to cultural backgrounds and socialization both rooms are connected to completely different ideas and requests for uses, staff, design and equipment, and different demands and expectations. Direct transmission from room functions of the first order, in the case of a kitchen the possibility to prepare meals, is not possible in a symbolic kitchen room of an online environment. The design of computer-based applications and media-mediated environments can convey to a comparable offering character and through the selective use of environment-related properties and features reference to a social utility value (Gaver 1996; Norman 1999). This use, however, cannot be entirely in accordance with their real utility value (Eco and Traban 2002). Symbolic rooms of online environments are not used and experienced as physically real space (Dieberger 2003). But in the second order "kitchen" means a specific socio-spatial context in relation to communication processes. The kitchen is also an informal room, for instance, a meeting room for the "kitchen cabinet," which means the unofficial communication processes of parts of the government and handpicked advisers. Kitchen talks are not intended for the public. Such informal symbolic rooms were popular in MUDs like the "bar" and the "pub." In contrast a lecture room stands for formal action, to be held publicly.

While online text-based environments with specific language definitions and descriptions refer to real-world architecture, three-dimensional environments display symbolic rooms on visual characteristics. 2-D environments such as MOOs have no possibilities to reflect the built room itself, its size, and specific design. Spaces of MOOs are invoked only in browser windows, called frames. The window content defines the room volume. Within this range graphical symbols or icons give references to the room setup or equipment items. These cannot be used directly as in three-dimensional MUVEs. Instead, participants use specific environment commands to sit down or to share with others that have taken their seats (Haynes and Holmevik 2001). In this case the option of sitting or standing up to the beginning or the end of the communication has significance for social interaction between the participants. With the "sit down" signals the persons in room express their willingness to start in the joint communication; "getting up" on the other hand refers to an end. MUVEs, such as Second Life, offer extensive possibilities of room elements and interior decoration to be presented visually and very close to the real physical model. Free arrangement of equipment including three-dimensional elements in the function-specific configuration is possible, such as a circular seating arranged for group work or an arrangement with all seats directed to the front for a lecture hall. The decoding of social offers is based on the specific room designs and the equipment elements (Suler 1996). But a prerequisite for realization is a room design or equipment referring to known socio-spatial types and associated features. It is primarily a recognition basing on the connection between socialized and culturalized spatial patterns and related symbolic rooms and this makes online "places" of MUVEs, such as Second Life, to a socially attractive and authentic environment for online communication.

4.4 Constructing Identity: Using Avatars and Role-Playing to Experience Social Roles

Another important aspect considering the use of virtual worlds as, for example, Second Life in educational contexts is the possibility to make students experience different social roles and identities during learning processes. The internet in general already offers many possibilities to play with the performative construction of identity.

Despite the fact that we always act in certain ways to construct and perform our identities, in real life it is in most cases bound to our bodies and their appearance, e.g., our age, sex, or race. On the internet and in virtual worlds these physical limits do no longer exist. In the beginning of online research it was thus believed that we construct our identities here by the texts we produce, for example, in chats (Thomas 2007). Virtual worlds as Second Life where users interact as self-created avatars offer the chance to perform our identities through our avatars' appearance and actions. As a consequence we also get the chance to deconstruct our identity into manifold facets and express different aspects of one's personality: We can have a different identity in each single virtual environment (Filiciak 2003). Virtual worlds foster the possibility to express manifold and often unknown aspects of the self, to play with the original identity, and to try out new ones. This creates the chance to construct a new identity which might become so fluent and manifold that it is hard to tell if we can still consider it as an identity (Turkle 1999).

In educational contexts the method of role-playing is often used to make students experience unknown situations and social roles and the consequences of their actions and to evaluate the situation and their behaviors afterwards. However the realization of the method and its advantages is often confronted with the problem that the students are not able to adopt to their roles completely and act according to the setting of the play. They are still bound to their original identities and roles since they cannot change their appearance. Virtual worlds as Second Life thus offer a great possibility to overcome these obstacles and consequently to make use of educational role-plays in a new and gainful way.

In 2008 we took the chance to experiment with didactical methods in Second Life in the context of a seminar at the University of Duisburg-Essen. The seminar took place completely online in Second Life; the students and their teacher mostly only knew each other as avatars and by their Second Life names. Among other methods the students had the possibility to try out role-plays, which were originally designed for real-life interactions, in the virtual world of Second Life.

The setting of the role-play we used was originally created for schools with teenagers as a target group. In the play there exist three scenarios, each with two adults (mother and father) having a discussion with their teenage child about a party. In each scenario there are detailed descriptions for all three characters (a very mild mother or a strict father, a son who tries to convince his parents by arguments, or a daughter who is used to always get what she wants). It is obvious that in real life the students in the seminar are differed from the roles they had to play here, not only with regard to their age.

At the beginning we were confronted with the same problems that usually occur in real life when using this method. There were only few students who voluntarily wanted to participate in the play. However after the first scenario had been played the reserved attitude of most participants in the course changed and we did not have to force or induce others to take a role. From the audience's point of view those playing roles seemed not only to have a lot of fun, but they also were much more immersed in their roles and really acted as if they were the worried mother of a teenage son or daughter. Thus the main goal of the method of role-plays, i.e., to take over a different identity and make experiences from this perspective, was fulfilled.

Another main advantage of using role-plays as a method in virtual worlds like Second Life is the fact that you are no longer bound to real life in terms of physical appearance or the spatial settings in a classroom or at university. You can create a whole visible location according to the setting of the role-play and its story. The actors are no longer restricted to their age or sex, making it possible to create avatars which fit best to each role and thus there is no problem to change from male to female, old to young, and vice versa.

However, to fully benefit from these advantages, a lot of knowledge about Second Life and the creation and design of objects and avatars is necessary. New users cannot start immediately; they need to spend time in Second Life to gain experiences in the virtual world and in handling the software. Also problems might occur concerning the hardware equipment which is an important prerequisite for Second Life. There is still the need for powerful computers especially with regard to graphic cards and it cannot be expected that for example all students in a class or in a university seminar own a computer which satisfies all demands.

Yet, we are of the opinion that role-plays in Second Life are a very recommendable method for social learning in virtual worlds. The chance to make experiences in different social roles or to test one's own behavior and reactions in new and unknown situations offers manifold educational benefits.

4.5 Conclusion

We have shown that three-dimensional virtual worlds definitely have the potential to function as a social space. As it turned out, however, the architectural and spatial design is of particular importance. Real-world experiences are transferred into the virtual world; well-known metaphors of space also exist in MUVEs and thus have effects on social communication processes.

To support the community in Educity we have identified three key design elements: a recognizable public social space in the form of the Palace Garden, possible retreat into customizable more intimate and personal spaces in the form of group-land, and encouraging social interactions based on familiar metaphors, such as games and dancing in the recreation area.

In the layout of group and work spaces, the design is of particular importance. In the study it became evident that interior design and sensations and the type of communication are closely linked. In the processing of group tasks and implementation of meetings the intended target and the desired mode of cooperation have to be kept in mind, and the used space is to be designed accordingly.

Finally, in the implementation of role-playing games, great potential can be recognized. Precisely because the environment of Second Life is open to choice and the appearance of avatars is easy to change, operating room and people can more easily be adapted to the relevant scenes and roles in the role-play. A transfer of a known metaphor in the virtual space lets us expect a deeper level of immersion and a more intense experience of the roles played.

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Chapter 5
Social Navigation for Learning in Immersive Worlds

Jon Dron

5.1 Introduction

Multiuser virtual environments (MUVEs) have long been used in the learning process, typically to enable engagements akin to those found in traditional learning situations, but without the costs and constraints of the physical world. Such uses are important but fail to take advantage of parallel developments in other technologies, notably the web, that make use of multitudes of individuals' behaviors to offer help and guidance in learning. This chapter is concerned with ways that MUVEs can support collectives, in which the crowd is a first-class agent in a system, and how those collectives may help or fail to help people to learn in such environments. Building on theoretical foundations of collective formation, the chapter offers speculations and ideas for approaches to environment design that can take advantage of collective processes to improve learning.

5.1.1 Soft Machines

Once touted as the universal tool, we now have a richer view of computers as, additionally and simultaneously, universal media and universal environments. In no case is this more true than in immersive environments, where process, space, and design weave an intricate dance that is entirely mediated by the machine yet formed out of human interaction.

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While it has long been realized that we must take a total systems view when designing computer systems in which people play a part, it is now becoming clear that social computer programs themselves have a structure and logic that is only partially determined by the software that we design. Equally, they are driven, both in algorithm and interface, by the people that instantiate and inhabit such programs that, together, form a complex adaptive system that is part human and part machine. An emergent entity, the crowd (formed by the mediated interactions and, as often as not, the separate or partially separate actions of individuals that form it) is a determining factor in giving such software its functionality and behavior. This part-human, part-machine cyborg has been characterized as a collective, similar but not identical to collectives in nature such as bee, ant, or termite colonies.

The behavior cannot always be determined with great accuracy in advance as it depends not only on the nature and interests of the crowd but also on how they affect each other within the virtual environment. In turn, this means that it no longer makes sense to think of the algorithms and interaction designs of such systems as purely programmed, but that some of the algorithmic and interaction design of the system exists both in individuals that use it as well as the emergent crowds that develop as independent and active agents within it. While at first glance this may seem similar to traditional systems views of software design, it is radically different in its effects and implications about how we should design such systems because it implies that any design is only ever a partial and constantly evolving specification.

This chapter is an exploration of some methods and techniques, some tried, some not, which might be used to enable crowd intelligence in the service of learning. It begins by examining the various forms of collective that emerge in nature and in man-made systems and how they may help and hinder the learning process, referencing existing work in the area. Partly informed by previous work on social navigation in web environments, adapted and extended to consider the unique nature of immersive spaces, the chapter goes on to suggest ways that pedagogical benefit can be most effectively achieved in an immersive, crowd-driven space and how adverse effects can be reduced or eliminated.

5.1.2 Soft and Hard Technologies

Immersive worlds are innately soft, flexible, and malleable technologies: processes that occur within them are often not embodied in software but in the actions, norms, rules, and methods of the people who are using those environments. This is not unsurprising, given the strong tendencies for people to replicate real-world behaviors and interactions within them combined with their ability to flaunt or ignore physical and moral laws that restrain action in the physical world. Immersive spaces are thus rich in both hard, embedded technologies and soft, human processes, norms, and rules. Like all technologies, they are assemblies (Arthur 2009), rich in flexibility and potential, opening new vistas of what Kauffman (2000) calls the "adjacent possible." They are spaces in which multiple independent agents interact directly and indirectly (e.g., through leaving artifacts and constructions) and which evolve into unforeseeable complex systems. To understand them, and their potential, as well as to manipulate the dynamics of such environments to achieve particular ends, it is therefore worthwhile to explore ways that emergence occurs in other multi-agent systems. In particular, it will be helpful to look at collectives, a class of system in which local interactions lead to intelligent group behavior.

5.2 Collectives in Nature

Collectives are systems in which group behavior emerges from individual actions of organisms, whether within the organisms themselves (such as the behavior of the immune system in humans or the regulation of heartbeats) or between them (such as in the formation of herds, flocks, ant trails, and termite mounds). In nature, it is possible to identify two broad families of collective: we classify them here as:

1. Those that rely on immediate stimuli caused directly by the actions of other organisms (referred to here as *direct* collectives)
2. Those that rely on stigmergy, where communication is mediated through those organisms' effects on the surrounding environment (referred to here as *stigmergic* collectives).

5.2.1 Direct Collectives

In direct collectives, behavior such as flocking, herding, or the dances of bees results from creatures reacting to other creatures' behaviors in more or less sophisticated ways, typically replicating or amplifying such behaviors themselves and thus influencing more of their kind. Note that the interest here is in collective behaviors – we are not concerned in this chapter with systems in which an agent plays a distinct role within the group: in some higher organisms, notably including humankind, social systems have evolved that, for example, involve lookouts or pack leaders with distinct influential roles, but these are not collectives. In a collective, it is the combined behavior of many independently acting individuals that leads to group behavior.

Direct collectives emerge from a mixture of network (immediate interactions with neighbors) and set dynamics. Only when the behavior that causes large-scale changes in the crowd occurs in more than one organism does it set off a response in others that leads in turn to the larger collective behavior. For instance, the movement of a single animal in a herd to avoid a predator will have little or no effect on the herd. Herds will not take avoiding action in the presence of a predator unless more than one of the herd has reacted to it (Miller 2010). A single member of the herd may trigger greater alertness in those around it, but it is only once they too have recognized the threat that they begin to move and thus set in motion a chain of behaviors that we recognize as typical of a herd. Similarly, bees are not impressed by a single bee dance (though intensity does play a role in persuading them), However, if more than one dancing bee indicates the same food source or new nest location, this increases the probability that the hive will move en masse towards it. Similarly for flocks of birds, changes in direction are not the result of one bird's choice but a combination of each bird's awareness of multiple birds nearby. The fact that numbers are significant means that this kind of collective behavior is only partly a *network* effect: it has as much to do with *set* operations, quite literally involving the counting of the numbers of nearby organisms behaving in a certain way that leads to change. Human systems work in much the same way: crowds attract crowds, as any street entertainer will tell you although there are also more direct individual communication processes at work. A single person watching another is a poor attractor, but a crowd is a powerful magnet for others, which in turn attract still more. One person does not constitute a riot but, beyond a certain threshold, mob formation is partially driven by the behavior of the many.

5.2.2 Stigmergic Collectives

In a stigmergic system, communication is mediated through signs left in the environment (sign-based stigmergy) or changes to that environment itself (sematectonic stigmergy) (Bonabeau et al. 1999). Termite mounds involve both sign-based and sematectonic stigmergy. They are formed, in part, through pheromone-laced bundles of mud acting as signals to other termites to drop their bundles of mud. The stronger the pheromone signal, the more likely are they to drop their balls of mud nearby, leading first to towers, then arches, and complex structures that have a complexity that humans would have difficulty in matching through top-down design. Sematectonic stigmergy helps to guide further structuring based on signals such as heat or fresh air in too great or too small a quantity. The combination of sematectonic and sign-based stigmergy is what leads to the phenomenal capacity of the termite mound to regulate its temperature and achieve optimal temperatures in different parts of the nest (Miller 2010).

Ant trails are similarly formed through ants returning to the nest with food leaving pheromone trails. As each ant returns to the nest with food, leaving its own trail, it strengthens the trail, attracting more ants to the source of food. The trail evaporates once ants are no longer returning with food, so the system regulates itself to an optimal level needed for fast and efficient transport of food. Equally interesting, where two routes are available (such as a thin branch and a thick branch across a stream), the process will naturally optimize use of those routes. The behavior of individuals, acting on local stimuli and with no further guidance, leads to collective intelligence of the group as a whole (Bonabeau et al. 1999).

In stigmergic collectives, as for direct collectives, the reaction gets stronger the more participants are involved – this combination of agents leads to emergent and complex patterns in which the whole community becomes involved in making judgments or designs that are global (community-wide) in scope despite the fact that no single individual is aware of more than local stimuli. Again, this is mirrored in human systems such as money markets or stock markets, where money and stocks act as signals to individuals acting on limited information that determine, in a statistically significant manner, the movements of those markets at a global level. Stigmergy is a large part of the mechanism behind the "invisible hand" of the economy (Heylighen 2007). It can also be seen in systems as diverse as the formation of footpaths or the movement of traffic.

5.2.3 A Third Kind of Collective

In human systems, there is a third kind of crowd intelligence. While both stigmergic and direct collectives are common, there may be, and, in the case of computer-based systems, usually is, some further mediation of crowd behaviors by a single or small number of intentional agents. Rather than a system that is solely composed of each individual making local decisions that lead to group behaviors, there is also a centralized authority, human or machine, that collects individual behaviors and feeds it back. A classic example of this process in action would be a blind ballot or vote, in which votes are counted and some action taken based on the results that in turn affects the group who made the vote in the first place. Where the process is iterated, the effects of the process lead to further individual decisions, much as we would see in direct or stigmergic collectives in nature, that again affect the whole collective. In computer systems, this iterative behavior is often embodied in a highly dynamic self-organizing system. Google's PageRank algorithm, for instance, is used by Google Search to rank results, giving extra weight to pages that are implicitly recommended through links, themselves weighted through further links from other pages – pages that are implicitly more highly rated as a result of links to them carry more weight than those with fewer inbound links. This drives a stigmergic feedback loop (Gregorio 2003): a page that appears at the top of Google rankings, is more likely to stay there simply because of the operation of the Matthew Principle, a process of preferential attachment wherein the rich get richer while the poor get poorer, because more people viewing a successful page means that there are more people who may refer to it, thereby boosting its PageRank. The system is saved from falling into a fixed Stalinist regime of stagnation in which the top sites invariably remain at the top through being constantly fed with new pages, through corrective algorithms such as intentional ageing that are part of Google's complex (and secret) formula, and through Google being part of a much larger ecosystem in which many other factors play a significant role in establishing the popularity of a web page. If Google Search were the only means of finding a page, the risks of preferential attachment preventing novel and probably better pages from rising to the top of search results would be high.

Similarly, collaborative filters that mine behaviors looking for similarities and make recommendations based upon what they find are making use of a combination of algorithm and the local decisions and actions of individuals acting somewhat independently to form a collective. Again, feedback loops can drive more highly ranked resources to greater prominence, the effects of those behaviors influence the larger crowd, and the decision-making process is distributed across multiple agents with no individual in charge.

Tag clouds, typically formed by counting tags and displaying them with different font sizes weighted according to popularity, are another common form of collective system, in which individual tagging behaviors are amalgamated by an algorithm and fed back to the crowd. Again, there is a feedback loop involved, whereby the previous use of a tag will encourage others to use the same tag when classifying resources such as photos, bookmarks, or blog posts.

While these kinds of system display dynamics that are superficially similar to the stigmergy found in nature, the fact that the algorithms and interfaces that perform the combinations, aggregations, averages, and so on are occurring not only in the individuals that make up the crowd but also in machines makes them importantly different. The creator of the system is playing a large role in shaping interactions, akin to that of evolution or a deity defining the meaning of pheromone symbols for ants and termites. In some ways, the virtual space and its algorithms are defining the physics of the interactions that occur there. People are also applying their own algorithms as individuals, much like organisms in nature, but they are doing so in response to stimuli that are intentionally designed and which obey laws hidden in the algorithms and interfaces of the software. As well as massively increasing the range and potential of collectives to perform useful work, this extra stage of mediation also introduces scope for something which, thanks to evolution, is seldom found in nature: mob stupidity.

5.3 The Wisdom of Crowds and the Stupidity of Mobs: Seeking Educational Value in the Collective

While there are many social navigation methods and techniques that can influence behavior, what is far less clear is how such approaches might have a positive value in an educational setting. When people are aware of what others are doing (or have done) and are influenced by them, it is at least as likely that it will lead to mob stupidity as it will to crowd wisdom. The intelligence that may be found in a stigmergic system is largely determined by the algorithms that drive it. Very similar processes affect the ways people behave in currency markets as the ways ants behave in forests and the overall system gains relatively little from the intelligence of its parts. Even where such systems lead to what appears to be more intelligent emergent behavior (such as, in the case of termites, the formation of termite mounds or, in people, optimal paths across lawns) it is still far from clear how such intelligence can be turned to pedagogical purposes. Most trails and other forms of social navigation are implicit expressions of preferences and, if not, typically relate to a specific context that is not necessarily discernible and may not be transferrable to a different context. Whether this will have any bearing at all on helping someone else to find a learning path that is useful remains a largely unanswered question.

5.3.1 Collectives in Non-immersive Virtual Spaces

Among the earliest writers on the potential of collectives in education, Sasha Chislenko suggested that crowds might play important roles in helping each other to learn through collaborative filtering (Chislenko 1997). He was drawing inspiration from prototypical uses such as Tapestry (Goldberg et al. 1992), Beehive (Huberman and Kaminsky 1996), and PHOAKS (Terveen et al. 1997) which enabled others to share the benefits of each other's knowledge through matching similarities in interests. Since then, many have attempted to use collaborative filters in the educational process but with very mixed success (Anderson et al. 2003; Drachsler 2009; Dron et al. 1999; Recker et al. 2000). As I and others have noted (Drachsler 2009; Dron et al. 1999), the application of collaborative filtering methods is very different in an educational setting than when used to match simple preferences for films, books, or music. The fundamental reason for this is that to learn is to change: what was of value to us when we were learning something is, almost by definition, no longer valuable once we have learnt it because it has changed us as a person. I may have found a particular resource to be very helpful when learning basic arithmetic, but I no longer need anything vaguely similar to it in future when I am learning advanced statistics, by and large. Predicting future needs from past behaviors that show implicit preferences is made more problematic by the fact that I may have made a poor initial choice from the range of choices available to me: I might have learnt something better or faster another way. It gets worse: my motivation to contribute explicit ratings (which might at least give a more accurate gauge than simply mining my history) is likely to be much lower than my motivation to rate, say, books or movies, because there will be no obvious value to me from doing so. Rating books and movies gives me more accurate recommendations in future, whereas rating things relating to what I have already learnt is of no obvious benefit to me, and, while altruism is a good motivator for some, it is hard to get a large number of ratings that way. To make matters worse, the fact that people's learning needs are much more diverse than their tastes because we all start in a very different place from one another means that the data are naturally sparser than they would be when matching tastes. Despite these issues, progress has been made. CoFIND, for example, succeeds in capturing traces of previous needs by exposing its learner model through explicitly created pedagogical tags known as qualities (Dron et al. 1999). Unfortunately, this process is tedious for the end user and greatly magnifies the cold start problem experienced by most collaborative filters, so is of limited practical use.

Apart from collaborative filters and related recommender systems, several other kinds of collective have been used with educational intent. Among the most notable of these are those that make use of social navigation, including Educo (Kurhila et al. 2002), Comtella (Vassileva 2004), the Knowledge Sea II (Brusilovsky et al. 2004), and Dwellings (Dron 2005b)). Others make use of social visualization to indicated relationships between people, actual and latent, whether through direct connection of forms of dialogue captured by the system (Donath et al. 1999; Vassileva 2008). Still others use swarm-based approaches to help guide learners to appropriate resources (Gutiérrez et al. 2006; Tattersall et al. 2004). The humble wiki may also be seen as a collective application (Ricci et al. 2007), albeit one that is not intentionally designed with embedded algorithms to assist the process (although the MediaWiki server behind Wikipedia and other sites also contains tools to show the most popular pages, for example, that are more computer-aided). Indeed, the simplest of Usenet newsgroups exhibits some collective properties: people are more or less attracted to threads depending on the number of messages already posted – too many are as bad as too few in such a system. There are also examples of memetic evolutionary processes occurring in many forms of electronically mediated dialogue where norms of behavior, use of language, shared terminologies, and so on develop not through top-down decisions but through processes of copying, sense making, and pattern formation within the group.

In the vast majority of social systems that intentionally or otherwise make use of collectives, the same stumbling blocks continue to emerge: crowds are only wise under a limited range of circumstances, typically when unaware of the actions of others and usually only when making particular kinds of decision (Surowiecki 2004), so it is far too easy for stigmergic and similar systems to magnify errors rather than converge on useful solutions. Much of my own work has been concerned with identifying ways to avoid this problem, resulting in a set of ten principles of educational social software design described in Dron (2007) that are primarily intended to limit the risks of stupidity in mobs.

Despite the problems, a number of collective-based solutions have been shown to work well as learning tools and it is notable that the two most-used learning technologies on the Internet today, Google and Wikipedia, both make extensive use of stigmergic collectives to help people find valuable resources and people from which to learn. While the algorithms may leave a little to be desired when compared with what we might imagine to be possible in an ideal world, sheer bulk of material and force of numbers makes both systems effective tools for finding reliable and high-quality content from which to learn. This is only possible because of quantity and diversity, two factors that are lacking in all but the very largest of social systems.

5.3.2 Collectives in Immersive Environments

The principles of stigmergy and more direct herding or flocking behaviors have been applied in many social computing systems and are the cornerstone of social navigation (Farzan and Brusilovsky 2005; Forsberg et al. 1998; Riedl and Amant 2003), whereby the behaviors of others can help to determine effective (or ineffective) paths through hypertexts and virtual spaces. Social navigation plays an important role in virtual spaces and arises naturally from those environments whether intentionally or not. For example, the mere presence of people in Second Life draws others to spaces that are inhabited, a process that is greatly aided by tools within the system that indicate where activity is occurring.

In virtual 3D environments such as Wonderland, OpenSim, World of Warcraft, or Second Life, virtual worlds may provide a complex mix of the mediated, immediate, and stigmergic forms of crowd intelligence. This combination is part of what provides perhaps the greatest potential value in virtual worlds when compared with those of the physical world. While we are all familiar with the benefits of being able to bend the laws of physics and extend the limits of human capabilities in such spaces, the fact that we can bend to dynamics of complex behaviors through the intelligent design of mediated collectives makes them a powerful set of tools for enabling crowd wisdom to play a role in assisting their inhabitants.

5.3.3 Immersive Worlds and Educational Collective: A Gap in the Literature

A sizeable body of work has been undertaken in virtual worlds to make use of social navigation (e.g., (Chen et al. 1999; Grammenos et al. 2002; Ruddle 2005)) as well as to simulate and extend the kinds of crowd interactions found in the physical world, where direct collectives are a naturally emergent feature of people grouping together. Another area that has attracted interest has been the exploration of social networks in social spaces (Rosen and Corbit 2009). Far greater use still has been made of immersive environments in a learning context, including large dedicated virtual environments built for that purpose, such as ActiveWorlds and older, less immersive worlds such as LambdaMOO, as well as many thousands (at least) of Second Life spaces created and used by universities and other educational institutions (Gregory et al. 2009), not to mention other virtual environments like OpenSim and Wonderland, where development is extensively driven by academic uses. However, it is very curious to observe that it is very hard to discover examples of the use of algorithmic methods of generating mediated collectives like collaborative filtering, reputation modeling, social tagging, or anything more than basic recommendation systems in virtual worlds. This is a huge area offering potential value to learners that seems to have been almost systematically ignored in the literature.

Bearing in mind the extensive research of virtual environments in learning and substantial body of literature on social navigation in such spaces, even allowing for the paucity of research in other forms of collectives in immersive spaces, remarkably little use has been made of collectives for the explicit purpose of learning. Of those that have been created, most are highly constrained in the methods used and make little or no use of crowd dynamics. For example, a wrapper around the adaptive hypermedia system AHA! provides navigation support based on learner and content models and suggests approaches to interface adaptation, but no social information is used in generating those interfaces (Luca 2007). In this final part of the chapter we will be describing approaches that might be used and uncovering benefits and risks of doing so.

5.4 Potential Approaches for Mediated Collectives in Immersive Environment Literature

The rich data that are available in virtual spaces provide more opportunities for data mining and user tracking than in conventional web environments. This is partly because existing environments tend to be centralized – there is no need to track from site to site. However, even with a distributed node, the wealth of interactions and navigation data with a virtual space tend to far exceed such data for a 2D web space where, with a few exceptions, interaction is only visible at a whole-page level. In this section we briefly consider a few of the possibilities. However, it should be noted that the literature on collaborative filtering, social navigation, clustering, reputation modeling, and so on is very rich and most of the methods available can be applied effectively in a virtual space.

5.4.1 Aggregations and Averages

The use of footprints or signs of wear and tear is quite common in virtual worlds as a means to show, quite effectively, areas of popular interest. In a learning context this may be of limited use because of the risks of (a) mob stupidity, where the Matthew principle may be significant and (b) the averaging of behaviors of large populations that may cancel out individual differences or preferences. Unfortunately, without further information, it may be hard to identify which of these two forces dominates in any given system. The effects of averaging can be somewhat polarized if an environment, or part of one, is only used by a specific community with a shared interest, but, in such a case, the risks of cumulative advantages gained by early visitors still limit the value of such a naïve approach. However, there is great scope for making use of intentionally provided differentiators such as tags and labels used, which provide a more parcellated and focused means of gathering and aggregating useful information from many individuals. It is also possible to consider differential weightings given to certain users either because of their allotted role (e.g., teachers) or through a more self-organized process of reputation mining.

5.4.2 Item-Based, Human-Based Collaborative Filters

A great advantage of using recommender systems in virtual environments is that, unlike in the physical world, it is very easy to identify objects with which people interact and, to a reasonable extent, discover intentions and feelings towards them by observing the context of use. An avatar reveals much about a person who would not be so easily discovered even when they interact with digital objects on the web –

focus of attention, movement, profile, mood, social interaction with others in the environment, and previous paths are all harder to discover in a non-immersive environment. The distributed nature of the web, combined with incomplete knowledge of behavior, makes the gathering of implicit recommendations unreliable at best in web-based systems. The fact that I appear to spend 10 min viewing something, for example, may mean that I am otherwise engaged drinking a coffee, viewing multiple pages at once, or just clicked something and forgot about it. Similarly, unless dubious or intrusive methods are used, histories of navigation between disparate sites are typically hard to discover (there are exceptions such as the Flock browser that manage histories locally or that mediate via, say, Facebook logins, but they are imperfect mechanisms). The contained nature of current virtual worlds and our potentially complete knowledge of behaviors within them, as well as the greater attention that is typical of inhabitants of such spaces, makes it more likely that we will be successful in matching similarities between one user and the next than when we attempt similar things via the web or other less immersive systems.

Identifying similarities between people is a relatively reliable process in an enclosed virtual world. There are many facets of behavior and different kinds of metadata that may be mined to seek commonalities between people and things that may then be used to link them together. Based upon previous behavior we can make suggestions such as "others who visited this building also visited…" or "people who are like you (choice of avatar, locations visited, kind of dialogue, similar friends, similar tastes in music, etc) also like…"

5.4.3 Network Analysis

People in virtual spaces make friends, join communities, and comment on others much as they do in conventional web environments and similar methods may be employed to map social networks. This has attracted some research interest already (Rosen and Corbit 2009), though little (if any) relating to learning. Identifying who interacts with who, which are the most connected nodes, which objects are most commonly shared, and so on can provide rich data for learners in search of others with whom or from whom to learn. Because, by definition, we already know and trust the proximate parts of our social network, we can have a clearer idea of what kind of information and help we might expect to gain from parts of the network that are less proximate. This specificity is important: the more knowledge we have about the kind of help we might get, the more effectively we will be able to make choices that help us achieve our learning goals.

As well as conventional social network analysis, virtual spaces also allow us to observe, directly, who people interact with, for how long, and, through content analysis, about what, thus enriching our social network models and enabling more accurate and targeted recommendations.

5.4.4 Reputation Models

Similar methods to those used in network analysis and collaborative filtering may be used to identify those in a community with greater or lesser reputation. For example, those who create objects that are more widely used (or, better, used by those with similar characteristics to a given subject) may be given extra weight when offering recommendations or may be more easily discoverable when visiting a virtual location. The PageRank algorithm is among the most successful in helping to identify reputation and has already been considered for use in virtual worlds as a means of improving linking (Eno et al. 2010).

5.5 Potential Interfaces for Mediated Collectives

Once we have successfully identified a means of collating information about people and objects in virtual world that can be used to affect future behavior, we are faced with the task of presenting our discoveries in a form that will have an appropriate influence. Immersive systems offer many more opportunities than traditional non-immersive interfaces to offer rich forms of guidance and signposts.

5.5.1 Leaving the 3D Interface

Most virtual worlds provide a variety of means to list those around us, list friends, list locations, search for others, and so on, with hyperlinks, maps, and similar tools to teleport or otherwise locate items, locations, or people of interest. In such cases, all of the well-tried and commonplace methods used in adaptive systems, recommender systems, and search engines may be used to good effect. However, though such techniques are useful, they fail to take advantage of the unique affordances of immersive spaces and are sufficiently well covered in the literature to be ignored here.

5.5.2 Landscape Shaping

The shape of the virtual space is infinitely malleable, allowing us to (for instance) hide or reveal objects, modify paths, create or demolish walls, or generate whole objects in response to the information about the learner that we have gathered. It is also possible to design the system to encourage individuals to engage in environment shaping. For example, enabling visitors to drop rocks to build virtual cairns is a simple but effective means of social navigation that is found in nature but which may be enhanced in the virtual space through, for instance, providing people with an indefinite supply of marker stones or giving different users different kinds of marker. We might, for example, use a clustering algorithm to group similarly intentioned learners and provide them with stones of a particular shape or color to drop on cairns. Alternatively, we could provide an assortment of stones and allow learners and teachers to self-identify their purposes in dropping them. Future visitors would thus be able to distinguish what kind of people with what kinds of needs found a given landmark or object interesting, helping to identify pedagogical purpose as well as preference.

5.5.3 Highlighting

Various methods may be used to draw attention to things of interest and deflect attention from things that are less interesting. Colors can be used to great effect, as can relative levels of brightness or shadow. In combination with other methods, these may help to provide the kind of differentiation that learners might need. For example, if teachers or others of higher reputation leave a different color or intensity of footprint, it may help to select useful paths. Conversely, using the same technique, teachers may find it valuable to follow trails of students to discover what is of greatest interest.

Movement is especially effective in drawing attention to items of interest. For example, the Knowledge Garden represented items of knowledge as flowers that moved when browsed (Crossley et al. 1999), thereby offering a means to both highlight topical knowledge and to enable natural processes of decay to prevent the magnification of errors typical of systems that run too easily into the Matthew Principle. Adding a wireframe to an object of interest has been used to good effect in the 3D extension to AHA! (Luca 2007).

Footprints and other trail indicators have been quite widely used to show paths to items of interest (e.g., (Ruddle 2005)). If combined with other explicit and implicit techniques, these may give useful information about where to go next (and where not to go). It should be observed, however, that such cues have been found to result in unexpected behaviors – notably, we have found that some people explicitly avoid following the paths of others (Dron 2005a).

5.5.4 Explicit Signs

Many immersive environments use signs and icons to draw attention to objects of interest, such as pointing an arrow or floating a light bulb nearby. More explicit signs may be used to give richer or fuller descriptions of what they point to, which may have notable value in an educational setting where it is important to show not only that something is considered valuable but also why it is considered valuable. Combined with explicit tagging and/or exposure of a user model (so inhabitants of the world are able to see why the sign is pointing in a given direction) such an approach may offer notable pedagogic benefits.

Graffiti may provide an effective tool at low computational cost that enables people to tag or label objects. Used in combination with effective filters, these may provide a customized experience making use of the collective in a manner similar to that offered through wikis.

5.5.5 Filters

Hiding or revealing information according to needs is a commonplace approach in adaptive systems but carries risks of excessive control by the machine: unless we have excellent algorithms this method is prone to preventing learners from accessing information or people who may be helpful. One means to avoid this is to put the filtering under user control. A simple way to implement this in a virtual environment is to provide filtering goggles or glasses to the user, who may then decide whether he or she wishes to apply such a filter. The filter may, for example, show only footprints of a certain kind (e.g., of beginners, or teachers, of those with explicit interests in a given subject area) or make visible signs painted on objects that are intended for one kind of user or brighten certain people and objects compared with others. Because the world is entirely malleable they may, of course, provide improbable distortions, enlarging, distorting, animating, or illuminating desirable and useful objects.

5.5.6 Beyond the Visual

Where immersive environments are enhanced with haptic feedback, much use may be made of texture, density, solidity, and other features revealed through haptic interfaces. For example, it may be harder to move towards things that the collective considers of little interest, or smoother objects may be considered more suitable than rougher ones (or vice versa). For systems that employ odor, the potential is even greater; making items (or people) that the collective considers harmful or of poor value smell bad would be a powerful tool for social navigation, for example.

5.6 Conclusions

To build an immersive environment employing collective for learning that goes beyond simple direct or stigmergic effects it is necessary to consider algorithms and interfaces and, through experiment and study, to discover how people react to them. The potential of virtual immersive spaces to assist in collective-guided learning is enormous because of both the richness of data about people and objects that can be gleaned and the richness of interfaces that may be constructed to present the processed data.

In terms of data that may be discovered, the slow evolution of virtual environments over the past few decades has led mainly to centralized, isolated environments and, though this is beginning to change, it has made some aspects of data collection simple–what happens in Second Life stays in Second Life. All in one place. To what extent the scrutability of such interfaces will remain, as virtual environments become more distributed or embedded in web browsers and apps, remains to be seen. However, even in a fully distributed space, the fine-grained information on interactions within a given space is still vastly superior to that which can be discovered in most web-based systems, even with tools such as heat maps and rich analytics.

In terms of presentation, we have discovered that a collective based on simple preference does not usually provide enough information to help learners effectively. Learners need to know more than whether other learners liked a certain object or person: they need to know why that entity was considered valuable, in what context, with what goals or needs in mind, and for what kind of person. Virtual spaces can provide a far richer range of differentiating cues for distinguishing such factors than traditional web or 2D interfaces, offering a richness and range of indicators that can be far more expressive and informative than their 2D counterparts without becoming unusable.

The challenge of discovering what works best lies ahead and will require a significant amount of empirical research, comparing methods and approaches. But, with such rich data to draw upon and such sophisticated means of representing it, the rewards may be substantial.

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Biography

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Part III
Collaboration

Chapter 6
3D Digital Environments for Virtual Teams

Michael A. Schuler

6.1 Introduction

Complex tasks are seldom handled by individuals only. Based on a mutual agreement on the anticipated outcome, composed teams of experts from different areas contribute their knowledge and workforce for a common goal. In case the team is well balanced, collaborates, and leaves egoistic behaviors behind, it can achieve an outcome superior to what the sum of all individual team member could obtain. The strength of teamwork is visible in team sports as demonstrated, for example, by France who lost with many individualists against teams of less skilled players by collaborating as a team in the FIFA World Cup 2010 (FIFA.com 2010). Collaboration is used in many disciplines, e.g., in product development, where specialized knowledge and experience from various areas (engineering, production, design, marketing, distribution, or management) are required to successfully proceed from the idea to the final shelf product.

Ideally, the team is closely located to the main area of operation to benefit of face-to-face meetings for communication, socializing, and collaboration, inevitable in case of physical work like construction sites. Nevertheless, globalization and the shift to an open (Bonk 2009) and rather flat world (Friedman 2004) require the consideration of international teams that are not subject to one company and its internal and local employees but (external) experts in their fields who are also knowledgeable in the (local) social, cultural, and regional behaviors and traditions. Interorganizational teams are especially required if products are composed of parts which require highly specialized knowledge and expertise; examples can be found in the automobile industry or IT sector.

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Nevertheless, international teams have also multiple disadvantages, which are, among others, the worldwide scattering (as members should be selected based on their expertise and knowledge rather than their location), their cultural and social background, and affiliation to other companies and projects. In this chapter, we take a closer look on this challenge with focus on how different technologies, i.e., 3D spaces, can be applied. In general, the scattered team can collaborate by:

1. Relocating the team members to a common office
2. Choosing different team members with fewer qualifications but being local
3. Use advanced information and communication technology (ICT) for distant collaboration (virtual teams) or
4. Considering (3D) digital spaces as an innovative technology for synchronous collaboration, communication, and collaboration

We should accentuate that 3D spaces could be seen (in a broader sense) as ICT in a three-dimensional setting. With respect to the focus of this chapter, we distinguish between ICT frequently applied for team management, coordination, and communication and prospective ICT, which is currently subject of research and not commonly used in industrial projects.

As we describe the advantages on an abstract level with some practical examples, a later portability on any environment should be straightforward. The chapter follows a use case but blends it with current research. Besides a brief introduction into 3D spaces, we describe the technology from the perspective of virtual teams, i.e., how 3D spaces can be successfully integrated in real-world settings while minimizing the risk of failure for project managers and team members. Following the introduction, we investigate in Sect. 6.2 how (scattered) virtual teams currently operate. The focus is set on socializing, identification with the project, communication, and simultaneous collaboration. In Sect. 6.3, we look into the advantages of applying 3D spaces as one prospective ICT to support the communication among the team members, to intensify the immersion within the team, and to reduce the overall costs of collaboration and team meetings. We explore 3D spaces but limit ourselves on two environments: Second Life and OpenWonderland. Second Life was chosen as a commercial platform that is probably the most common virtual world allowing a high degree of in-world freedom with respect to creativity and Open Wonderland as an open-source 3D space following a philosophy of establishing an environment for (team) work. Section 6.4 depicts two examples demonstrating how teams can work on a project while not being at the same location. We conclude the chapter by deducing implications for virtual teams using 3D spaces as ICT (Sect. 6.5) and outline areas for future research. Universities demonstrated multiple use cases of (international) collaboration and communication via 3D spaces, but up-to-date the transfer to industry is restricted to some test implementations and smaller scenarios. We discuss proposals for future research, i.e., combining different (emerging) technologies to overcome current limits like technology acceptance, usability, functionality in a business environment, and standardization.

6.2 Virtual Teams

Virtual teams consolidate experts from participating companies to (simultaneously) join their expertise on confined projects. In this section, we introduce the reader to virtual teams and discuss selected references (Sect. 6.2.1), as well as the management (Sect. 6.2.2), communication, socializing, and collaboration with focus on ICT in an international context (Sect. 6.2.3). The term *virtual* is used *conceptually* and reflects the idea of a *traditional* team with all members being near the same location, even though it is in a virtual space. Traditional and virtual teamwork is always based on high flexibility and ability to cooperate, collaborate, and communicate with each other to fulfill aimed goals, dealing with people in real life and real scenarios using real equipment.

6.2.1 Globalization and Virtual Teams

Globalization and the need for flexibility that are crucial on international markets forced organizations to adapt their traditional organizational forms with today's demands. Even without interest in extending their business to new markets or becoming a global player, companies have to comply with (international) standards, competitors, or requirements for supply chain integration. While local experts know their field of expertise, the implications of globalization are generally exceeding the capabilities of local teams (in terms of grasping all aspects in a defined time period), i.e., if culture, language, and social characteristics create barriers. One option to respond, and subject of this chapter, is the formation of temporary (virtual) teams to use distinctive knowledge and expertise for a specific task and a given time period.

Virtual teams are a group of people dispersed across many locations, communicating via ICT, and striving towards a common goal (Hakonen 2010) or projects "that require the creation of several coordinated multidisciplinary teams bringing together highly skilled individuals working in dispersed geographical locations" (Guzm'an et al. 2010, p. 2). Members of a virtual team come from several cultures, are able to work in and from different locations, have different teamwork practices, and speak several languages, although English is commonly used (in different flavors and levels), and meetings and communication activities rely strongly on modern technologies (Guzm'an et al. 2010).

Team size, member satisfaction, diversity, knowledge management, the available technology, and monitoring are relevant variables for establishing virtual teams successfully (Hakonen 2010). Such teams can also include one or more subgroups being responsible for different project stages. Furthermore, the number of subgroup members and leaders is variable. Especially team processes and outcomes are influenced by the quality of leadership (Ocker et al. 2009). In the following section, we take a closer look on the management.

6.2.2 Virtual Team Management

As we will describe below, the integration in the general business process is of high importance as everyone (and this is similar to traditional projects) has to commit (partial) work time to the virtual team and cannot proceed simultaneously on their usual tasks. In addition, the nature of virtual teams to be organized across branches and organizations might cause conflicts regarding affiliation and the own core business and its philosophy. Therefore, clear criteria of demarcation between company and virtual team have to be defined, supported by a later reintegration into the business processes despite the project tasks. Projects, virtual companies, and virtual teams share an important commodity: *they exist until their business objectives are fulfilled or lapsed*. The management is (in all cases) the key to success and covers the whole lifetime from the beginning (*preparation*) to the end (*disbanding*); see Fig. 6.1 for a visualization of the main stages, *preparation, project launch, execution, benchmarking*, and *closeout* (Guzm'an et al. 2010).

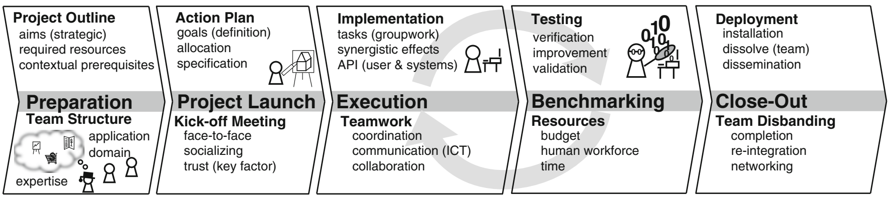

Fig. 6.1 Phases of a project

The preparation stage can be split into two phases: (1) defining the project (outline) and its (strategic) aims and (2) team composition with task assignment (Guzm'an et al. 2010).

The first phase is further subdivided in three levels: (1) defining strategic objectives, (2) planning required resources (e.g., time, cost, manpower), and (3) specifying the contextual prerequisites, i.e., preconditions, expected influences during the project, and anticipated outcomes. Without saying, this stage is the most critical one, as an error or misunderstanding would be carried forward throughout the project, with constantly increasing costs to correct errors later. With respect to the team composition, this might be the most significant stage for experts' advise in all essential domains to predict later risks and suggest potential solutions, i.e., time constraints and technological feasibility. Predefined tasks allow realization by non-expert, yet management and planning should rely on expertise. While the project outline runs along traditional projects, the team selection often requires more effort as the team members can be selected without limitations on distance (increasing at least the number of options as well as the time for search, evaluation, and negotiation).

The second stage describes the project launch and includes the action plan as well as the first kickoff meeting. After deciding on the members on the virtual team, the coordination and setup are far more complex as communication is induced by time zones, language, expectations, comprehension, and missing relationships, just to name a few (Callahan 2009). In general, a first (face-to-face) kick-off meeting is initialized, in which the whole team defines the action plan based on the overall goals. Although virtual teams are supposed to communicate via ICT, the initial face-to-face meeting could support building (initial) trust by becoming acquainted with each other, similar to small talk while having a smoke or coffee (Vyas et al. 2007). Socializing is one of the key factors for successful teamwork, virtual or not. During the kickoff meeting, the action plan is defined, containing a more detailed break-down of tasks including the allocation to team members and a detailed description of what to achieve and how to perform. The third phase (project execution) is about on fulfilling individual or group-based tasks: (1) how to communicate and collaborate in case of distributed groups and (2) how to present the results to team members as well as for later dissemination. In contrast to (traditional) teams in close vicinity, feedback and reports require advanced coordination and standardization to prevent (social and informational) exclusion of distance team members. While short meetings or casual remarks during socializing events supported the general overview about the project, we need explicit instructions about communication and reporting behavior. Without sophisticated coordination and communication, synergetic effects and effective development could not take place in virtual teams.

The benchmarking stage is about tracking the progress, budgeting, and anticipating outcomes with respect to the plan and quality defined before. As coordination and collaboration of virtual teams is often without face-to-face-meeting, motivation and affiliation with the team might suffer over time. Therefore, benchmarking (including distribution of status reports) in (shorter) time intervals is necessary to detect problems and deviations from the project plan as soon as possible to take appropriate counter actions. That is, the whole project is split in iterations, each consisting of an execution and a benchmarking stage. Testing implies verification of implementations as well as validation against the overall project aims and the context of the project itself. In addition, the testing should discover problems and suggest improvements for the next iteration.

The fifth stage close-out comprises the deployment of the project outcomes including the dissemination and exploitation in the anticipated context as well as potential other markets or scenarios. With respect to a successful deployment, it is necessary to keep a (core) team for coordination, whereas the other team members are disbanded and reintegrated in their previous tasks. To maintain a high level of satisfaction and motivation among all team members, the disbanding requires a constructive, careful, and efficient process (Guzm’an et al. 2010). Furthermore, social and work ties should be kept alive by modern networking approaches to (1) keep achieved team structures alive for other projects and (2) provide access to the gained knowledge and support in case of problems or future inquiry calls.

Distance has the largest impact on the management of virtual teams as the project leader is responsible not only for achieving the project outcome but also to maintain the togetherness of the team. Besides having a profound understanding of modern technology, project management, and human interaction, the management also has to handle the distance and its implications on motivation and trust. The trust in other team members is generally created through face-to-face interactions, a form of communication not given for virtual team members not knowing each other personally (Serrat 2009). Coordination, cooperation, communication, and visibility are negatively impacted by distance, where, e.g., time zones, languages, and cultural differences increase the complexity and cause further barriers in the real project (see Martinic (2009), Fig. 6.2, as well as the elaboration in Sect. 6.2.3).

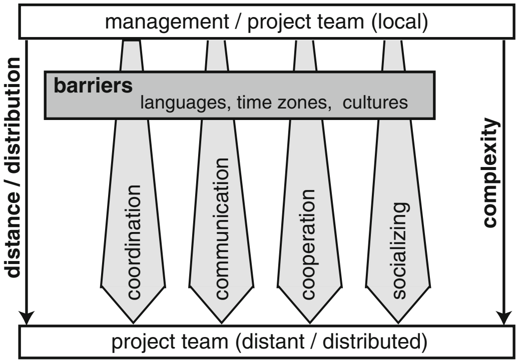

Fig. 6.2 Distance builds barriers and negatively influences team work (Martinic 2009)

Modern ICT facilitates spatial expansion of teams. Without the continuously increasing bandwidth of the Internet and thereon build technologies, communication would not be sufficient to manage projects. The next section surveys current ICT technology to sustain socializing, communication, and collaboration despite given barriers. Nevertheless, we discuss in Sect. 6.3 that 3D spaces provide an even more sophisticated toolbox for team members and project management as these adapt easily and naturally with real-life (projects) and help to vanish barriers (Dreher et al. 2009).

6.2.3 Communication, Socializing, and Collaboration

Communication is the key to success for virtual teams and defines the essential tool box for collaboration and socializing. As discussed above, the team members including the management have to exchange information about project details and reports, whereas different types or priorities of tasks ask for specific forms of communication. Without further details and being exhaustive, requirements can be allowed media formats, achievability, accessibility, security, synchronicity, scalability, or expectation in (immediate) replies. Recent studies show that traditional IT is still the major means for collaboration; the dominant three tools are e-mail (96%), phone (mobile) (77%), and video (54%) and web conferencing (51%). On the other hand, modern communication tools, generally being associated with the Web 2.0 era, are not yet used on a regular basis (<10%) (The Economist Intelligence Unit Limited 2009). Figure 6.3 depicts features with respect to scalability to more participants, possible media formats at the same time, synchronicity, bandwidth, and availability of protocols for later review. Without any question, all kinds of communication bare their advantages over others (with some more qualified for team communication), but none stands out to be the best choice for all requirements. And using more than one risk that exchanged information is not aligned, misplaced, and, therefore, later overseen or lost.

In general, communication between (virtual) team members is done via Voice-over-IP (VoIP) or videoconference, to allow personal exchange and coordination, and text, to keep protocols and deliver messages where immediate replies are not necessary. (Note that videoconference gets close to face-to-face communication but lacks scalability to many participants and might breach privacy (private home, background) or bares individual problems (e.g., facial expression and shyness)). Erlandson et al. (2010) recommend voice chat for discussion and debate in virtual teams to compensate the different places of team members if being online at the same time; see also Fig. 6.3 for a comparison of different communication technologies; e.g., traditional face-to-face communication, e-mail, and different types of conferencing tools.

ICT	Scalability	Media Formats	Synchrony	Bandwidth	Protocol
E-mail	high	multiple	no	low	yes
Telephone	low	single	yes	medium	no
Smartphone	low	multiple	yes	medium	no
Video	low	single	yes	high	no
Chat	medium	multiple	yes	low	yes
Wiki	high	multiple	no	low	yes
Social Network	high	multiple	no	low	yes
Online Office	medium	multiple	yes	medium	yes

Fig. 6.3 Communication technology by distance and time restrictions (He 2008)

Socializing in virtual teams refers to the fact that "individuals define themselves in terms of their social group memberships and that this group-defined self-perception produces distinctive effects on social behavior and inter-group relations" (Hakonen 2010, p. 8). Social factors are crucial to determine whether communication in a computer-supported virtual team can be incorporated to achieve the project goal within the defined time period. Being present in a virtual team depends on the social presence of one team member to another in a virtual environment (Allmendinger 2010). Social cues in computer-mediated communication are important factors to build interpersonal trust, being a key factor for successful teamwork (Hakonen 2010).

If individuals know their part in a social community (and how others rely on them), they achieve an intrinsic motivation to contribute to the project in their best effort. Virtual teams can be seen as small, closed social communities with various expertise to achieve the project goal (Chang and Zhang 2008). In addition, socializing also implies coordination by having (hierarchical) roles with responsibilities assigned to them. Coordination provides larger teams with an overview of progress and evaluation of task execution and outcome and prevents (duplication of) work not required for the project outcome. For virtual teams, management is far more challenging compared to traditional team in just one place. On the one hand, management has to use ICT to monitor and instruct the team members without being too influential on how to work as this would increase pressure and decrease motivation, i.e., as we assume to have only experts in their field who knows how to achieve a given goal in their discipline. The most difficult task for managers in virtual teams is solving problems and conflicts without face-to-face-meetings as most ICT does not allow group meeting with all communication forms being available.

Socializing and communication directly influence collaboration. ICT has to exceed classic communication to support productive collaboration beyond exchange of messages by text or voice. ICT generally separates communication from the working environment and causes media discontinuity; e.g., remote desktop connections allow access to distant systems and tools; Adobe Connect provides a combination of several video streams (video, slides, and software); and Google Docs allows synchronous collaborative work on the same document.

The lack of integration shows further limitation for successful collaboration, i.e., with respect to time and interruption of workflow. At team meetings, questions often relate to small issues which require short and immediate answers (via text messages), discussions (via voice or video chat), or access to applications like development environments (via remote desktop). Tools for simultaneous communication merge several media channels into one interface allowing each individual to follow the required channel based on the situation.

6.2.4 Advanced ICT for Virtual Team

Prior to demonstrating alternative ICT, we have to recapitulate and summarize requirements for ICT used in virtual teams. Without any doubts, existing ICTs like e-mail and instant messaging are valuable tools and the Web 2.0 provided marvelous platforms to build (social) networks, build common knowledge networks (Wiki), or communicate using new collaborative technologies (whiteboard, mindmaps, online office applications or project management). And application programming interfaces (APIs) prevent ICT islands as functionality and data can be exchanged; e.g., ICTs access systems to add data or screenshots to the communication.

APIs focus on computer-to-computer exchange and do not include (groups of) users. But communication and therewith socializing are, as mentioned above, more than exchanging text, video, or voice. It is also about emotions expressed by appearance, body language, facial expressions, and voice modulation and about being together at the same time in the same space, for instance, for the job and in off times like visiting coffee places. With virtual teams, this is not always given as distance and time zones put restrictions on meetings. Even common situations can cause conflicts based on culture and personality and are almost impossible to resolve without face-to-face meetings (Dreher et al. 2009). So far, we talk about ICT from a rather functional perspective. The common idea is an immersion of the user in the actual communication. That is, using an avatar for physical and social presence and interaction to add appearance as well as facial expression for the communication (Allmendinger 2010). Furthermore, the space would be extended by another dimension (3D) to converge the communication with the reality. What are the implications for the user? First, communication benefits from spatial aspect, e.g., physical locations can be represented including immersive sound systems with fading volume with distance. Analogue to reality, several users can come physically together to talk, including its visualization (difficult to get in voice chat), to whom (position and orientation of the avatar), in which role (appearance, standing, and movement), and what intention (facial and body expression, voice modulation). Presentations are visible to everyone at the same time (restriction applies for security, culture, and technology as mentioned above), allowing to reply or comment without delay, i.e., using manifold media formats like chat, voice, or visual expression.

Networked virtual environments [NVEs; see Liang et al. (2009)] define spaces for communication and interaction, whereas different domains imply specific features, i.e., social networks with focus on communication, relation, and exchange of information. With increasing connection bandwidth and powerful hardware for advanced graphics, the environment might even be enhanced by 3D avatars (compared to (profile) images) and virtual worlds with user-generated content; examples are Second Life or Blue Mars (Liang et al. 2009). The *game-like* interface with high flexibility, the 3D presentation, and usage of (humankind) avatars address users who prefer natural interfaces over standard graphical user interfaces. NVE provides multiple communication channels, e.g., audio, text, and visual signals to display, for example, nonverbal information.

The prospect of NVE is to create a virtual society (Bosser and Nakatsu 2006) based on common understanding from the reality, including intelligent virtual avatars (so-called bots controlled by the NVE rapidly responding to virtual world events) and visual perception (Liang et al. 2008)—a space where, e.g., people can meet, interact, and socialize similar to the real world. Intelligent virtual environments (IVEs) merge the virtual and real world and enhance the immersion by eliminating the distinction of avatars controlled by users and (intelligent) bots controlled by the IVE (Reiners et al. 2012). In its perfect form, the user is fully integrated in the continuously developing virtuality.

Computer-based (virtual) spaces that are able to expand and enhance our ability to collaborate (and communicate) synchronously with other users are called collaborative virtual environments (CVEs). Here, it is about incorporating multiple multimedia formats, for example, nonverbal information and technology, to support social presence that extends the experiences with the real world by haptical devices, like (3D) head-mounted displays or sensory gloves, and intense immersion with the environment (Konstantinidis et al. 2009). All factors are targeting a higher motivation and satisfaction of involved users by sharing experiences, build social bindings, and benefit from synergies and knowledge of all collaborating team members.

From an ICT perspective, 3D spaces offer an increasing number of communication advantages. They extend the traditional capabilities of teleconferencing and text/voice communication by adding spatial dimensions. Unique is that channels can be used concurrently without media breaks. They can be chosen depending on the kind of reply and recipient, all at the same time in the same space rather than using different applications or only have minimal support for each media type. In addition, the social presence is increased for all channels by using avatars. In general, the user's social presence in text chat is very low and requires a larger amount of time to perform tasks than using voice chat but losing simultaneously the protocol functionality that text chat provides by default. For example, the lead speaker can use the voice channel to broadcast the message to all present team members, while queries can be submitted via instant messages without interrupting the meeting while being heard by all. The voice as well as instant messaging channel can be annotated by further media being projected into the 3D space. Besides slides, all (authorized) avatars can upload and project images and videos on specified walls or place 3D models of their work for demonstrations or initiation of discussions. As we demonstrate in Sect. 6.3, another advantage lies in the transaction costs, which are reduced by limited cost for traveling and required software and hardware. For group projects simultaneous work is very important and most 3D spaces empowers such collaboration. The real-time progress of team members can be visualized and communication via instant messaging, voice chat, or gestures is available. Therefore, virtual teams are able to work in-world and share knowledge and their experiences via different communication channels.

In modern learning environments the lecturer is often confronted with multinational students; it is also required to consider cultural norms, religions, and ethics for members of virtual teams (Dreher et al. 2009). 3D spaces require personal computers connected via Internet to allow participation and socialization of many people at the same time (Chang and Zhang 2008). Today, CVEs are primarily known for their gaming applications, so-called massively multiplayer online role playing games (MMORPGs; like World of Warcraft) and for educational purposes. But apart from gaming and education their very popular application area is recreational and social usage. Perhaps, the biggest difference between gaming and social CVEs is the absence of explicit goals. For instance, Second Life provides its users with multiple options for communication and content creation without underlying goals, rules, and processes. 3D virtual worlds are created and imagined by its inhabitants and therefore very well usable for the purposes of virtual team environments (Pinkwart and Olivier 2009).

6.2.5 *Enhance Virtual Teams by Modern ICT*

To enrich the cultural exchange as well as the individual experiences in multicultural teams in general, it is important to provide an effective and sophisticated project and team management. Different geographical locations, time zones, and cultures often result in working and communication barriers between team members (Brown 2009). In this case, it is important to facilitate certain processes like team building and exchange of information and communication to lower the risk of potential problems and increase the overall efficiency. Team leaders and managers have significant influences on the team's behavior (Brown 2009) by providing superior technology for communication and support to create different values within the (virtual) team, i.e., trust, mutual respect, self-perception and awareness, commitment, expectation about the outcome, and time management. The relevance of good management qualities and advanced communication technology is crucial as team members originate from different cultures inhabiting unique characteristics, e.g., language, beliefs, values, working style, or skills (NOAA 2008). Understanding communication is very important and recognizing the importance of our daily conversation helps to build effective communication skills as required by (virtual) team members. In fact, everyone should be open for what other members say or write to understand our own biases and perceptions to avoid negative communication (AEAONMS 2007).

Using ICT enriches communication and basic business interaction. For instance web portals centralize communication about project information, bugs, and progress. Keeping a project moving forward also requires to take advantage of time differences, e.g., to exchange information and data during the shift change. Even though the traditional face-to-face meeting is ideal to communicate using multiple channels, modern ICT is taking over this old-fashioned interaction by providing NVE with enhanced services that compensate for drawbacks like traveling time and cost. Efficient communication encourages the development and allows creation of synergies in joint projects, as how virtual teams typically are. This advantage is about improving (or creating in the first place) products and services, as well as increasing sustainability, effectiveness, and flexibility for the team (PLASTIVAL 2010).

Nowadays, most projects require specific knowledge in multiple areas, increasing the importance of choosing the best experts for the project team. As mentioned above, this might imply to have people come from all over the world to the place of activity. This is especially true in research or prototype projects where expertise cannot be compensated by diligence and commitment. For example, developing a new product including its production line and distribution channels requires experts with knowledge in, e.g., design, engineering, business administration, marketing, or law. Collaboration is difficult to achieve with traditional ICT as distance restricts synchronous work on constructional drawings or building prototypes, which has to be sent back and forth by mail or postal services. (Networked) 3D virtual environments offer tools to collaborate at the same time on the same artifact similar in face-to-face meetings; e.g., the virtual environment can be used to build prototypes, being accessible (and modifiable) by all team members at the same time. Furthermore, other team members can observe the progress to include the information in their activities, e.g., building business models.

In the following section, we discuss how 3D spaces can be used in different projects, whereas this chapter accounts two projects being part of the University of Hamburg in Second Life project (Reiners 2010): the development of a container terminal and a bottle factory for a new (virtual) brand. Thus, we explain how virtual team scan collaborate, take advantage of the 3D environment, and improve the overall outcome.

6.3 3D Project Environment

The discussion about virtual teams demonstrated the relevance of ICT to support communication, collaboration, and socializing and even more important to keep it alive. Team members work in different surroundings and are confronted with manifold barriers that are not necessarily given (e.g., time zones, lack of spontaneous meetings or face-to-face communication) or demonstrate less influence (e.g., culture, language, company) if the team is able to meet and work on site. In this section, we present a brief introduction in 3D spaces (also known as virtual worlds, virtual environments, digital ecosystems, alternative realities) and discuss the advantages for teams coordination and socializing.

The introduction is followed by a brief case study describing the experiences from two projects, i.e., how 3D spaces were integrated in the real-life context and how the advantages prevail the risks. Thereby, we use two exemplary virtual worlds to visualize and expose features as well as limitations, without implying that these worlds are the first choice for projects and virtual teams. After the hype in 2008, the medial exposure of virtual worlds declined, whereas the (scientific) interest and research is still progressing and results in countless environments and new markets, i.e., education with various 3D technologies.

6.3.1 3D Spaces

The (research) community is using various synonyms and categories to describe and distinguish the focus and target group of 3D spaces. Some of the best known categories are massively multiplayer online game (MMOG) with further distinction in role-play (MMORG), first-person shooter (MMOFPS), and social games (MMOSG). Although (business) gaming is a valuable method to improve team cohesion (Wolfe and Box 1987), we focus on 3D spaces featuring tools for team work, meetings, and collaborative work, i.e., 3D spaces specialized on user-generated content. Without loss of generality, we use Second Life (commercial product by Linden Lab) and OpenWonderland (open-source project) to emphasize the advantages and risks of 3D spaces (Dickey 2005; Delwiche 2006); however, the concept can be transferred to other 3D spaces like OpenSim, BlueMars, or Entropia (with certain restriction to their provided functionality). For a classification of 3D spaces in different categories based on target group or age see KZERO (2011), a general introduction into the subject can be found at Rymaszewski et al. (2006) and Weber et al. (2007). In this chapter, we use the following definition: a 3D space can be seen as an online environment with a game-like immersion and social media functionality but without game-like rules or goals and can foster group participation and socialization by a rich array of communication media (see, e.g., Constable (2008)) In short, 3D spaces allow users to navigate to a (user-generated) environment using an avatar. The user can interact with the environment (via interactive components or bots) and other (simultaneously online) users (via ICT) (Pinkwart and Olivier 2009). Depending on the kind of 3D space (or provider in case of customization), the user profits from functionality, for example, interfaces to the real world, modifications of the environment (e.g., positioning, modifying, removing, or combining objects), number and kind of tools to communicate (voice, chat, gesture), collaborate (presentation, whiteboard), and socialize (meeting areas, network tools, notifier about online status), or market integration (currency and payment system). The visualization for virtual worlds is, in general, not restricted to 3D; example for 2D Papermint, for isometric perspective (2.5D) Habbot; and is either realistic (Playstation Home), fantasy (Moshi Monsters), or a mixture of both worlds (Second Life). Here, we focus on realistic 3D spaces such that users can project their working environment and experiences from the real world on the virtuality without additional barriers. This includes that objects in the 3D space should be projections from the real world with respect to their functionality or visualization. Note that this does not restrain new designs or functionalities, yet a telephone should imply voice calls, and objects for voice calls should be easily recognizable for this function by common elements (in particular considering different cultures, experiences, and knowledge in virtual teams). Interaction with 3D spaces is performed through different devices such as keyboard, mouse, or advanced hardware like Kinetic, while feedback is given through visualization on screens, head-mounted displays, or other haptic devices. And even though the input is still by mouse and keyboard, the human–computer interaction in 3D spaces feels more intuitive compared to traditional interfaces (e.g., Windows) as it often adopts real-life situations and reactions (Lee and Kok 2008)

3D spaces can be distinguished from virtual reality (computer-simulated environments that simulate real-world scenarios, often with sensory and haptic systems to improve the realism, e.g., flight simulator) and augmented reality (the real world is augmented by computer-generated elements like sound or graphics, e.g., navigation projected through glasses on the street). Virtual reality is often used for educational purpose in aviation or medical training (doing surgery on a artificial dummy) as it supports high degree of interactivity between real and virtual world. The user is able to explore and manipulate the environment using special hardware while receiving a visual and haptic feedback through, e.g., head-mounted displays to receive a maximum immersion. Regarding virtual teams, 3D spaces tie together manifold tools (as classic ICT) but offering an interactive, persistent, and simultaneous space. The 3D and usage of avatars reflect the reality in a project-related environment with an intu-

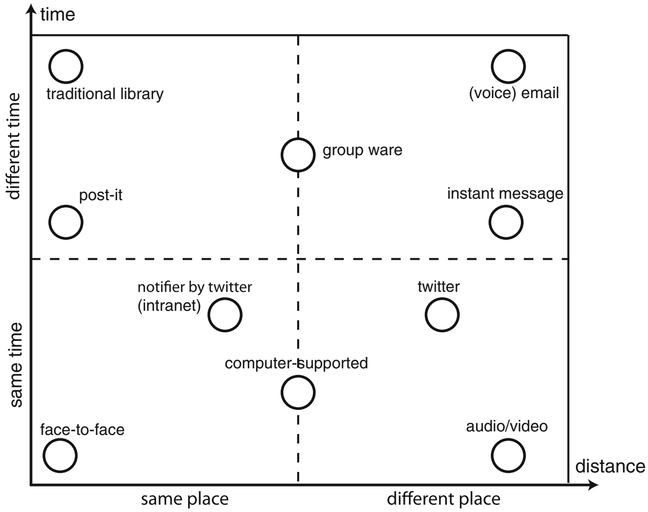

Fig. 6.4 Use of ICT for communication: risks and benefits [cf. Hamilton (2010)]

itive handing. Thus, meetings can be compared to real-life meetings, decreasing the relevance of distance, time zones, cultures, and context (de Oliveira and dos Santos Nunes 2009).

6.3.2 Real-World Concerns in Virtuality

As with ICT, it is most important to integrate the technology into real-world projects without building an additional barrier consuming man power, time, or financial resources. The project manager has to select the 3D space best matching the project requirements, i.e., ICT, access, compatibility, integration in the IT of all project participants, and further feature needed to collaborate (e.g., in-world construction of objects, shared whiteboards, execution of desktop applications).

Due to geographical distance and different time zones, problems occur that do not appear in traditional project management. Therefore, conflict resolution capability and cooperation are required to fulfill the anticipated objectives. Organizational dispersion, such as electronic security and sharing information, as well as cultural problems, like language, misunderstanding, trust, and use of technology, can be solved. Building trust is one of the key factors to resolve obstacles. Besides highly skilled members, special leadership is required to establish and complete complex virtual projects.

3D spaces offer different sets of features to exchange information with the real world. Figure 6.4 shows communication channels including their suggested use in virtual teams and 3D spaces to ensure an effective communication process and prevent lacks of security. For example, it might be counterproductive to meet in-world to discuss project results, if these are not accessible. Here, OpenWonderland with its focus on business applications allows integration of desktop applications like OpenOffice or Eclipse. The virtual team can stand around the *software*—being projected on a virtual wall—with their avatars. Each one can take control to, e.g., point out errors in a source code or continue writing on a protocol. Compared to other solutions like Skype, Google Docs, or Adobe Connect—to name a few—3D spaces combine multiple channels in one environment while users are present—and visible—via their avatar. The feeling of being in one room is essential for socializing, improving motivation, and coordinating activities. Note that Second Life does not have features like application integration.

6.3.3 Collaboration

Collaboration means team members work together—eventually from geographically dispersed places—to arrange and solve (sub-)tasks and assemble their (partial) results later into a final outcome. Therefore, it is crucial to understand collaboration and the socio-cognitive process of group work in joint projects beyond the general technical (i.e., tools for computer-supported collaborative/cooperative work, CSCW), social, and organizational management (Nova et al. 2007). Collaborative activities between team members support the acquisition of higher-level cognitive and problem-solving abilities to develop communication, social, and higher-order thinking skills. This leads to personal success and an overall higher team performance (Konstantinidis et al. 2009).

The restriction of face-to-face meetings (due to the extensive cost and time consumption to meet in real-world locations) can be compensated (to a large extent) by 3D spaces. Virtual teams are not only able to communicate synchronously via different communication channels like audio or video channels; they can also perform various types of activities simultaneously in the same virtual space, i.e., sharing applications to edit documents or present slides (Hasler et al. 2009). 3D spaces also use avatars, which add individual visualizations to otherwise faceless names. In addition, 3D spaces (in contrast to other media) visualize who is addressed during a communication by eye contact (turning the avatar in this direction) and audio (by an immersive audio system where the volume fades with distance) and, thereby, increase the immersive impression. For example, two avatars sitting next to each other at the round table (Fig. 6.5) can talk without being necessarily heard—by limiting the distance of their voice—and, therefore, disrupting the main conversation (Pinkwart and Olivier 2009).

3D spaces offer further advantages in fields like engineering, product development, or design. Instead of using stand-alone applications to create prototypes of objects, the team can work simultaneously, allowing immediate observation, modification, and discussion of (animated) 3D objects (Dreher et al. 2009). In general, teams require continuous coordination of resources to be able to efficiently accomplish goals and react immediately to changes (Bayerl and Lauche 2010). The shared

Fig. 6.5 Discussion in virtual teams (Pinkwart and Olivier 2009)

space and experience increase the efficiency, as all participants can input (without barriers normally given with ICT) their knowledge, rather than demonstrate and describe alterations and discover problems. Compared to reality, it is easier to gather experts from different fields and use synergetic effects to cut project duration and to improve the overall outcome, being presented, simulated, and tested in the 3D space (Lauridsen 2009).

6.3.4 Socializing and Communication

Socializing and communication is one of the key factors and directly influences the motivation, efficiency, productivity, and, therefore, the overall success of the project. In virtual teams, common opportunities to socialize (e.g., coffee breaks, chatting, lunch, or dinner) are not possible. Even the awareness of colleagues results generally from (written) communication and exchange of outcomes at milestones. Similar to collaboration, the avatar projects the user into a 3D space, where socializing is comparable to real life; i.e., the 3D space also offers non-work-environments to meet, interact, and communicate about non-work-related subjects. Note that in both the reality and virtuality, the team members have to fulfill contracts and have to keep socializing to an adequate level during work hours (Nova et al. 2007) and cannot be carried away by the variety given in 3D spaces.

Users interact with the 3D space. They have the ability to create and trade objects and extend the environment to their needs. With 3D spaces including components to socialize they become more and more interesting for the purposes of virtual teams as they combine all required features discussed before (Liang et al. 2009). Avatars are able to fit a (predefined) role by changing their physical appearance and their clothing. This helps team members to identify with their role far more naturally (Dreher et al. 2009).

Oertig and Buergi (2006) describe how import an excellent communication style is for the collaborative leadership. Therefore, selecting creative leaders, who are able to manage by influence rather than by authority, is very important. Top management still needs to continue face-to-face relationship building and communication, even if the team is dispersed over many countries. Another important factor, which is particularly important in this context, is continuous training, especially for new team members working from different continents. This will help to reduce potential distrust and, simultaneously, build trust on the other side.

6.4 Use Cases

The integration of 3D spaces depends on the purpose and intended support for the (virtual) team. During preparation and project launch phase (see Sect. 6.2.2), the inclusion of 3D spaces has to be planned as it influences the team structure (e.g., having a team member with expertise in 3D spaces), required resources (i.e., selecting the 3D space according to required functionality, hardware, bandwidth), and specification of goals (intended use of 3D spaces, e.g., prototyping, development, or presentation). Here, we focus on phases 3 and 4 and assume a settlement on Second Life and OpenWonderland, respectively.

6.4.1 Creating an Environment for Process Simulation

The first case describes a project in Second Life developing a virtual container terminal simulation (Reiners 2010; Burmester et al. 2008). The first meeting (including discussion about goals and plans), the entire communication and socializing had to be done online within the 3D space. Of the seven team members, three met in real life before the project started, whereas we only knew the avatar identity for the other four members. During the project launch, all team members but one had none or only few experiences with 3D development but contributed different expertise to the kickoff meeting: expertise about the project topic (container logistics), experience in Second Life from a user perspective, knowledge about design and usage of required (external) tools, and programming. The role of the project leader (and the strategic aims) was specified in advance, but otherwise everyone had to decide on activities, short-term goals, and allocation on the fly.

A later evaluation of the first kickoff meeting revealed that the experience came close to a real-life meeting as the (spatial voice) communication resembled a natural discussion with presentation by individuals as well as small groups. The projection as an avatar helped to identify the speaker and allowed to associate a real person in a specific role with it. The project leader wear a suit, while the planner had a notebook and the worker tools. The impression in 3D spaces is comparable to be in a large room, while standard conference (communication) tools require coordination of speakers as everyone is basically standing at the exact same point in space (no distinction by origin of voice, or in case of phone conferences, by image or video streams if voices are similar). The bonding of the team (and therewith the motivation for the project) was strengthened by project-independent chats and demonstration of (private) locations and objects as well as exchange of interests (Pinkwart and Olivier 2009). Note that it is advised to keep the main characteristics constant over time (clothing and other visual parameters like hair changed similar to real life, but even a complete avatar change works if it is following a pattern, e.g., using different animals or themes).

The simultaneous work in the 3D space enhanced the motivation, engagement, and efficiency: (1) immediate feedback prevents development in the wrong direction; (2) no redundant work by exchanging experiences and objects for re-use; (3) motivation by seeing the results of others (and therewith obligation to support the team); (4) request for help in case of problems; (5) using synergistic effects as developed objects can be re-used; (6) direct verification of compatibility of different activities; (7) possibility to directly improve or fix objects. All results are visible, such that the progress (with respect to the project timeline) can be monitored; the developed outcome is validated against the (strategic) aims, simulating processes for a logistics lecture. Second Life was chosen in this case (besides the team support) for the freedom in design and object interaction (through the internal programming language LSL) as well as the almost real-world behavior through the physic engine. Results from simulations could be used to compare different disposition strategies, to design algorithms that assign tasks to the vehicles, to be visited by students to observe the logistics processes, or to test modifications for the real-life terminals. Figure 6.6 shows two different stages of the terminal. We should emphasize that the interactive and highly visual environment caused an enhanced *learning by observing and doing*-effect as experienced team members could explain processes while performing them, even though they were in different real-world locations.

6.4.2 Virtual Teamwork

A large number of companies have already started using CVEs for business purposes, including online sales, product promotion, and meeting support (Pinkwart and Olivier 2009). Here, the collaboration with respect to communication dominates the purpose of the 3D spaces, while the first use cases depicted the collaborative design and development of scenarios. One drawback of virtual teams is that they work

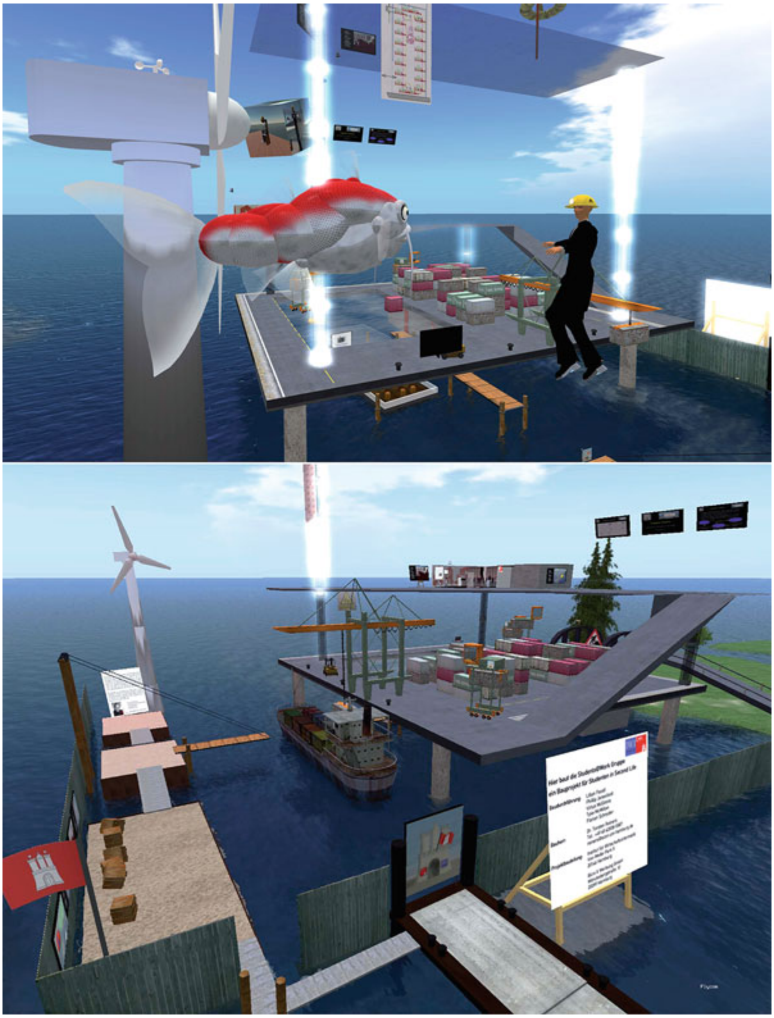

Fig. 6.6 University of Hamburg container terminal (Dreher et al. 2009)

in different locations and might not be able to identify themselves with the project. Creating a virtual office space (and its corporate identity) with an office for each team member (which can be modified to include personal objects and required tools) allows stronger identification with the project and better bonding within the team. While Second Life is more about visuals, OpenWonderland also offers effective tools for business meetings, basically everything that can be found in a real-world office, that is, communication (telephone, chat, fax, TV, video streams, etc.), presentation (whiteboard, slide presentation, etc.), or collaboration (integration of any computer application). A possible scenario for a group meeting could be as follows (and applied in our meetings with team members from Australia): The team with five

Fig. 6.7 OpenWonderland with applications projected on the walls

members is meeting in OpenWonderland, whereas only four of them have connection to the Internet. Thus, one is only connected by phone and visualized as a sphere. The aim of the meeting was not about creating 3D objects but on discussing a strategy paper and business reports. The strength of OpenWonderland is the integration of applications on any surface, still a missing feature in Second Life. Independent of the real-world location, everyone can observe the activities and can take control to edit documents. This is not restricted to one application, but—if necessary—further surfaces can be used to open other applications, whiteboards, presentations, or live cams to the real world (see Fig. 6.7) The group interaction process is characterized by communication and coordination activities which affect individuals and intragroup as well as intergroup relations. And a successful group interaction generally refers to team performance and personal success (Hasler et al. 2009).

Butter et al. (2010) describe an advanced inter-world integration of team members, where activities are synchronized across various devices and virtual worlds. For example, an information board to post messages (images, videos, notes) is immediately synchronized via a server to all connected devices, e.g., other 3D spaces, mobile devices, or web sites.

6.4.3 Advantages and Risks

Within 18 month roughly 90 percent of corporate virtual world projects fail due to insufficient understanding of the technologies and mechanics. Therefore, it is important to understand the influence on group and communication processes resulting from the design of 3D spaces. Today, the empirical research on sociability and usability of 3D spaces is still in its infancy (Hasler et al. 2009).

Mainly, economic advantages using virtual project teams generally result from economic benefits occurring from an almost perfect just-in-time report management system according to the requirements set out and, if available, from a 24 h working cycle. This so-called “follow-the-sun strategy” allows asynchronous working in conjunction, with respect on the aimed targets of the project, to be able to provide and deliver highly integrated and solid solutions when the onshore team leaves the office. Inherent economic advantages are offered to the customer. Virtual project management in combination with virtual teams always offers companies higher economic benefits, for instance, if skill set compatibility of its members and technical resources are provided. Hereby, no compromises should be accepted on the experience of the team members to achieve lower costs per hour using technical resources more efficiently. Furthermore, scalability is also a very important economic factor, because, according to the requirements, “it is much easier to ramp up the team size” (E2E Solution Providers 2011, p. 1).

Several opportunities and risks are associated with using these CVEs as so-called eCollaboration tools. Modern CVEs support group tasks in 3D spatial designs as a result of a working process or are at least important for such processes. Task-specific aspects of work processes require CVEs that offer 3D visualization, data sharing plus simultaneous text, and audio-based communication channels. Those avatar-based CVEs allow gestures, free movements, and expressions of emotions through avatars. Most of these functions are as well feasible with other communication tools, like video communication, but CVEs have the additional benefit that the avatar only exhibits the characteristics the user behind him explicitly wants. Therefore, they do preserve the privacy of the user and prevent undesired transmission of emotional expressions—in comparison to traditional video communication. CVEs can also serve, e.g., as a practice cooperation between virtual teams and are very well useable as a solution for training and real work scenarios when real-world scenarios might be too expensive or too dangerous and cooperation via rich 3D spaces seems to be very motivating for many team members.

Virtualization of communication, modern CVEs, and several advantages in communication technology support companies and also globally distributed virtual teams. In many cases such computer-mediated technologies do not perform as expected and do not generate the expected results. Mostly, technical information richness and insufficient user experience with these technologies cause inefficient results in project management stages (Fiedler and Gallenkamp 2008).

6.5 Discussion and Outlook

Virtual projects and their management incorporate a system for collaborating in virtual teams “for a finite period of time towards a specific goal” (Rolfes 2001, p. 1). As described before, globalization and its need for flexibility “has led to many changes in the nature of project team work” (Oertig and Buergi 2006, p. 1). The main focus is set on networked teamwork, like traditional project management does. Collaboration always involves and requires team member and partner selection, a leading project manager, stakeholders for financing the project aim, implementation, and project completion (Rolfes 2001). VPs are generally located in several industries and do not depend on firm size.

Successful project managers have to be extremely people oriented, because they have to create an environment that is innovative and productive, still with a very high performance, using different human and technical skills at the highest possible level. Different business areas have to be connected and aligned, such as scheduling, budgeting, risk management, monitoring, and procurement to accomplish the specified goals (Levin and Rad 2003).

The selection of the right people for the virtual team includes further criteria as team members have to be experts in their area, know about work responsibilities, but also match the team characteristics on a global level. Working under limited supervision and feedback characterizes the situation of those employees and partly social (real-world) interaction is also reduced. Besides this, very good time management and organizational skills are expected, too. Self-motivation, concentration, and demonstrating very good performance are obviously required, like in every other job, too (Rolfes 2001). Hence, virtual teamwork is characterized to be a more complex process than traditional face-to-face work. A virtual team usually consists of a project manager, project leader, and further six to nine project team representatives from various functional areas, like marketing or technical development (Oertig and Buergi 2006).

Project managing requires collaborative leadership with very high self-motivation, yet skills in communication and conflict resolution (Levin and Rad 2003). One major disadvantage in virtual projects is having individuals working in a virtual space. The way people collaborate and cooperate with each other in a team should not be taken for granted. Lack of familiarity and site-specific cultures may be sources of conflict (Oertig and Buergi 2006). Besides the human element, different project characteristics, like project team size, language, duration, virtual project environment, type, and costs, have a deep impact on the project's results.

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Biography

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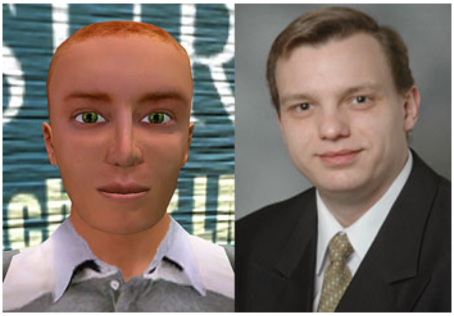

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Chapter 7
Second Life as a Virtual Lab Environment

Dennis Maciuszek, Alke Martens, Ulrike Lucke, Raphael Zender, and Thomas Keil

7.1 Introduction

Hands-on experiments in real-life labs are an integral part of modern chemistry, biology, psychology, physics, or engineering education—both in schools and in higher education. Unfortunately, such real-life labs come with a number of drawbacks. They are bound to a physical location. Resources are limited. The school or university can only provide lab workstations to a certain number of students. Experimentation time is restricted to the time the teacher has booked for class—which will often be as short as 45 min—or that the students have booked individually. Lab devices and machinery as well as consumable materials are costly. Experiments may endanger the students' health or in case of animal experiments harm the creature. Bringing a nuclear reactor to the classroom would not only be dangerous, it is impossible. Neither can complex ecosystems like a rainforest be re-created in class. There are experiments which are very time consuming or which simply cannot be observed in a lifespan, e.g., the growing of redwood trees or the development of forests. All these factors inhibit free experimentation, which should be the essence of educational lab exercises.

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A promising approach to address these shortcomings is to augment science and engineering education with computer simulations. For instance, the effects of small changes to whole systems can be experimentally shown and explicated—better than in theoretical explanations. Interactive computer simulations of experiments are often referred to as *virtual labs*. Although these have existed for a while, until recently each lab was a stand-alone application for a certain educational context implemented in a certain programming language. Basic things like the interaction design, the graphics, simulation details, or collaborative tools had to be conceived and implemented for every virtual lab. Now that the hype about multi-user virtual environments (MUVEs) like Linden Lab's *Second Life* (SL) is over and it has become clear that neither can virtual world entertainment or socialising replace real life nor are virtual environments the place to make lots of money, eLearning designers have started to discover the technology. In particular, virtual environments that already come with appealing user interfaces, realistic 3D graphics, powerful physics engines, Web 2.0 functionalities, and authoring tools for content designers appear to be promising as a basis for virtual lab implementations. We have created a virtual cognitive modelling lab in *Second Life* for an applied artificial intelligence (AI) course at our university. This chapter reports both positive and negative experiences.

To provide background knowledge for understanding the underlying educational approach, Sect. 7.2 first introduces the psychological framework of inquiry learning and then situates the eLearning paradigm of virtual labs in it. Section 7.3 describes our concrete virtual lab setup in Second Life. Section 7.4 details experiences and results. Section 7.5 discusses these by drawing informal conclusions and reporting more formal evaluation results.

7.2 Inquiry Learning and Virtual Labs

The constructivist teaching method behind virtual labs is inquiry learning (aka scientific discovery learning); see, e.g. de Jong and van Joolingen (1998) or Woolf (2009, Sect. 8.2). Students performing chemistry experiments in a school lab, writing a lab report, and arriving at conclusions about substances and chemical reactions would be a typical example of a traditional inquiry learning setting. The students mimic the working methodology of scientists and rediscover laws of nature. By investigating questions and discovering the answers themselves, they actively construct their own mental models of natural phenomena. Constructivism believes that this leads to better anchoring of concepts in the learner's knowledge.

Virtual labs translate this teaching approach to eLearning. The phenomenon to be discovered is simulated in a computer and visualised on a screen. Experimentation requires the learner to "interact" with the simulation. To be more precise, there are many possible ways of realising "virtual", "interactive" experiments. Figure 7.1 proposes a design space of virtual labs, i.e., decisions a designer has to make.

A virtual laboratory may stand on its own as a pure eLearning environment. Yet, it may also extend a traditional presence-learning course given by a teacher. Real-life lectures and virtual labs together would form a blended-learning scenario. Technically, this would be a mixed-reality setting.

Instead of using stationary PCs for homework after class, students could access and perform "dry" experiments on a laptop directly in the classroom or lecture hall, or on small, mobile devices such as mobile phones or PDAs at the local café, in the park, while travelling, and so on.

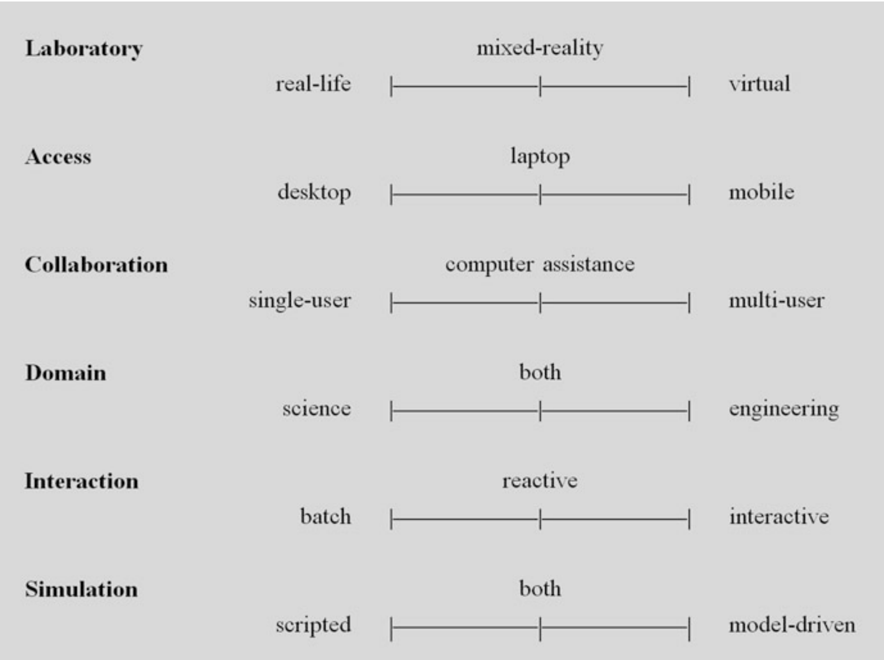

Fig. 7.1 Design space of virtual labs

Forming mental models through inquiry is a hard task (de Jong and van Joolingen 1998). Teachers may assist in the real-life lecture hall—or if the lab environment is designed as a collaborative, multi-user application, remotely by tele-presence. Students may work together on the same computer, in the same location, or collaborate remotely, as well. The latter case would mean a computer-supported cooperative learning (CSCL) scenario. If the designer cannot guarantee that an assistant is present, he or she should support model formation by computer assistance as in cognitive tools or even intelligent tutors [ibid.; Woolf (2009)].

In analogy to a real-life lab, virtual labs can help teach different knowledge domains, in particular science and engineering topics. While the simulation of a foreign country, an historical period, or a courtroom may be regarded as virtual labs in a wider sense, we will stick to the more traditional meaning of "experimentation" here. In a science experiment (Schauble et al. 1991), the student experiments in order to derive the model (reaction equation, historical discovery, diagnosed disease) responsible for the behaviour of a phenomenon. He or she produces discoveries. In an engineering experiment (ibid.), the student constructs a model (robot, vehicle) that generates a desired behaviour of a device. He or she produces inventions. In a virtual lab, the phenomenon or device is a computer simulation. In both, the science and the engineering view, the learner interacts with a simulated environment by manipulating simulation parameters through virtual tools. He or she notices changes in the on-screen visualisation, manipulates parameters again, and so on, until a model has been derived (science) or constructed (engineering) that is consistent with the learning objective.

Interaction with a simulation might simply involve batch processing (Fritzson 2004, p. 406), as opposed to reactive or interactive interaction. The software computes results based on input data for the whole duration of the experiment without the possibility of the user interfering. It could plot results onto a graph that the learner may then study, arriving at a new hypothesis which he or she can validate by modifying parameters and initiating a new batch run (Fig. 7.2).

Yet, in many cases, pedagogical use of virtual labs will require the simulation to respond to user manipulation of parameters "live", during run-time (Fig. 7.3).

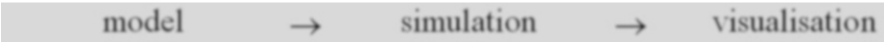

Fig. 7.2 Non-interactive simulated experiment

Fig. 7.3 Interactive experiment in a virtual lab

When constructing a virtual plane, an engineering student might not only wish to view data on the vehicle's aerodynamic performance over time and space, he or she would want to fly the plane in an *interactive* simulation (the metaphor "on the fly" is actually used to indicate live responses of a piece of software). Rafaeli (1988) defined reactive responses as reacting to the latest message and interactive responses as reacting on the basis of the whole message history.

A virtual lab can simulate (Lorenz 2001) interactive experiments that teach, for instance, chemical reactions or the aerodynamics of a vehicle. This would usually involve simulation in the strict computer-science sense: execution of an experiment over space and time based on a mathematical model (Zeigler et al. 2000). Furthermore, a virtual lab can simulate the actual, real-life lab environment and equipment, e.g., a chemistry lab with workstations, chemicals, machinery, and tools. These create a narrative frame around the actual experiment. If parameters are virtual tools and the visualisation is a virtual environment, this can make the interaction more intuitive and the experience more life-like. For instance, *Sniffy the Virtual Rat* (Alloway et al. 2005) is a virtual Skinner box in which the learner trains an animated lab rat. In a virtual lab, such environments need not be limited to classroom scenarios, but could appear in the form of a biological habitat—a lake, an ocean, and a rainforest—or a medical surgery, a factory, etc. In contrast to the actual interactive experiment, the narrative frame would be a "simulation" not in the strict sense but as an everyday-life term: reconstruction of reality (Martens 2008). Here, behaviour is not driven by realistic models, but simply scripted to happen as desired. A nurse's injection needle need not be modelled to the extent that pressing it with a certain force injects a certain amount of drugs. The learner may just drag an icon and drop it on the virtual patient.

Summing up technology requirements, any inquiry-based virtual lab will need a modelling and simulation environment—possibly for interactive modelling and "live" simulation. Domain knowledge needs to be expressed by dynamic models. These might be discrete state transition process models (finite automata, statecharts, Petri nets) or spatial models (cellular automata), or continuous differential equations. In the absence of a teacher, the virtual lab needs cognitive tools or intelligent tutoring assistance. If a teacher is involved, it needs a user administration system with access rights and an authoring tool for setting up experiments. In online scenarios, virtual labs require a network infrastructure and Web 2.0 functionality for student collaboration. If laptops or mobile devices are to be used for pervasive access, the designer must consider that these may need fast CPUs for computing simulations, high-quality video cards for display of virtual environments, or fast wireless connections for synchronous collaboration. Alternatively, one can simplify the scenario: use only asynchronous communication (forums instead of chat) or host computations on a server.

The following section details our design decisions for a concrete virtual lab to be used in undergraduate education.

7.3 A Cognitive Modelling Lab in Second Life

We have experience with lectures and exercises in applied methods of artificial intelligence (Applied AI) from 2001 to 2005 as part of the research group Modelling and Simulation at the Department of Computer Science at the University of Rostock. In 2007, the new research group eLearning and Cognitive Systems was established, whereas the responsibility for the Applied AI lecture remained in the hands of Modelling and Simulation. In 2009, we started a new course on our own, which took place in addition to the traditional Applied AI lecture/exercise combination. We wanted to try a new teaching style based on inquiry learning as well as game-based learning, i.e., using video games for educational purposes.

7.3.1 Course Content

In the years 2001–2005, our main responsibility was giving the exercises in Applied AI. The related lecture, given by a colleague, was based on the textbook by Russell and Norvig (1995). Our course took place annually in the summer term with around 50 third-year students of computer science and related disciplines participating. After each term, a small evaluation (questionnaire and/or interviews) took place. Additionally, all students had to pass an exam. In the exercises, we gave the students homework sheets including three to five tasks. The tasks had different levels of difficulty. Usually, there was at least one task to repeat part of the lecture content, one simple transfer task where knowledge from the lecture should be applied to a new setting and one more demanding transfer task, where it is not clear in advance which part of the lecture has to be applied to a new problem description. The exercise lessons consisted of solving these worksheet tasks (usually together with the students) and of discussion and/or presentation of additional problems and solutions.

Our observations were the following: due to the fact that solving the exercises at home was voluntary and not a precondition for taking part in the exams, only a few students arrived with solutions in class. Over a term, the number of students with solved exercise sheets receded. Over the years, approximately half of the students interacted actively in the lessons and at least tried to solve the presented (homework) exercises during the lesson (in interaction with the teacher). Naturally, the results of this behaviour led directly to effects in the exams. As a rule of thumb (and not surprising), the more active and interested a student had been in the lessons, the better were the results in the exam. In most cases, students had no problems solving the repetitive questions, but the more complex the transfer tasks had been, the fewer students could solve them.

In 2005, we were able to change the teaching style, as we were now responsible for both lectures and exercises. Thus, we developed a lecture style where small interactive sequences were mixed with the traditional "ex cathedra" teaching. No extra homework had to be prepared. Small exercises were directly integrated into the lecture. Every time an exercise phase had been reached, students were given a little time to read the task description and to think about potential solutions. Here, we mixed individual and small group approaches. After the reading and preparation time, the tasks were solved in collaboration—teacher and students. Regarding the exams, the results of this approach proved to be slightly better. However, due to the fact that the experiment took place only once, we have no long-term observation and cannot empirically support our observation.

Regarding the evaluation of the students' opinion about the lecture/exercise combination from 2001 to 2004 and the approach in 2005, we found no real difference. The students more or less liked the topic and the presented content. In some aspects, opinions about the exercises and the lectures show variations which depend on small-scale changes in the lecture content (and naturally also in the related exercises). One aspect was surprising. It was not really related to the evaluation, but led us to the idea to test a new approach. After having participated in the Applied AI course in their fifth term, some of the students came back to us later for their thesis work. When confronted with tasks that would require prior knowledge in AI, we saw that almost all of the students were not able to autonomously transfer taught knowledge to the new setting. In most cases, the students did not even realise that a task required AI techniques or algorithms. After explaining this relationship, most students were able to see the connection. Still, they were not very creative in solving tasks related to the AI background.

With our game-based approach in 2009, we tried to develop a new setting in which students would "detect" AI solutions on their own. Our main idea was that after a process of own knowledge construction in the sense of a constructivist approach, students would be more easily able to grasp the underlying AI ideas and to autonomously use them in new settings.

We conceived a project course "Game AI". It centred round the programming of intelligent software agents—programs that act autonomously on the basis of perceived sensor input, internal computations consulting a knowledge base, and actuators through which they manipulate the environment. An application area would be autonomously moving robots—or non-player characters (NPCs) in a video game! We applied a cognitive modelling view on Game AI (Funge 2004) that basically treats game characters as people with artificial minds. Understanding existing NPCs' behaviour and modelling how they "think" are a cognitive modelling task—the science view of inquiry learning. Actively programming "thinking" and behaviour is the Applied AI perspective—the engineering view. The course was targeted at computer science students in third year or higher. In the 2009 course, seven computer science students and two physics students in their third year as well as one teacher student (computer science) in a higher semester took part.

7.3.2 Technology Setup

We wanted to investigate prospects of using an existing 3D MUVE infrastructure for the purpose of setting up and running a high-end virtual lab, i.e., opposite to a completely mobile one. Linden Lab's Second Life seemed to meet the requirements. Second Life is an immersive environment in which the user navigates a 3D world with an avatar. It allows user-generated content by in-world 3D design tools and the *Linden scripting language* (LSL). The virtual lab designer may construct mathematical models via the script editor. Simulation of those models would happen via the script interpreter and a physics engine. LSL is state-oriented and therefore supports discrete models better than continuous models. Visualisation is straightforward, i.e., instead of "dull" diagrams, the student gains feedback through life-like, animated objects. Manipulation of parameters would happen by changing the behaviour of objects with the script editor or directly by avatar interaction with the environment, i.e., the ecosystem, the factory, etc. Moreover, Second Life is a *social* environment with support of communication and collaboration between teams and team members. Features include text and voice chat, instant messaging, and groups. In collaborative tasks, students' avatars can manipulate the shared space.

A variety of virtual labs exist in Second Life: virtual hospitals (Toro-Troconis et al. 2008), ecosystems (Ye et al. 2007), a pharmacy lab (*Pharmatopia* at Monash University, Australia), or a technical visualisation by the North German Technical Inspection Association coupled with a virtual meeting room (Boerger 2009). A couple of SL-based labs teach cognitive sciences (Weusijana et al. 2007) or computer science (Fortney 2007; Hobbs et al. 2007)—the disciplines associated with our AI course. This encouraged us to build our own Second Life-based prototype.

In accordance with the design space in Fig. 7.1, we made a couple of design decisions. We created a mixed-reality setting, as the course should consist of real-life lectures, projects to be done inside the virtual lab, and exercise sessions in which an instructor would be present in a classroom, presenting instructional material, while at the same time asking the students to enter the virtual world and perform experiments in-world. A graphics-rich MUVE like Second Life would not run on a mobile device, so we used desktop and laptop computers for accessing it. Students should be able to work in teams of two. Even when they were sitting next to each other, they would be able to use two PCs and have their avatars manipulate the environment collaboratively. We were not forcing both members of a team to have their own avatar, but it turned out that the students wanted it that way. We further planned for some true multi-user sessions in which to collaboratively discuss projects. The introductory exercise was science-oriented, albeit in an informal, playful manner. We gave the students a virtual creature. In the fashion of a behavioural scientist, they had to observe how it acted and responded to stimuli, as well as examine the script code to understand how its AI worked. Later on, the focus was on engineering. Assuming the roles of game designers, the students were to create intelligent agents, i.e., game characters, themselves. They would still formulate cognitive models, but in LSL, for the purpose of executing them to effect NPC behaviour. This would involve a lot of programming, compiling, and debugging. Yet, a MUVE scripting language allows the designer to begin with little code and advance by small modifications, always checking the effect in-game by engaging in interaction with the programmed agent (especially construction of new objects happens interactively in Second Life, as avatars work on 3D objects in-world). A programmed character does not just walk a certain distance or pick up one item, its script can be a true cognitive model that guides its reactions to different stimuli interactively in relation to internal "thinking". The term "scripting language" is misleading in this context. Students would not script, i.e., arrange a static sequence of atomic behaviours, but instead build models to be simulated in the strict, computer-science sense. For the programming tasks, we would provide very few virtual tools. The only "scripted simulations" would be non-intelligent objects, such as obstacles for the NPCs. For instance, a trapdoor to be avoided would not simulate the actual fall. Figure 7.4 summarises the decisions made.

We rented a *Second Life* parcel (2,048 m^2, 468 primitive objects—which turned out to be quite limiting—for € 110 per year) on the European University Island II and constructed a five-story lab building (Fig. 7.5). It consisted of a ground floor as a general meeting point and four floors for four student teams. While the teacher student worked on the ground floor to create a virtual meeting room, including several cognitive tools, groups of two (in one case three) computer science/physics students moved into the lab floors.

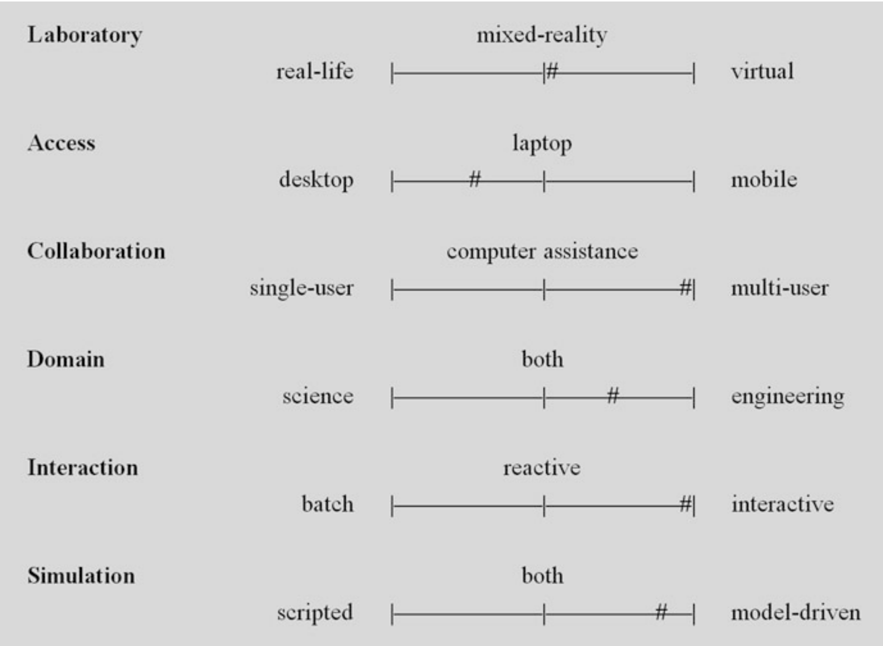

Fig. 7.4 Design decisions for the cognitive modelling virtual lab

By running the course with the described setup, we were curious to find out whether the students would accept the new technology and associated teaching methodology emphasising inquiry learning. Our hypothesis was that the game-like environment would strengthen intrinsic motivation and facilitate the acquisition of practical skills. AI should be more than a theoretical construct. Graduated computer scientists should be able to actually conceive and implement intelligent algorithms and agent modelling.

Another question was whether the chosen technology was suitable for the task. On the one hand, Second Life and LSL already come with basic agent technology such as sensors and events (seeing of objects, "hearing" of typed text, collisions, passed time, etc.), internal states, or actuators (ways to interact with the physics engine, such as movement by impulse, force, or a target). On the other hand, AI algorithms are usually costly in terms of computational complexity. Even though Game AI approaches problems much more pragmatically than theoretical computer science, game programmers would normally not implement "speed-critical portions of AI code—such as the code required to do a graph search, for example"

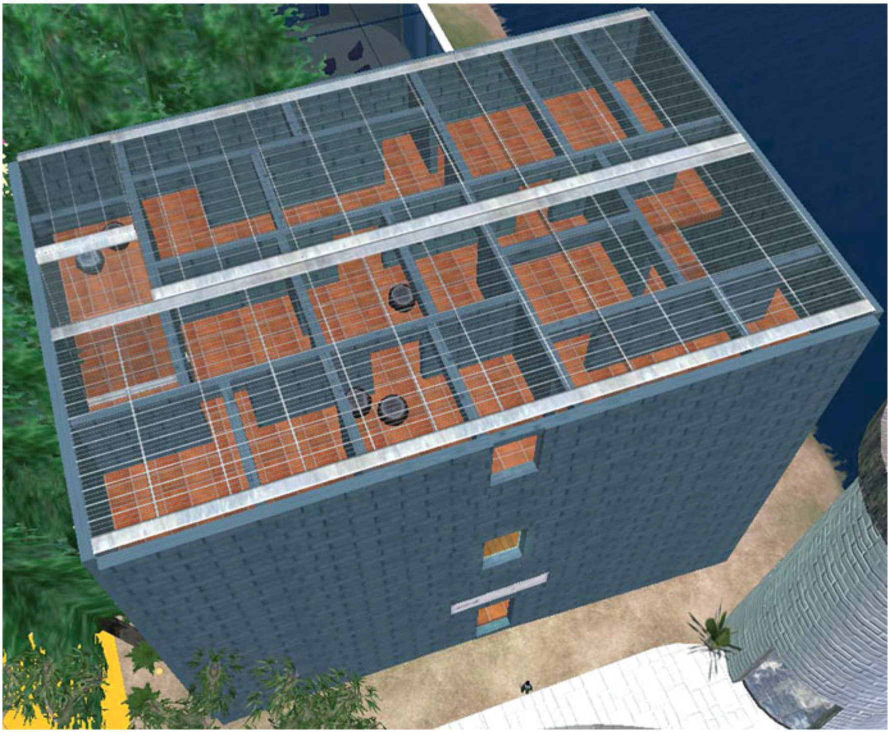

Fig. 7.5 The virtual lab building

(Buckland 2005) in a scripting language. A scripting language is intended to attach small pieces of behaviour to existing higher-level units (such as Second Life objects) implemented in a full, lower-level programming language such as C++. Normally, one would implement time-critical AI in the more powerful lower-level language. The major drawback of LSL seemed to be space. The interpreter has only got 16 KB of memory in which to do its processing (64 KB in the newer Mono engine).

7.4 Experiences and Results

Our *Second Life* lab environment first came to use in ten practical exercises that ran in parallel with the lectures. The students were to apply what they had learnt in theory to actual software agents in the virtual world. They met with the lab instructor in a university computer lab for 2 h a week. In addition, they were expected to spend time experimenting on their own, where and as much as they pleased. To the first meeting, they had to bring their created avatars. This did not pose a problem. Depending on motivation and skills, some students just stuck with a premade appearance, while others customised their virtual researchers in detail.

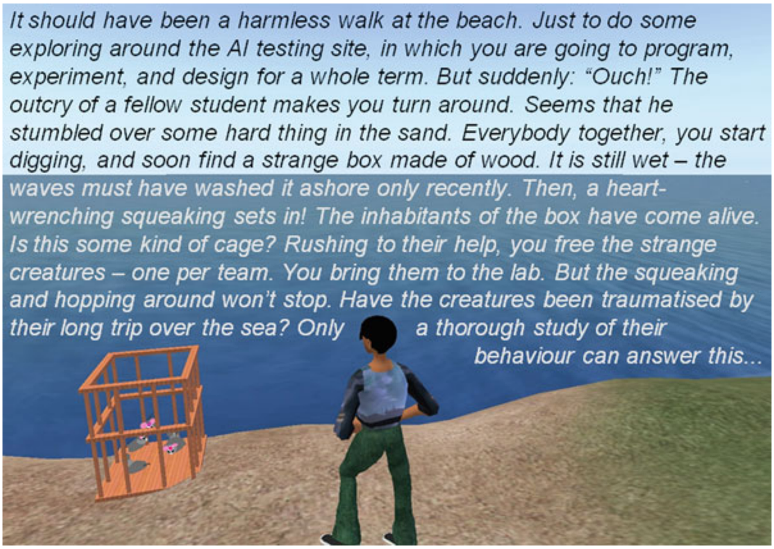

Fig. 7.6 Backstory for the virtual lab exercises

7.4.1 The Exercises

Exercises 1–3 covered the basics of agent programming in LSL. As a motivational vehicle, the first exercise introduced a narrative frame for the semester: the story displayed in Fig. 7.6.

Thus, each team picked up a virtual laboratory mouse. We found these in-world at *Freebie Heaven* (in the collection "Free Animals" by Steller Sunshine). They came with exactly the basic agent behaviour scripts that we needed. Further objects used in the exercises came from this site as well, but later on we only used the design, and no code. Each student team took their mouse to one of the five floors of the lab building, where they moved in for the rest of the term. At this time, they familiarised themselves with Second Life in the role of a user. Again, this was not a problem. Apparently, interaction is intuitive to anyone familiar with current video games. In this exercise, we applied the science view on inquiry learning. By observing the autonomous behaviour of the mice (squeaking, hopping around), interacting with them (typing "follow" to have them follow the avatar), and studying the LSL code—in conjunction with a short lecture by the instructor—they learnt about variables, functions, states, events and actions (i.e., stimuli and responses, in cognitive psychology terms), perception, control structures (conditions and loops) as well as spatial navigation by vector algebra.

From Exercise 2 on, the engineering view took over, as students were asked to "teach" their mice new tricks, i.e., design cognitive models to be executed. To continue the backstory, we introduced some tasks by messages in a bottle placed at the virtual beach. Exercise 2 taught perception—"seeing" in the form of visual sensors and “hearing” in the form of responses to typed-in chat text. Exercise 3 practised agent steering as the most basic form of acting intelligently in games. The textbook (Buckland 2005), which lists the algorithms Seek (move towards a target), Flee (move away from a target), Arrive (Seek and come to a smooth stop), Pursuit (move towards a moving target, anticipating its course), Evade (move away from a moving target, anticipating its course), Wander (randomly walk around), Obstacle Avoidance (move around a detected obstacle), Wall Avoidance (move away from a detected wall), Interpose (move in-between two targets), Hide (move behind an obstacle that blocks another agent’s line of sight), Path Following (move along predefined waypoints), and Offset Pursuit (Pursuit at a certain distance). Everybody had to implement Seek, Flee, and Arrive. The rest was optional. LSL turned out to be well suited for implementing vector algebra—at least in theory. In practice, the students evoked large amounts of unwanted behaviour, from objects that would not rotate as intended to mice that ended up in the neighbour’s garden or at the bottom of the virtual sea.

For Exercises 4–8, we adopted a game scenario directly from the lectures: the Wumpus world [taken and adapted from Russell and Norvig (1995)]. Our story continued with a new plot twist. The Wumpus, a genetically engineered monster from the lab the mice had escaped from, had come from the sea to take them back. The students had to program their agents so that they would escape the monster—as well as some trapdoors to deadly pits. True to the textbook, the game plays out on a 4×4 discrete grid. A stench indicates the Wumpus is near (on an adjacent tile), while a breeze indicates a near pit. “Smelling” and “Feeling” perception was realised as sensing a brown and a blue “phantom” (i.e., penetrable) ball, respectively, within 1.5 m (i.e., on the current tile). Besides advanced sensors and actuators, Exercises 4–8 taught knowledge representation and memory as well as problem solving in the form of logical reasoning. We broke down the theory from the lectures and the textbook to a set of rules almost ready for implementation, for instance:

```
if (known(not(breeze34)) || known(not(breeze43))) {pit44 = 0;}
```

`known` and `not` were functions defined by us. This rule in LSL means “If the agent already knows that there is no breeze in $tile_{34}$ or it already knows there is no breeze in $tile_{43}$, then it can conclude that there is no pit in $tile_{44}$”. Still, students struggled a lot with this task. This was not so much due to computational complexity but to difficulties understanding what to do—both conceptually and practically. Where Second Life was supposed to be an illustrative environment facilitating learning, LSL actually seemed to get in the way. For the teachers, it was rewarding though that some students did get the logical apparatus to work in Second Life and that they collaborated well. For instance, one team implemented the more difficult reasoning rules, while another team realised the simpler trapdoor, or an arrow to be shot, which was of medium difficulty.

Work had got stuck in the reasoning exercise, and time was running out. The students needed more approaches to cognitive modelling and applied AI from which to choose in the coming game design projects. In order to prepare them for these, we handed out different mini-projects for individual teams in Exercise 9. These covered cognitive abilities and AI algorithms related to decision making (performance measures), further knowledge representation (categories, decision trees), further reasoning (probabilities—this was partly initiated by students), further applications of steering (Obstacle Avoidance in a continuous Wumpus world), as well as further memory and mental states (finite state machines). Some projects were met with more interest than others. It seemed that at this point frustration with LSL was at its high. To our knowledge, nobody even tried to seriously implement Exercise 10 on Planning, an advanced form of problem solving. We had made an effort at supporting intrinsic motivation by designing a new environment—a small maze—and by concluding the story. Students were asked to implement behaviour of the evil Wumpus finally collecting some of the mice and returning them “home”. To this end, it had to compute the shortest path through the maze when visiting all three mice placed inside. Each possible movement between two mice, the entrance and a mouse, and the goal (a boat) and a mouse was defined as an action with a certain cost (the walking distance). Figure 7.7 shows an in-world top view of the Planning maze with possible actions. An actual Planning solution involves the automated generation of a tree data structure containing all possible sequences of actions and then choosing the least costly path.

The exercise was probably too difficult. In addition, motivation might have been low due to extrinsic motives, as evoked by the approaching exam period for other courses. Surprisingly, at a later point student motivation would go up again. Admittedly, this might have been related to extrinsic motives about our own deadline for handing in projects. Yet, it is amazing that one of the approaches picked up the idea of Exercise 10 and even improved on it by refining the graph and placing the exercise idea in an interactive, real-time setting (Level 4 in Sect. 7.4.3).

7.4.2 Group Meetings

The final part of the course was a project. Each team had to craft the level of an AI-rich game. To this end, we also used Second Life for virtual group meetings. The students had to come up with and agree on a common scenario, define connections between the levels, and discuss individual level designs with their peers. Altogether, we held two meetings at the ground floor of the virtual lab building. In both meetings, the instructor from the exercise sessions acted as a moderator. Besides speaking some introductory words, most of the discussions happened via text chat. This would better structure the conversations between ten people and provide an easy-to-use document for later reference, both in the design process and in evaluations for research purposes. The teacher student held additional consultation sessions with the individual teams (using different media), prepared the level design sketches for presentation, and crafted a number of collaborative tools. By these meetings, we extended the virtual lab paradigm towards a CSCL scenario. We have to admit here that the reason behind holding virtual project meetings was pure scientific curiosity. We might just as well have met in person at the university.

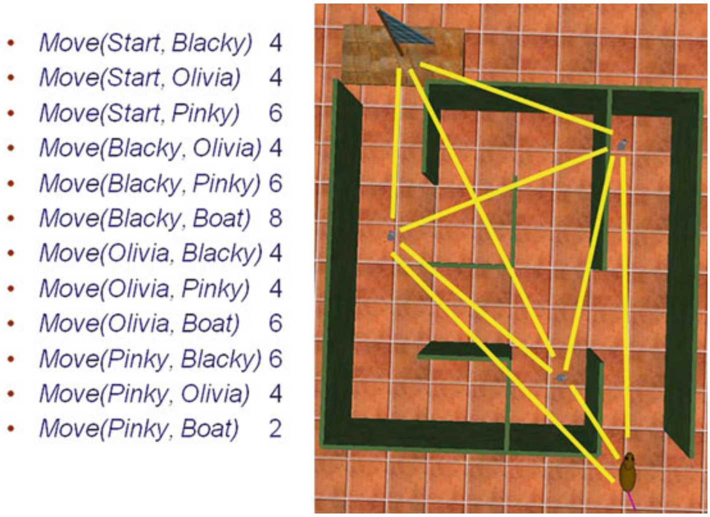

Fig. 7.7 Slide from the exercise sessions detailing the planning problem

In the first project meeting, the students brainstormed the game story and shared first ideas on individual levels as well as interfaces in-between. Prior to the meeting we had indicated that the action-adventure genre would be suitable, hinted at some possible story ideas—none of which got picked up here—and had asked students to collect their own ideas and send them to the teacher student. In Second Life, we met in the ground floor at a virtual seating area. First ideas were displayed as a texture on a virtual, non-interactive whiteboard (Fig. 7.8). In the course of the discussion, the participants agreed on a prison-break scenario. Arriving at this had been hard work. Apparently, the rather chaotic nature of the synchronous text chat did not encourage fantasising. Heavy interference, structuring, and inspiring of ideas were required on the part of the moderator.

The second meeting, in which the teams presented their level designs, went better. Having two users at most do a presentation with questions allowed afterwards led to better structuring of the chat. In addition, discussions were focused on more concrete information. By this time, we had outfit the virtual meeting room with new collaborative tools besides the sitting area and virtual whiteboard. There now was a speaker's desk—as well as poster walls for the level designs (Fig. 7.9).

Even though they were non-interactive as well, the poster walls were a success. They provided background information for the discussions (we had to increase the size of the textures though so that text would be easily readable), but most of all they focused attention on a current point of interest. We had the current speaker's avatar stand in front of his poster so that it was clear who was presenting. Such visual cues might have facilitated discussion already in the first session. For instance, a participant might have raised his avatar's hand, before he would be allowed to speak (Fig. 7.10). Second Life provides a pool of gestures to choose from. This may be extended by own animations. In Fig. 7.8, one of the students is playing around with

Fig. 7.8 Virtual whiteboard

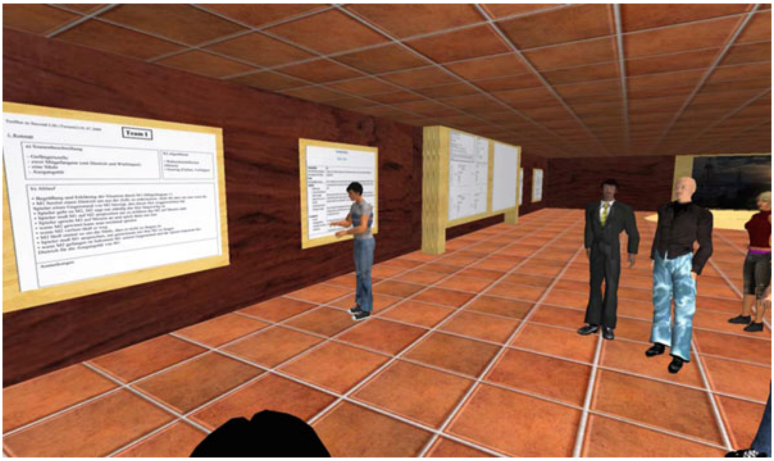

Fig. 7.9 Virtual poster walls

a primitive "hat". While these behaviours felt distracting at first, an item like this might actually function as a token to indicate the current speaker.

All in all, these collaborative and cognitive tools [see, e.g. Woolf (2009) for the difference between these and for further categorisations] can be created using existing Second Life technology. They were useful and structured chaotic online collaboration. We had successfully translated some aspects of face-to-face collaboration to virtual environments. Still, the experience did not live up to the real thing. After the virtual sessions, students told us almost unanimously that they would have preferred real-life meetings. At that time, we were already exploring alternatives that would go beyond in-world Second Life technology.

Starting from our design decision towards a highly collaborative scenario (Fig. 7.4), we wanted to set up a powerful communication system to cover the manifold areas of activity in our project. For this purpose, we made use of an advanced tele-presence infrastructure developed in another research project at our institution (Zender et al. 2009). The overall design goal of this system was to transparently interconnect several environments for face-to-face, online, and virtual learning. On the basis of a service-oriented architecture (SOA) we experimented with providing a number of educational services that can be invoked by different consumers in an easy and flexible manner (Zender et al. 2009). As depicted in Fig. 7.11, this included:

- Various platforms: Besides the lab/gaming environment and a meeting room in Second Life, we connected our campus-wide learning management system Stud.IP, where courseware as well as general organisation of and communication in courses are handled, and on-site labs (real-life computer labs, lecture halls, etc.).
- Various services: For a bidirectional communication, we made use of a video streaming service for tele-lecturing and a cross-platform messaging service.

This allowed our students to access the lectures of the course, both live and retrospectively, from their individually preferred environments. In the learning platform, we integrated the slides of the talk and a video of the lecturer with the help of an embedded player. In Second Life, the slides were shown on a large screen in the virtual meeting room of the SOA-based project (situated on the neighbouring parcel). The audio of the lecturer was mapped to her avatar. See Fig. 7.12.

Fig. 7.10 Avatar raising hand to signal intention to speak

Capturing of the on-site lecture took place with the help of *Lecturnity*, a common lecture-recording software. In addition to the given on-demand playback of the archived recordings, we added mechanisms for live streaming of the lecture as well as a sophisticated SOA infrastructure for association of recordings with courses and for brokerage of services, the so-called University Service Bus.

Additionally, it was possible to send and receive text messages between the platforms, transparently combining Bluetooth chat on mobile phones with Second Life's internal messaging system. For this purpose, we had to extend each list of available participants by the users from the other environment. In this way, for instance, the Second Life user could also see and exchange messages with all the on-site students (or their phones, respectively), and vice versa. This is demonstrated in Fig. 7.13.

We selected Web services to realise the SOA infrastructure. While the PHP-based *Stud.IP* could be easily extended in this way, we faced some challenges for the other environments. Regarding Second Life, the client software cannot be modified, which required us to introduce a so-called surrogate executing our SOA actions and talking to Second Life using its native protocols. Regarding the mobile phones, we had to bridge between the IP-based Web services on the one hand and the Bluetooth networking and services protocol stack on the other hand. These mechanisms of interoperability are a subject of our further research (Lehsten et al. 2010).

In the old meeting room based on traditional Second Life technology (lab ground floor), all students had to gather online via their avatars in order to participate in group discussions. In the project meetings for discussing the game design, however, many students did not see the point in meeting online. They would have made the effort to physically come to university in order to have a face-to-face meeting, which they regard as easier to handle. With the new, SOA-based technology, students can

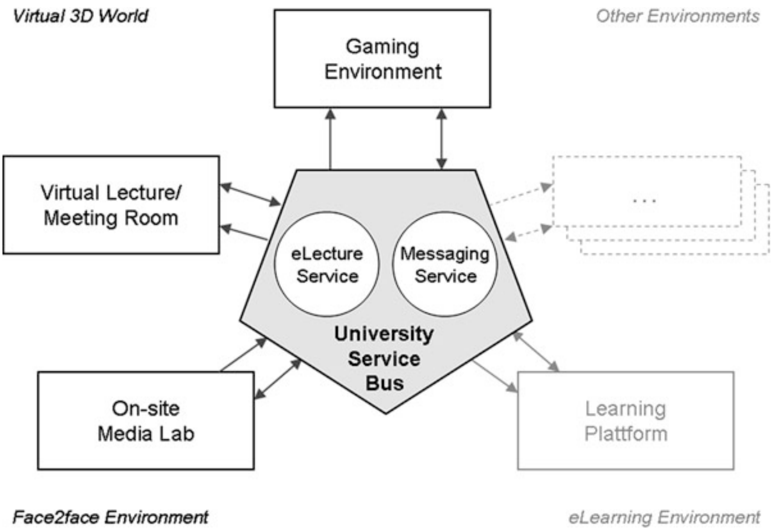

Fig. 7.11 Interconnection architecture with adapters to platforms and with exemplary services

now decide whether they prefer to take part physically or through their avatars. For some students, attending in person may not be possible, especially when thinking of projects that involve cooperation between different institutions.

7.4.3 Student Projects

Each student team had to craft one level of the prison-break game. We did not require much of the graphical design. Instead, the focus should be on implementing intelligent opponents. The students were to create the "brains" of NPCs. After the project meetings, we did not enforce a comprehensive software engineering approach, either. Of course, one needs to have an outline of the AI algorithm, but then a small-size scripting language allows a trial-and-error approach to programming. By this, we maintained the virtual lab learning scenario. The downside of giving the students more individual freedom was that there was very little further co-ordination between the teams. No puzzles evolved that require an item found in one level to be applied in another one. The only interfaces in-between remained the vertical doors. When the students began handing in their tasks, however, we were amazed at their sudden creativity. Despite initial frustration with Second Life and LSL—which to the students seemed to contradict everything they had learnt about structured programming—they had come up with original ideas and clever workarounds to make them real, leading to the modelling of quite intelligent agent behaviour.

Fig. 7.12 Integration of face-to-face lectures in Second Life (German: "My avatar goes to class.")

This success could be attributed to the fact that now the lecture and the exam period were over and the students finally were able to freely experiment as they pleased, without temporal constraints and without the weekly supervision. As noted already in Sect. 7.1, free experimentation is a core idea behind inquiry learning—and behind game-based learning as well.

The whole project is a four-level action-adventure game. The player finds his or her avatar imprisoned and must escape. Level 1 is the prison cell—an uncomfortable dungeon with mice running around, feeding of half-eaten food. The cell is situated below the office of the prison administration, which is guarded by deadly flying robots. Levels 3 and 4 contain further security mechanisms that need to be overcome before the player can reach the roof and be free. The goal of each level is to solve a puzzle or a mini-game that opens the door to the next level higher up. The works of the students show the creativity that inquiry learning can stimulate. And they show what is technically possible in designing for virtual environments on the scripting level. It may therefore be instructive to look at the results in detail.

In the first level of the prison-break game, the actual prison cell, the player is confronted with two mice—nicknamed "Pinky" and "Brain" after two popular cartoon characters (this is basically as much as the similarity goes). They talk to the player via chat or interact otherwise, e.g., using the dialogue box functionalities of Second Life. Pinky offers to open the exit to the next level in exchange for a wedge of cheese Brain stole from him. Hence, the player's goal is to convince Brain to give back the cheese. The level is roughly divided into two parts. The first part includes playing a dice game called *Meiern* (comparable to the game *Mia*) against Brain. In the second part, Brain runs away from the player. He can only be caught with the help of Pinky. When caught, Brain offers to return the cheese, and Pinky announces that the exit can now be opened for a short while by touching it.

Fig. 7.13 Seamless exchange of messages between Second Life and mobile phones

The level design concentrates on functionality instead of elegancy (Fig. 7.14). The pillars near the centre are necessary for the part where the player has to catch Brain. On the bottom left, the entrance to the level (from the ground floor) is visible. The stairs to the next level are on the upper right-hand side. Due to its simplicity, the level is dominated by the two mice.

The first part of the level begins with a conversation with Pinky and Brain that introduces the interactive story. This is realised using the touch events and the chat. Both mice have separate states for each step in the progress of the level. The story is a finite state machine (cf. Sect. 7.4.1). Furthermore, internal communication is used to pass messages between the mice, which are available for interaction concurrently. To finally start the dice game, the player must type the word “meiern” or a sentence including that word into the chat. Brain listens, its parser accepts the string, and he agrees to play the dice game with the player.

Fig. 7.14 Design of the prison cell

Fig. 7.15 A running dice game: player rolled less (32–33) and must lie about the result

For the dice game (Fig. 7.15), the students used the chat and the dialogue box (`llDialog()`), which supports buttons. With these, the player can choose what value he or she announces. This will either be the actual rolled value or, if it is too low, a lie. The rolled value is internally determined by a random number generator and passed on to the player via the dialogue box.

For the opponent, the students used a probability-based reasoning algorithm. The AI has to make two different decisions. When the player announces a value, the AI has to choose whether it calls the player a liar or trusts him or her, in the latter case rolling the dice again. This is done by comparing two probabilities. One is the probability that the player has actually beaten the last value the AI had rolled. The other one is the probability of rolling a higher value than the player. These values are averaged and compared to a third, randomly generated value between 0 and 1. If the third value is greater than the aforementioned average, the AI decides not to trust the player, otherwise it rolls the dice.

The other decision takes place when the AI rolls a value lower than the one announced by the player. In that case the AI has to lie, i.e., choose a number higher than the player's value, but still convincingly random. This is realised with another random value that is scaled down to favour smaller numbers and then fit to the player's value.

The resulting AI opponent shows a surprisingly authentic behaviour and is a tough opponent. We found this idea particularly intriguing. Developing a cognitive model of lying (even if it is a very simple model) and an AI that can convincingly fool the player was at no point hinted at in the lectures or exercises.

The second part of the level begins once the player has beaten Brain in the dice game. Brain begins to run away from the player (Fig. 7.16) in a way that always brings the pillars between them.

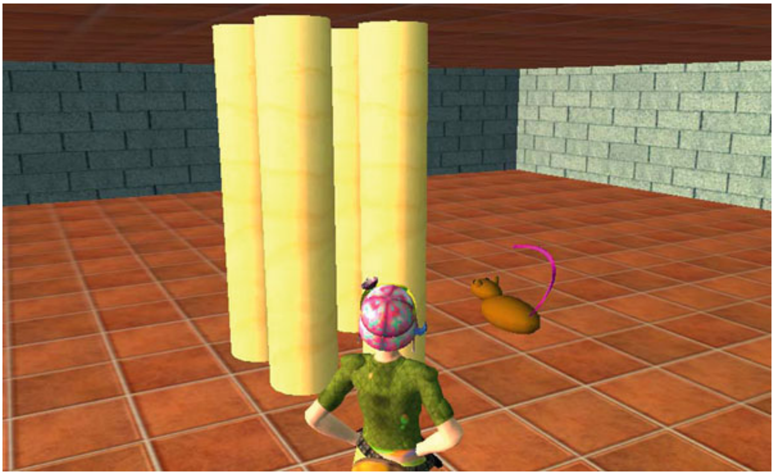

Fig. 7.16 "Brain" running away

Brain is definitely faster than the avatar and cannot be caught. The solution to this puzzle is to ask Pinky for help by touching him. He will step into Brain's path (similar to the Interpose steering behaviour, cf. Sect. 7.4.1). Thus, Brain can be caught between Pinky and the avatar. Immobilised, Brain surrenders, and the player has successfully completed the level.

The AI algorithm used for Brain's movement is a Flee steering behaviour (cf. Sect. 7.4.1). It detects the current position of the pursuers (the avatar, Pinky when required) using the function `llSensorRepeat()` and then tries to maximise the distance. The students used waypoints to discretise the continuous space of Second Life. The circular area around the pillars is divided into eight sectors of equal angular distance. Each sector has a waypoint assigned to it. The positions of Brain and the pursuers are converted to sector numbers (1–8) by comparing their distances to the different waypoints. All further calculations use that sector information. For the distances between Brain and one of the pursuers, the AI takes the smallest possible value (i.e., the values for the distances are always positive and less than or equal to 4). Both directions (forwards and backwards) are separately calculated using algebraic signs. If two pursuers are detected, the one with the greater distance is ignored. Brain then moves one sector into the direction that gets him away from the nearest pursuer: forwards, or turning around (`llSetRot()`) and backwards. This calculation is performed whenever in the state hunting the sensor event for visual perception (sensor setup: `llSensorRepeat()`; response to event: `sensor()...`) is raised. The movement itself is realised via the function `llSetPos()`, which simply moves Brain to the waypoint assigned to the destination sector.

In their implementation, the students have shown that even with the limited capabilities of LSL an evolving story can be presented. The authenticity of the level suffers from a lack of design efforts. For instance, there is no graphical representation of the dice, and it does not really look like a prison cell. Nevertheless, the completion of the main task, i.e., the Game AI, is convincing and a good example for what can be achieved even with a small-size scripting language like LSL.

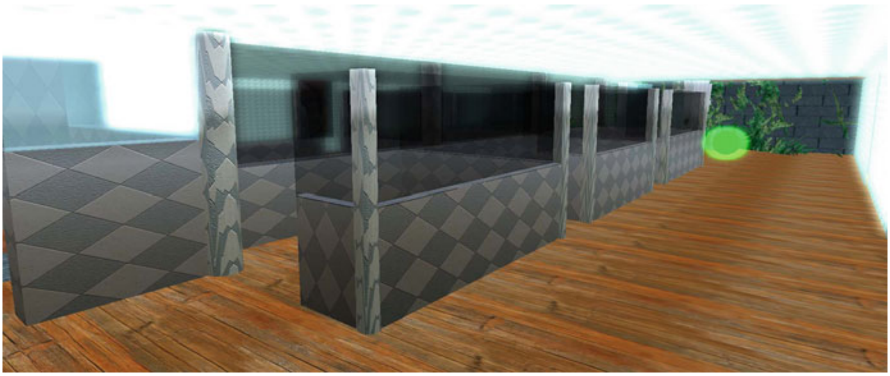

Fig. 7.17 Level 2 as seen from one corner of the room (one third of the "U" shape)

The second level of the game project is a hide-and-seek scenario in an office-like setting (Fig. 7.17). Two robots patrol along the corridors and capture any intruder they detect. The next level can only be accessed through the exit door. To open this door, the player needs to find a keycard located at the further end of the U-shaped level. The player must sneak through the room and avoid the robots.

The room is partitioned by several office cubicles bordered by a U-shaped corridor. The walls of the cubicles are partially transparent. That enables the player to see the robots before they see him or her. The excessively shiny white ceiling and walls and the glowing spherical robots are intended to generate an ominous and futuristic atmosphere. Furthermore, the bright colour of the robots makes it easier to see them through the glass windows (Fig. 7.18).

The player moves his or her avatar through the level as usually in Second Life. The robots have a periodic patrol pattern they run through individually. On standard patrol, the robots glow green. Sometimes a robot stops at a waypoint and begins to flash yellow and green. In that case, the sensor range of this robot is larger than usual, and the player should maximise his or her distance to that robot. If a robot detects the player, it starts to glow in red, visualising that the player has lost the game. The detected player is caged in a cylindrical cell that realises the teleport back to the beginning of the level. During the game, many hints are displayed via the chat window, text hovering over the robots or other objects, or a notecard the player receives in the beginning.

The robots are controlled by a Path Following algorithm with fixed waypoints (cf. Sect. 7.4.1). Based on a generated random number, the robot has a chance of ten percent to switch to a state of higher attention. This is indicated by flashing yellow and green and effects a higher sensor range. After a few seconds, the robot switches back to normal state and continues its patrol. A robot switches to the "red" state when it

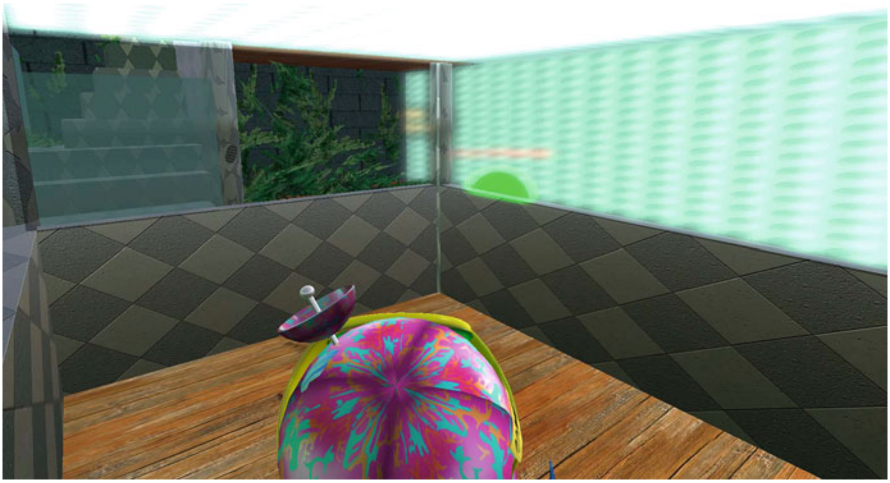

Fig. 7.18 The player hiding from a robot in an office cubicle

has discovered the player character. This idea shows that the students had learnt to apply the programming concept of a basic finite state machine (cf. Sect. 7.4.1), even if they may not have been thinking in these terms. Robot movement is implemented with the LSL function `llMoveToTarget()`.

For teleporting the player back to the beginning of the level, the students had to draw on a trick: Teleporting an avatar on its own is not possible, but teleporting an object with an avatar sitting on it is. The cell the player gets caught in contains a script that teleports the cell (and the avatar sitting on it) to the beginning when the player sits down on it. The command for sitting down on the cell was renamed to "teleport". A hint explaining how to teleport is given via the chat.

This level shows the possibilities in optical design given by Second Life. The implemented AI algorithms are quite basic, but in combination with the design of the level even these algorithms succeed in generating a sufficiently plausible context.

For the third level, the respective student team designed a physics-based clone of the classic *Pong* game (original version by Atari, 1972). The story concept is quite simple: The door to the next level is guarded by a security system that has to be beaten in a game of *Pong*; thus, it is a mini-game within the Second Life game. If the player beats the AI opponent, the exit door opens, and the next level can be reached. The level design is shown in Fig. 7.19.

It is dominated by the *Pong* playground. The white bars are the *Pong* paddles. The chair on the right is the controller. The robots in the background are mainly decorative elements. The closed glass door to the left is the exit to the next level. When the player approaches the exit door before having won the game, one of the robots gives out a hint about the AI and the *Pong* game. The entrance door as well as a chest with ammunition that activate the scenario are not shown in the figure. The central part of the level is the *Pong* game. The avatar has to sit down on the controller. This starts the mini-game (Fig. 7.20).

The one paddle is controlled with the standard Second Life movement keys (cursor keys or WASD); the opponent's paddle moves following an AI algorithm. The ball moves straightforward across the field and bounces off the walls and the paddles.

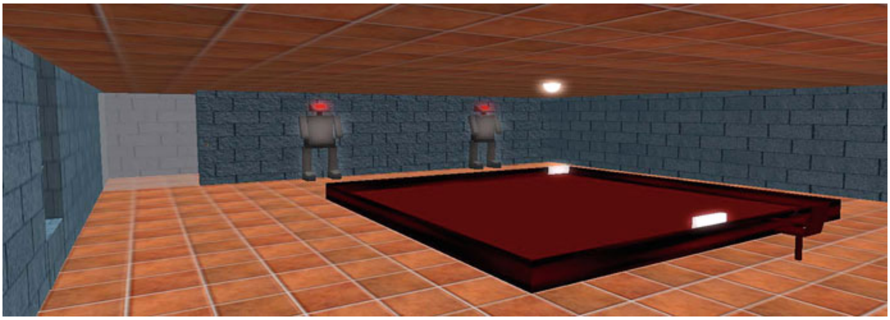

Fig. 7.19 Design of Level 3 as seen from the entrance door

When one player fails to reflect the ball (the ball touches the wall behind the paddle), the other player receives a point. Three points are required to win the game.

Several algorithms are used to implement the behaviour described above. The main problem that had to be solved was to use LSL for realising physically correct movement of the ball and the paddles. As mentioned above, LSL is state-oriented and therefore not ideal for continuous problems. In the case of the ball, the students used a workaround that utilises the collision with the floor as the main controlling event instead of a timer or sensor event. In the case that a collision event has occurred, the new force driving the movement of the ball is calculated and applied. The calculation of the force itself includes acceleration, stabilisation at the desired speed, and compensation of the friction. Friction had to be implemented empirically as the documentation of the physics engine in LSL is rather vague.

The AI opponent uses a sensor to detect the ball and a Pursuit algorithm (cf. Sect. 7.4.1) to move the panel towards the estimated position of the ball. A formula for uniform linear motion (*distance* = *velocity* * *time*) is used for anticipating the position. The motion of the paddle is a simple `llMoveToTarget()`.

All in all, this level shows some of the difficulties that can occur when implementing physical motion in LSL. The possibilities the language offers are diverse, but due to a lack of a profound documentation solutions have to be improvised or implemented empirically.

The fourth and last level of the adventure is a stealth game. It features robot wardens that search for the player and are able to teleport him or her back to the beginning of the level. The keycard to the exit door is guarded by a single robot warden that usually does not leave its position. The player has to distract the robot to reach the keycard. This can be achieved by using a security camera that issues an alarm on sensor contact. All robots including the keycard guardian follow the alarm signal and collectively move towards the camera room. This gives the player the opportunity to get the card and finally open the exit door.

Figure 7.21 shows the level layout. The entrance is on the left, the exit to the roof on the right. In between, there are rooms connected by doorways. The robots patrol the rooms to find and capture any intruders. The keycard is located in the room, in the bottom right corner, where the silvery keycard guardian keeps watch.

The player can move his or her avatar through the level (Fig. 7.22) using the usual first- or third-person view. When a robot detects the player, it tries to touch him or

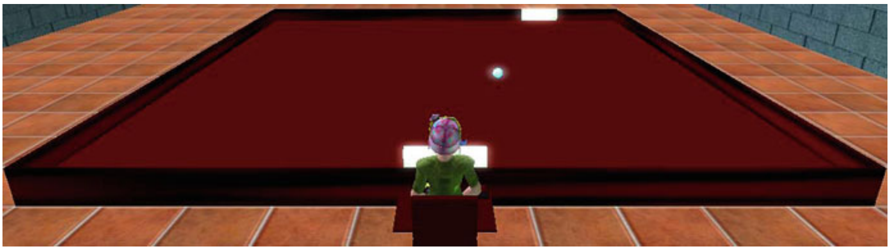

Fig. 7.20 A running Pong game

Fig. 7.21 Top view of the forth level

her, until it is successful or the player leaves the room. If touched by a robot, the player is captured in a cell that teleports him or her back to the beginning of the level (as in Level 2). If the player manages to leave the room, the robot loses visual contact and stops following directly. This is due to the implementation of sensors in Second Life and shall be explained below. If the player reaches the keycard, he or she can pick it up by touching it. The exit door opens once a keycard is rezzed (i.e., created or "materialised" in the virtual world) near the door switch.

This level utilises various AI algorithms to generate a satisfactorily authentic environment. The robot wardens use a Planning algorithm (cf. Sect. 7.4.1) for their patrol routes. Each robot maintains a local knowledge base that contains the current urgency (a kind of priority or utility) of every room. The longer a room has not been visited, the higher is its urgency. The algorithm chooses one of the rooms of highest urgency. The level design is internally represented by a graph. This is another case where the students themselves came up with a solution for discretising continuous Second Life space. In Game AI terminology, a data structure as in Fig. 7.23 is called a points-of-visibility navigation graph (Buckland 2005, p. 334).

A breadth-first search provides the shortest path to the chosen room. In addition to the room nodes, the doors are represented by subnodes due to the fact that otherwise the robots would fly through walls (or bounce into walls, if not declared as "phantoms"). The movement of the robots is realised with a timer and the LSL function `llApplyImpulse()`. The formula to compute the impulse (or in physics terminology, momentum) is the uniform linear motion (*distance* = *velocity* * *time*) combined with the mass-momentum relation (*momentum* = *mass* * *velocity*).

While patrolling, the robots sweep the area with their sensors. Unfortunately, LSL does not provide a test for actual *visual* contact with detected objects within sensor range, i.e., they are detected even if a wall blocks the line of sight. Improvising such a function was not successful due to limited capabilities of LSL. To prevent the robots from being able to see through walls, the students implemented a check whether the detected player is in the same room as the robot. A detected avatar located in another room does not influence the robot's behaviour. An avatar in the same room is being chased using a Seek algorithm (cf. Sect. 7.4.1). The AI further detects which door is nearest to the player in order to anticipate the room he or she might escape to (in the sense of a Pursuit algorithm, cf. Sect. 7.4.1). This room is set to highest priority for the case that sensor contact is lost.

In designing this level, the students have shown that by a few AI algorithms a basically authentic behaviour of software agents can be achieved. This can be regarded as a proof of concept that even using a small-size virtual world scripting language, some more advanced intelligent agent reasoning (like a small-scale graph search) can be realised. For a practically oriented programming course on applied AI, this is sufficient. Having said that, problems related to designing with Second Life and programming in LSL as such seemed to exceed the problems of coming up with the actual AI algorithms.

This was reflected in many students' comments when they handed in their projects: "In LSL, trivialities become problems". Existing agent interfaces like sensor events as well as the physics engine or collaborative tools of Second Life like

Fig. 7.22 Two robots in the next room

group management should not be underestimated; after all they made such a project possible within the scope of one small course. But the somewhat cumbersome scripting language was a drawback. The finished game works fine for a single player. Yet, when we presented it to the public, and a large number of avatars ($\approx$15) were present, scripts crashed or would not start.

7.5 Discussion

Comparing the 2009 game-based learning course to the more traditional Applied AI courses, we observed the following: Many students did what we had hoped for. They found solutions for their games themselves which were close to classic AI techniques. Generally, the students liked the game-based approach and the combination of theoretical problems with practical work. As most of our students are interested in computer games, our game-based approach kept them motivated.

However, coming back to our main content, the Applied AI, we have to admit that now another effect occurred. In the traditional setting, students were not able to apply acquired knowledge to a completely different setting in a context that did not explicitly tell them to use AI. Now we found a situation where the students applied AI techniques without reflection and insight about the fact that these are actually part of AI. While Sect. 7.4.1 presents the student projects and relates them to the content

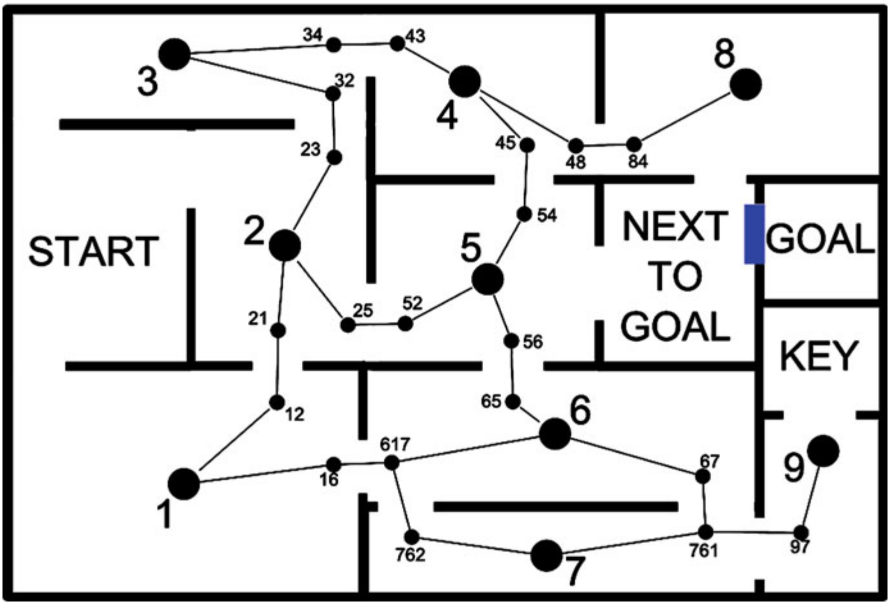

Fig. 7.23 Navigation graph for the planning task in level 4

taught in lectures and exercises, the students did not always make these theoretical connections in their final papers and documentation.

We accompanied our virtual lab experiment with a small-scale summative evaluation. This involved online questionnaires (via *Stud.IP*) with open-ended questions at the end of the lectures/exercises period (six respondents) as well as informal interview questions and discussions when the students presented their finished project work. Whereas the number of students in the Game AI course was far too small to obtain real evaluation results, some of the stated opinions are interesting with regard to educational efforts using virtual 3D environments.

Half of our students had already taken the above-mentioned traditional Applied AI course in advance to our course. All of them stated that they found it very interesting to have the chance to apply the theoretical knowledge from the traditional course to what they call a practical setting. In their opinion, our additional course has helped them to grasp the deeper meaning of AI techniques in programming. Students that had not participated in the Applied AI course in advance also mentioned that they liked the transfer of theoretical knowledge to practical settings. However, due to the lack of final exams, we are not able to evaluate the de facto success of the knowledge construction in our new setting.

Regarding the embedding of the AI techniques in a game-based scenario, we received positive feedback by all but one student. The latter stated that he found the basic story nice, but not more motivating than any other non-game setting. However, we know from his answers that this student has a strong relation to theoretical computer science. The positive feedback on the game-based approach came as we had expected. From another evaluation, we know that almost all of our students like to play computer games. Additionally, given the fact that students at this level have the chance to freely decide which courses they take, we can assume that the students who chose our course were particularly interested in the game topic.

Regarding the use of *Second Life*, we received ambiguous feedback. After half of the course, almost all students were annoyed with the virtual setting, as none of them had prior knowledge in the LSL. A serious obstacle in the students' opinion was the physics engine of Second Life (not its existence but the way it is implemented or does not work as expected). Given the choice of developing a game without a virtual world like Second Life, half of the students stated that they would have preferred pure Java with small "proof-of-concept" interfaces.

One student had decided to try this out. He realised a C++ version of Level 4 as his project. Naturally, the traditional programming language was superior to LSL in that it better supported structured programming, fast execution of algorithms, and configuration of a physics engine. It avoided drawbacks of LSL which forces the programmer to come up with workarounds and which is prone to run-time errors (when the system is overloaded, scripts can apparently run out of "energy"). The batch-processing style of programming in C++—there is no "live" manipulation of code—facilitates debugging. On the other hand, the virtual world/lab metaphor of Second Life provides a graphical third-person perspective, and it enforces thinking in cognitive models. The C++ solution was more like a technology-oriented "hack". The student was a very skilled programmer who invested a lot of effort to conceive and implement an own game engine including equivalents of sensors, actuators, and states. To less experienced or less motivated learners, Second Life provides all this already.

Despite their irritations with LSL, all students managed to work with Second Life at the time of the second evaluation at the end of the term. Some of them would still prefer Java or C++, but all of them agreed that the complex, "free access" user interface lent their games a certain charm which would not be available with a traditional programming language (at least in the scope of a smaller-scale university project). No student had bigger problems *using* Second Life. This might be related to the fact that most of them had prior experiences with playing online video games.

There was further irritation about the virtual group meetings. As some students had to sit together in a lab instead of working at home and meeting in Second Life (they did not have Internet access or a PC that met the requirements), these students found it a weird situation to sit close together and be forced to use Second Life for presentation and communication. After the course, these students admitted they would have liked to see how a pure distance education approach would have worked. Their guess was that in this scenario Second Life or a similar virtual world might be a valuable add-on. Summarising this small evaluation, we would state that:

- It is a valuable approach to put theoretical knowledge into a practical and also into a game-based context.
- The effort of developing and conducting such a course is comparably high; hence, only a small amount of students at a time can take part in such a setting.
- Using a virtual world has its merits in the context of distance education and time-location independence.

- Some new aspects of team interaction and collaboration seemed to arise, but further evaluation is necessary, involving a larger set of persons and probably also a broader range of personalities.
- Using Second Life can be a hindrance, especially in some aspects regarding the physics engine and LSL, which is not comfortable for computer scientists; however, it can be assumed that some obstacles disappear after getting used to the system.

We were able to evaluate the new, SOA-based CSCL scenario with 25 students from three courses (including the Game AI students). This time, we used questionnaires with closed-ended questions. First, we asked the students for initial attitudes regarding innovative eLearning materials and settings. The answers ranged from open-minded (15%) to deliberate (35%) and to sceptical (50%)—in contrast to conventional slides and scripts which were generally rated as important. The final attitude after finishing our experiments changed, where eLectures gained the same relevance as slides and scripts (almost 100%) and also live transmissions and virtual lectures were rated as mostly important (75%). This demonstrates that the results are not biased by a general affinity of the students towards eLearning mechanisms or material.

The frequency of using the service-based dissemination of eLectures did continuously rise during the experiments (compared to traditional linking of material in an eLearning platform), though students had initially signalled no willingness to make use of these mechanisms. Comparing different transmission techniques, streaming was recognized as appropriate especially for participating and frequent reworking of a lecture, while download was considered as helpful mostly for targeted revision of lectures prior to exams. The technical solution was rated mostly average to good. In general, the eLecture integration into Second Life polls worse than the compared version for the learning platform *Stud.IP*. As weak points, students mentioned mainly the image and sound quality, as well as the interaction facilities. This helped us to fine-tune the resolution and sampling rate in the streaming server and to define some guidelines for a lecturer how to deal with annotation features of the recording software and with interactive elements in the setting. Moreover, the students provided a number of suggestions for improvement especially of the Second Life-based solution.

Summing up, we implemented a virtual lab for cognitive and computer science education in *Second Life* in order to find out whether students would accept the new technology and associated teaching methodology. Prior to the experiment, we had assumed that the game-like environment would strengthen intrinsic motivation and facilitate acquisition of practical skills. We can maybe answer these questions best by falling back on the classic Technology Acceptance Model by Davis (1989). In this model, two variables influence the acceptance of a technology: perceived usefulness and perceived ease of use. Most students did perceive the inquiry learning approach as useful. It allowed them to acquire knowledge constructively, in a practical, applied scenario. At the same time, most students perceived Second Life, especially the physics engine and its scripting language LSL, as difficult to use. On the one hand, the existing graphical environment, the existence of the physics engine and its simulation capabilities, basic agent functionality accessible via a comprehensive scripting language, or a group and rights management system made Second Life a productive environment for rapid game development and interactive learning. On the other hand, the somewhat superficial documentation of LSL in its Wiki (lslwiki.net) and books [like (Moore et al. 2008)] as well as perceived bugs (possibly because the physics engine was quite new, see ibid.), difficulties with basic operations (e.g., rotation in 3D), or language elements that an advanced programmer perceives as missing (multidimensional arrays in particular, but also details like local functions in states) made LSL seem cumbersome. Difficulties with the technology got in the way of a motivating and constructive learning approach. It was helpful though that the students managed to come to terms with the problems in time. In the project phase, they came up with clever workarounds, their own approaches to discretisation, and their interpretations of presented AI strategies. Hence, we can still call the teaching experiment a success.

Another question had been whether the chosen technology would suit the task. The experience showed that, yes, it is possible to implement basic Game AI with a small scripting language. We are still not sure though why the implementations did not scale to a larger number of avatars in the lab building. This needs to be investigated further. In future Game AI courses, we may try out an alternative virtual world technology. We are currently looking at *OpenSimulator* (opensimulator.org), essentially an open-source version of Second Life that promises to be easier to configure. For instance, IBM are interfacing *Open-Simulator* with their collaboration software *Lotus Sametime* (IBM 2008). Jeschke et al. (2009) use Sun's *Project Wonderland* for their virtual lab environments.

A further idea is to make the virtual lab teaching scenario even more game-like. Students might program lab mice that compete in an obstacle course or robots that carry out missions in a space station. Rewards might include new features for these robots' appearance. In a study of six commercial simulation games (Maciuszek and Martens 2009), we found evidence that this game genre provides a high degree of interactivity, cognitive support, and motivational measures. The player can use virtual tools to adjust simulation parameters on the fly, gaining direct feedback from the visualisation (cf. Fig. 7.3). Simulation games provide in-game shops in which the player can buy new tools. Side conditions like weather make the simulation more interesting. Modelling is supported by in-game reference material like a virtual newspaper. Successful modelling is rewarded by scoring points. Usually, the player will find a large selection of models to choose from, e.g., many different vehicles in a flight simulator or animals in a vet game. Visualisation must not only be functional, but also aesthetically pleasing. We found four types of cognitive support: content structuring through missions, NPCs as virtual advisors, cognitive maps, and visual cues. The key to intrinsic motivation is that simulation games convey the inherent fascination of an activity. This can be in the form of animating complex machinery whose cause-and-effect mechanisms are stunning to watch, a short interval between modelling and rewarding action, authenticity like real announcements at a railway station, a career mode, extensive statistics on the player's performance, or virtual souvenirs like trophies or video playback of a mission. In our Second Life lab, we might apply these results by augmenting the narrative frame with mission goals, by using the messages in the bottle as a container for reference material, by finding a way to visualise an agent's mental state, or by providing virtual trophies in the form of inventory items.

While answers to our first questionnaire indicated that many students would support a more game-based approach in general (even though not all of the ideas above), there should also be a more factual version of the virtual lab for theoretically inclined students. After all, learners are different and can be motivated and inspired in different ways. Yaron et al. base their virtual lab exercises on scenarios that are both game-like and realistic (Yaron et al. 2005). For instance, "Mixed Reception" is a murder mystery in which chemistry students play as forensic scientists. This strategy might be able to address differently motivated learners at the same time.

Besides sticking to the engineering view of inquiry learning, we will further investigate virtual labs for pure science education. To this end, we have initiated cooperation with researchers in the domain of marine sciences (or oceanography).

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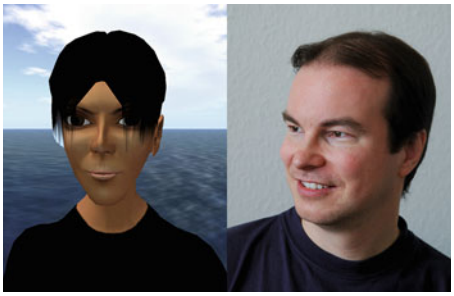
Biographies

Dennis Maciuszek (aka Dennis Ivanovic)



Dennis Maciuszek studied Computer Science and Psychology at the Technical University of Braunschweig, Germany, followed by a research and teaching position at Linköping University, Sweden, where he acquired a Licentiate of Engineering. Later on, he completed a Master of Arts education "Media Author" at Stuttgart Media University, Germany, focusing on projects in the areas of film and game design. Dennis was employed at the University of Rostock, Germany, eLearning and Cognitive Systems lab, where he was teaching and doing research for his Ph.D. in the area of game-based learning, which he is now finishing at the University of Education Schwäbisch Gmünd.

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Alke Martens studied Computer Science at the University of Hildesheim, Germany, and did her PhD work at the Universities of Ulm and Rostock, Germany. Currently, she is professor for Computer Science and Instructional Design and elected Vice Rector for Research and International Affairs at the University of Education Schwäbisch Gmünd. Her research interests include game-based learning, adaptation technologies for teaching and training systems, cognitive models of users, ubiquitous and pervasive learning, and system engineering. She is leader of several projects (e.g., South Baltic WebLab in the EU's South Baltic Program), is chair and co-chair of several international conferences (e.g., eLearning Baltics) and workshops, and is editor-in-chief of a German-language journal for Instruction in Computer Science.

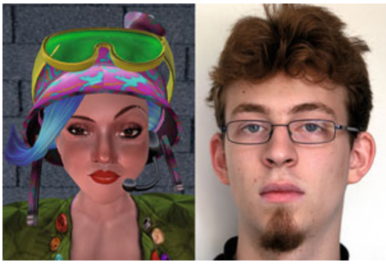
Ulrike Lucke (aka Black Urqhart)

Ulrike Lucke studied Computer Science at the University of Rostock, Germany. Afterwards, she worked there as a scientific assistant and postdoctoral researcher at the Chair for Computer Architecture. Currently, she is professor for Complex Multimedia Application Systems as well as chief information officer (CIO) at the University of Potsdam, Germany. Her research interests are focused on innovative IT infrastructures for education and research.

Raphael Zender (aka Aquaric Ferraris)

Raphael Zender studied Computer Engineering at the University of Rostock, Germany. Afterwards, he wrote his PhD thesis at the graduate school MuSAMA in Rostock and worked as scientific project assistant at the Chair of Computer Architecture. Today, he is scientific assistant at the Chair of Complex Multimedia Application Systems at the University of Potsdam, Germany. His focus in research and teaching is on the use of innovative communication architectures and media for teaching, learning, and research.

Thomas Keil (aka Harry Mattercaster)



Thomas Keil studied Physics at the University of Rostock, Germany. The topic of his Master's thesis is the behaviour of atoms in the presence of strong laser fields. In 2010, Thomas was an intern at the eLearning and Cognitive Systems lab at the University of Rostock, where he investigated Second Life and OpenSim as possible user interfaces for educational games in the natural sciences. He is now a PhD student at the Institute of Physics, working group Quantum Theory & Many-Particle Systems.

Part IV
Learning and Education

Chapter 8
Taking the Distance Out of Learning for Students Through a Virtual World

Sue Gregory

8.1 Introduction

As more students opt to keep up their busy lifestyles by working and studying full-time, many are choosing to study by off-campus mode (distance) to suit their way of life. To be able to do this, higher education institutions are utilising the tools available in the learning management system (LMS) to engage students in their learning. However, students are not as engaged as educators would like as distance students feel they are not getting the same experience as on-campus students who have access to their educator through lectures, workshops, tutorials, visits to their office and face-to-face encounters. A case study, comprising three years of research, will demonstrate that a virtual world can engage students in, what they perceive as almost the same as, face-to-face encounters. The case study will also show, with supporting data, that students using virtual worlds are achieving higher grades in their studies than those not choosing to use a virtual world as a learning tool.

Virtual worlds are used as teaching and learning tools where computer software-based solutions enable a person's 3D graphical presence, their avatar, to experience a simulated environment. A person can create their avatar to be anything they like, such as a human, animal or fantasy character (Gregory and Smith 2010). Virtual worlds are used as a teaching tool to engage students in their learning and are computer programs that "attempt" to simulate certain aspects of the real world (or a fantasy world). As a result, it becomes a "low cost space to substitute for many real world activities" (Gregory 2009a).

Through one's avatar, a form of a personal presence, real life can be imitated (Gregory and Smith 2010). An avatar is someone's alter ego and character which can be personalised. As of 11 November 2008 an avatar's name could be trademarked

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(Dannenberg 2008; Collins 2008) although one can often use their real-life name in more current versions of the software. Avatars, once in a virtual world, virtually talk, walk, run, sit, dance, fly, drive, ride, teleport (move location), make gestures (such as clapping or raising an arm), change appearance (such as size, clothing, gender, hair and skin tone) and interact with others and the environment (Gregory and Smith 2010). Gravity and atmospheric pressures exist where objects can be solid such as buildings or where one can move through them, such as water.

As outlined by Gregory and Tynan (2009), virtual worlds require students to engage in their learning activities by:

1. Mastering the technology which includes their computer skills
2. Using text, audio, sound and animated images to make meaning of the multi-modal resources available in virtual worlds
3. Using the social space to interact effectively (if this does not align with student's learning style or they are not used to this medium, this can be especially difficult)
4. Using the virtual world in its entirety as a learning tool or collection of learning tools

The research findings presented here have been collected since 2008 over four semesters, one in each of 2008 and 2009 and two in 2010. Reported here are a culmination of 3 years of data collection and analysis on the efficacy of virtual worlds as a teaching and learning tool. Results reported are in relation to distance students who used the virtual world in their study and participated on a voluntary basis. They were invited to complete end of semester surveys. These students had all online (including inworld, that is, in the virtual world) discussions recorded after ethics approval had been acquired.

8.2 Background

The University of New England (UNE), situated in northern New South Wales, Australia, has more than 80 % of students enrolled as off-campus (distance) students. These students are traditionally perceived as working from paper-based resources, alone and with little or no support from academics or their peers. With the introduction of off-campus mode in their offerings, many subjects are only offered online (that is, via the LMS through the Internet). With students able to study from anywhere, in their own home and at their own pace, enrolments in some subjects have skyrocketed. In the past, only mature-aged students (over 25) were able to enroll as distance students. With the busy lifestyle of students these days, the University of New England saw it as a requirement that distance education be available to anyone who desired to gain an academic qualification. The university also ensured that the experience was as fulfilling to off-campus students as possible. Off-campus students are not necessarily studying from a distance. Off-campus means that the students may be enrolled as on-campus students in other subjects providing the flexibility for students to enroll in subjects when they have a timetable clash with another subject, family commitments, or enable them to work to provide them with the lifestyle they desire.

In 2009, the University of New England established the DEHub (distance education hub), a research consortium in conjunction with Charles Sturt University, University of Southern Queensland, University of Central Queensland and Massey University (New Zealand). The DEHub investigates best practices in distance education and is an online space for disseminating information for the Australian higher education sector (see http://www.dehub.edu.au). In late 2009 the DEHub created a virtual worlds working group (VWWG). The VWWG assists in facilitating collaborative research into virtual worlds, identifying research gaps and/or needs and assists in providing information on best practices in the use of virtual worlds for teaching and learning. There are currently members from two thirds of the Australian higher education sector, including several New Zealand institutions. The number of members is continuously growing.

Through this connection, many educators have worked collaboratively to ensure the best possible and immersive experience for off-campus students. A tutorial model addressed by the author in other publications (Gregory 2009b; Gregory and Tynan 2009; Gregory et al. 2009) now includes sessions with students who are enrolled in other Australian higher education institutions through the VWWG connection. It makes sense to combine in-world classes to maximise students' learning.

A goal of UNE is to ensure off-campus student's experiences are the best they could possibly be which is why virtual worlds were introduced to the student's list of available learning tools. Currently, virtual world sessions are still voluntary as it is impossible to ensure that all students have the required hardware to enable participation. As universities move towards online methods of study materials, students are required to be able to use Web 2.0 technology at a minimum, including discussion boards, wikis, blogs and chat rooms. Interactivity occurs through these tools. The LMS provides these interactive Web 2.0 tools through the one portal. Virtual worlds are another avenue to provide online study for students. Students come together in a context that feels like a face-to-face experience, from their own home (anywhere).

A pilot study was conducted in 2008 at the University of New England to "clarify students acceptance of a virtual world as a learning space that might have applicability for their own study as distance learners and also in their roles as neophyte teachers" (Gregory and Tynan 2009, p. 379). Results concluded that the virtual world of Second Life is an engaging environment for the students. Further to this study, data has been collected, after refinement of the survey instrument, in 2009 and 2010. Students enrolled in education at the University of New England were able to experience learning the virtual world of Second Life. The students were enrolled in undergraduate and postgraduate subjects and were studying to become primary, high school and higher education teachers. Included were students who were also professional industry educators. The sessions in the virtual world were only a small component of an assessment task. Their key learning areas included almost all areas of the curriculum, such as English, science, information technology, human society and its environment, music, drama, religious studies, economics or the professional business industry. Depending on the subject the student was enrolled in, the learning objectives varied. All were of similar themes: to integrate social computing technologies as tools for learning in an educational setting; use and evaluate software suitable for classroom use, including social networking and computing tools; construct and present a personal philosophy for uses of social computing tools in an educational setting; and discuss the use of emerging tools in the context of technology development, educational paradigms, usage by various social groups, innovation and adoption by social groups. By attending Second Life sessions, students were able to achieve outcomes of their subjects, which are demonstrated in the Results section.

The author's avatar, Jass Easterman, Fig. 8.1, was created in 2007 and a space for teaching and learning with students established soon after. Once created, Jass's appearance has not changed so that students instantly recognise her in an unfamiliar environment. The aim was to create and conduct a range of teaching and learning activities based on constructivist and connectivism ideals taking into consideration adult learning theories.

8.2.1 Virtual Worlds as a Teaching and Learning Space Using Adult Learning Theories

At the heart of learning-centred constructivist environments are virtual worlds (Gregory et al. 2009) where alternative teaching and learning spaces are provided for interaction and engagement. Virtual worlds have the ability to combine synchronous (at the same time, such as a chat room) and asynchronous (at different times, such as discussion boards) collaborative activities including simulations that emulate the learning environment in context. Constructivist pedagogy takes place when students use the technology to explore and reach new understandings, through activities that are designed in a virtual world (Beldarrain 2006).

A virtual world, when underpinned by a constructivist approach to learning, is a suitable environment for designing learning experiences (Butler 2008). When

Fig. 8.1 Jass Easterman: the author's avatar

students internalise knowledge, it is "constructed in the mind of the learner" (Bodner 1986, p. 873). In his teaching, Butler (2008) used a variety of tools to enhance student's construction of knowledge within the virtual world. The author uses a variety of pedagogical approaches when teaching in a virtual world to enable students to construct their own knowledge. Knowledge that they already had was built upon. Students integrate these new experiences into their knowledge base (Slone 2009). Siemens (2004, 2008) introduced a new theory for the digital age to cater for the introduction of technology. As "knowledge is growing exponentially" through technology there is a need for a different approach to learning (Siemens 2004, para. 2). Academics should use a variety of pedagogical approaches as they become more aware of how students learn and adjust their teaching practices to cater for these styles.

Academics should also take into consideration how adults learn. Adults reflect and then take action based on their reflections when learning (Cranton 1992). When they critically reflect and take action on those reflections transformation takes place (Finger and Asun 2001). Virtual worlds enable much reflection on actions and each session was concluded with reflections on the time spent inworld. As Cranton (1992) suggests, value and beliefs are challenged, self-concepts can be threatened and opportunities to discuss these challenges were provided to students in each session so that they could be critically self-reflective of their learning. By challenging and reflecting on their learning, students learning in a virtual world can transfer skills learnt into their real-life teaching and learning.

Educators should be consistently thinking about their position on teaching and learning in virtual worlds in their "repertoire of pedagogic practices and help to claim these spaces for social and educational purposes" (Schutt and Martino 2008, p. 900). Flexibility needs to be provided to students who are not on campus so interaction can take place though a multi-modal virtual learning environment (Wood and Hopkins 2008).

By using a virtual world, educational needs can be assisted using methods with which the educator can identify (Carr et al. 2008). Depending on their level of experience, pedagogy in a virtual world will vary (Gregory, Reiners, and Tynan 2009). Greater autonomy, connectivity and opportunities are needed for socio-experiential learning by educators who believe there are new models of pedagogy required to meet the new generation of learners (McLoughlin and Lee 2008). According to Jeffery (2008), academics teaching in a virtual world "require a knowledge model, a dialogue model and a user-performance model in addition to any physical and behavioural traits necessary to make them interesting and credible members of the environment" (p. 181).

8.2.2 State of Play of Virtual Worlds

Lester (2008), former Academic Program Manager at Linden Lab, stated there were possibly 1,000 educational institutions using Second Life although it was difficult to accurately know. This inability to be accurate is supported by Cummings (2010) stating that 750 educational institutions operate their own island. However, it was impossible to know how many had smaller parcels of land that they were using for educational purposes. In 2007, Calonge (2007) stated there were 250 universities using Second Life. According to Gregory et al. (2010) the number of virtual worlds available now exceeds 200 which has shown a rapid rise from the reported 100 in 2008 by Collins (2008). Mitham (2008a) predicts that by 2012 the number will go beyond 900. Educators are reporting success in the use of virtual worlds for teaching and learning due to their immersive environment and engagement of the users (Bowers et al. 2009). There has been an emergence of different approaches to education through the use of virtual worlds (Ondrejka 2008).

Virtual worlds appear in the "Trough of Disillusionment" on Gartner's Hype Cycle (Fenn 2010). Educators who have been using virtual worlds as a tool for teaching and learning have moved out of the trough and are heading up the "slope of enlightenment" with some long-term educators already on the "plateau of productivity". The changes that are currently occurring in the most commonly used of virtual worlds, Second Life, have put strain on the education industry. In the last six months of 2010, Second Life has undergone many changes.

On 9 June 2010, Linden Lab, striving to make their virtual world more browser based and extending social networks (Rao 2010), dismissed 30 % of their staff (NewsLimited 2010), John Lester being one of these has since become Director, Community Development of Reaction Grid (Lester 2010). Jamison (2010) suggests that Linden Lab will concentrate on smaller markets, such as education, although current happenings in Linden Lab would suggest otherwise with the removal of 50 % educational discounts (Nelson 2010). Jamison (2010) also proposed that this is so Linden Lab can take their vision forward so that it is sustainable and reliable. Many companies and educational institutions are withdrawing from Second Life and creating business in OpenSim platforms, such as International Education Services Ltd (Craven 2010). Some are opting to abandon virtual worlds altogether, such as Telstra on 16 December 2009 (Cremorne 2009). However, many are choosing to stay, such as IBM (Gandhi 2010). Educators have the opportunity to take what they have learnt and transfer these skills to the platform that emerges to take the place of Second Life (Jamison 2010). Many web applications are now in the computing "cloud" and users do not like having to download the software needed to enter Second Life, although it remains vibrant (Robinson 2010). In early 2011, *Teen Life*, a duplicate of Second Life for the 13–18 age bracket, was closed, merging this age group into Second Life. Many schools have used *Teen Life* to educate their students in a virtual world. OpenSim platforms now have the opportunity to develop further.

A well-known research company in the UK on virtual worlds, Kzero Worldswide (2010, p. 9), graphs the virtual worlds that are currently being used worldwide. According to their graph, there is a lack of virtual worlds in education for anyone above 20 years of age. However, stated in another document by Kzero Worldswide (2008), the virtual world of Second Life is a space for commerce, education, meetings, groups, events and content creation, "a living, breathing environment", which is in an "extremely powerful position from a competitive perspective" (Mitham 2008a, p. 26). "Second Life is pretty safe for the next few years because new worlds need depth and difference" and development is going on all the time in Second Life.

8.2.3 Engagement

Engagement occurs on many levels in the Second Life sessions and has been reported by many academics whose students come away from their studies with more positive impressions (Constance 2007; Wood and Kurzel 2008; Farley and Steel 2009; Gregory and Tynan 2009; Zagami and Finger 2010). Throughout this study, engagement has been measured as student's feelings (affective), observable actions or performance (behavioural) and perceptions and beliefs (cognitive), or a combination of them (Russell et al. 2005).

Engagement is measured by attitudes and interests in a particular learning area and the interaction of student and space. Hu and Kuht (2002) state that engagement can be measured by the interaction of the student and institution's characteristics. Greene and Miller (1996) suggest that to determine achievement in their study, student's perceived ability and learning goals should be measured. If a student is engaged they have an "energetic and effective connection with the activities they are undertaking" (Schaufeli et al. 2006, p. 702). Students studying in the virtual world demonstrated their perception of engagement with the following student statement: "I can see the students engaged in this environment and developing understanding in life skills and applying these to real life."

Interaction in a virtual world does not replace face-to-face encounters, but it does enable academics and student to work with others from around the world (Apel 2006). Virtual worlds are engaging and interactive and this type of learning is not available through other Web 2.0 tools. Gregory and Tynan (2009) report that students studying in a virtual world felt that it was like a real face-to-face encounter which gave them the perception of being there in a real-life discussions.

8.2.4 Distance Learners

Students choose to study as distance students due to work and family obligations and would prefer a regular face-to-face education (Ostlund 2008). Face-to-face education that provides collaborative and social activities with other students is difficult to replicate in an online learning environment. To be a distance student requires one to be self-disciplined and organised. Distance students often make use of synchronous online tools such as *Facebook, Twitter* and other social networking tools to interact with their peers. A LMS offers chat rooms, discussion boards, wikis and blogs for these interactions to take place. Virtual worlds provide opportunities for students to use all these and more from the one location and at the same time providing students with the perception of being there in a face-to-face encounter. Students are using technology for their learning through social networking tools as they are becoming educational spaces.

If teachers used effective pedagogical strategies, “they automatically reach out to diverse populations” (Boyd and Moulton 2004, p. 68). To ensure that distance learners are catered for, a diverse range of flexible systems should be used to cater for all learners (Hollins and Robbins 2008). By using a virtual world, educators can use a variety of pedagogical approaches to their teaching of distance education students to enhance their learning, immersion and engagement. Authentic activities designed to achieve learning outcomes enable students to “learn the skills for seeking out the required knowledge as the changing situation demands” (Raeburn et al. 2009, p. 821).

8.2.5 Methodology

The collection of data for the research was triangulated via various means. Both qualitative and quantitative data was collected through surveys, recording of online dialogue and user time in in-world sessions and evaluation of student grades. As findings were collated across data sets, the impact of potential biases was reduced (Prevention and Public Health Group 2007). The study used the data to support the notation that a virtual world is an effective teaching and learning space for engaging distance education students in their learning.

Text was used as a main communication tool through a chat room-type facility where students and the educator could talk (via text) in local (to everyone nearby), group (members of educational group) and one to one. Audio was the preferred method of communication but was rarely used. Audio was more instantaneous as opposed to communicating via text, although through text, one has the time to think about what they say (write). More could be said if audio was used. There were two main reasons why text was predominantly used when communicating. The first was that to collect the online dialogue for research purposes, the educator would have had to transcribe the audio dialogue. By using text chat, the recording of online conversations was instant. The second and main reason for not communicating via audio was that some students were not able to get their audio features working on their computer. One student returned for three semesters (that is, she came to the second session when offered and has been returning ever since). This student has been unable to get her audio to work despite numerous attempts using experts from around the world to assist. This student lives in Sydney so it is not due to living in a remote region or having poor Internet connection. She has a relatively new computer. So, to be fair to all students, text chat has been used.

An educational group was created for the students called “Education Online” to enable students to talk in group conversations. The advantage of this is that they could talk to each other no matter where they were. People nearby could not hear. Groups were also valuable for students when they first came online and did not

Fig. 8.2 Activities in Second Life: (**a**) discussions under way in the virtual world, (**b**) virtual guest lecture, (**c**) role-play activity, (**d**) students undertaking a web quest, (**e**) virtual excursion to Sistine Chapel and (**f**) virtual excursion to Collab, National Science Museum

know where to find everyone. A simple request to the group chat and they would be teleported to the location.

"Education Online Headquarters" was a private space created for the students to provide them with a sense of "home". "Australis 4 Learning" was also established as a Second Life classroom and playground to simulate a real-life school so that pre-service teachers could undertake lessons in a more real context. Sessions were held one evening each week over the semester (13-week period) for up to 3 h. They were divided where the first half was spent discussing the perceptions of using of a virtual world as a teaching and learning tool. Various questions or leading statements were provided to encourage discussion. The second half of the sessions varied to provide students with experiences so that they could envisage how they could use a virtual world as a teaching and learning tool in their current and/or future teaching. Students went on virtual tours and virtual excursions, attended lectures from national and international guest, visited other educational institutions inworld, undertook role-play exercises and went on web quests. Images of in-world activities can be found in Fig. 8.2.

8.2.5.1 Quantitative Data Collection

Data was collected through post semester surveys to attain demographic information such as age and where people lived. A focus of the surveys was student's perceptions of a virtual world as a teaching and learning tool. A mixture of dichotomous questions such as yes/no, multiple-choice questions and the use of a Likert scale were used (Prevention and Public Health Group 2007).

8.2.5.2 Qualitative Data Collection

The surveys also included open-ended questions. Students were asked direct or leading questions/statements which were recorded for analysis about their perceptions of learning through a virtual world. All online dialogue in Second Life sessions were recorded. Qualitative data was collected to "gain insight into people's attitudes, behaviours, value systems, concerns, motivations, aspirations, culture, lifestyle" (Ereaut 2007) and engagement.

Focus questions and leading statements for students to address each week were based on "guided peer questioning", as outlined by Ereaut (2007). These questions have been asked over four different teaching periods in 3 years. They were based on generic questions such as:

- What are the implications of using social computing tools to create an educational environment?
- Why is it important to use social computing tools to educate students, or not, if you do not think it is important?

Questions that encouraged reflection and were open ended were:

- What are the pros and cons of using a virtual world as a teaching and learning tool?
- What does distance education mean to you when using a virtual world as a teaching and learning tool?

8.2.6 Results and Findings

The results are reported in three ways: firstly, through Ryan (2008) "16 ways to use virtual worlds in the classroom", demonstrating how it was used in this research and quotes from students that support these. Following are quantitative analysis on the data collected, concluding with some qualitative statements of student perceptions of learning in a virtual world as a distance education student.

Student's capacity to see the potential of teaching and learning in a virtual world increased as the student's levels of skills increased. This is demonstrated by the following:

> *Well, had another interesting session in Second Life last night. It all seems to be coming together as our understanding and control increases. Other students have some useful ideas*

and have been very creative with their outfits and abilities. . . I think that this tool has great potential for use in schools . . . At first I did not see the use for English in particular but have since changed my viewpoint and now feel that it would be a great learning tool for students. It has the capacity to be individualised for every class and teacher and therefore will become essential in the future.

This demonstrated how the students felt about their learning in the virtual world of Second Life and also how they reflected on their experience in regard to their future teaching.

8.2.6.1 Results Through Learning Activities

Activities for students were conducted on a weekly basis over a semester. Some of the sessions were organised as synchronous activities with their peers and the academic. Others were individual or collaborative group tasks set prior to the session for students to undertake. Ryan (2008) presented 16 ways to use virtual worlds in the classroom when demonstrating good pedagogical practices. These are outlined in Table 8.1. The first column is Ryan's 16 ways of using virtual worlds in the classroom; the second column is how Second Life was used as a teaching and learning tool including students' perceptions demonstrating how this pedagogy affected them.

8.2.6.2 Analysis of In-World Sessions

It is often stated that virtual worlds provide an engaging and immersive environment for learning activities. Table 8.2 shows the immersion that a virtual world provides for students. The students stayed way beyond the time allocated for the sessions. This was mostly due to the students wanting to continue with discussions. However, there were many occasions after the formal conclusion of a session students wanted to explore the potential of a virtual world further.

8.2.6.3 Age of Students

Combining results of 2008 and 2009, 21 students who used virtual world for a component of their studies completed the survey. Three students were aged under 29 (14 %), 14 students aged 30–45 years (67 %) and four aged from 46–59 years (19 %). These results show the maturity of the off-campus students with the majority aged over 30 (86 %).

In 2010 the survey instrument was amended as five extra subjects offered virtual worlds as a component of their studies. This group included first year pre-service students and it was necessary to change the survey instrument to get a better understanding of the age groups studying virtual worlds, mature aged and over the age of 25 years, who chose to study via a virtual world. This is supported by the age of students in 2008 and 2009 (Fig. 8.3).

Table 8.1 Sixteen ways to use virtual worlds in the classroom (Ryan 2008)

Virtual world usage	How it was used in Second Life by the author
Sixteen ways to use virtual worlds in the classroom (Ryan 2008)	How the pedagogy in Second Life was used with the students. *Quotes as per Gregory and Tynan (2009, pp. 380–382) (in italics)*
Adding a visual element (data visualisation)	No matter what virtual world was being used, it was ensured students had experiences so that they could visualise various scenarios in which they could use the virtual world in their current and future teaching. *"I found this activity daunting at first but have learnt so much now. I think the hardest part is actually imaging how you would teach a lesson." "I was imagining you could teach students and then organise a virtual excursion to language lab and they could trial there new language skills."*
Interactive library	A learning environment in Second Life was created, a classroom and playground, including a library and section for educational resources that house various interactive learning tools for students to use by themselves or with peers/future students. These virtual resources balance technology and good teaching. *"In a strange way I think exploring a virtual world can actually make that world more real than say looking at pictures or reading texts or even viewing a video."*
Connection device	There are various ways to connect in a virtual world. The first and foremost is via the Internet. If this connection is not available, then connection does not take place. The second way to connect was through sharing of inventories and information (notecards) and sending messages. These can be undertaken synchronously when others are online or asynchronously for others to collect when they next log onto the virtual world. They could also receive messages via email alerts. Online dialogue could be shared after sessions connecting the students even more with their virtual world sessions. *"Maybe we should keep in contact via notecards about interesting things after we finish." "Thanks again for your emails and support earlier this week. Five notecards rec'd so far." "Jass, I have to go—would you be able to copy and paste this IM session into a very, very long email for us? I don't want to miss out!"*
Role-playing device	A very effective role-play session was used on De Bono (1985) Six Thinking Hats which has been used by various students and reported in Gregory and Masters (2010a,b). Virtual worlds are an excellent space to undertake role-play activities. *"... we want to develop teaching simulations for our education students so that they role play before they go out on teaching practicum." "I'm trying to come from my blue hat 'reflective' position at the moment and reflect on my experience so far."*
Simulation device	Students experienced simulations developed by other educators on many occasions as they are used in an educational setting. Augmented reality is being used with students through the use of the X-Box with Kinect technology (Microsoft 2010) (controller-free software which responds to the user's movement) which is an example of where this technology is heading. Others have already developed simulations within their virtual world as outlined by the following quote after a virtual excursion with an international guest lecturer: *"... next is the logic for the avatar to influence the process. You can have some machines... check for the bottle to be operated by someone. If a dirty broken bottle, a button must be pushed to get rid of it. Otherwise the production will stop and must be checked by someone."*

(continued)

Table 8.1 continued

Virtual World Usage	How it was used in Second Life by the author
Games for learning	Many educational games were demonstrated that could be used in Second Life, most of them situated on the space created for them on "Australis 4 Learning" and "Education Online Headquarters". Students interacted with a variety of playground equipment where they played football and basketball and participated in yoga, exercises, Sudoku, UNO, arm wrestling, limbo and various web quests and role-play activities. They also participated in learning games when visiting other educational institutions or themed spaces. Games were often used as icebreakers or to enhance a learning skill. *"Have a look at this when it becomes available—it is something that you can set up with your students, small quizzes and things like that." "Is it a revision game?" "Does touching it make it respond to us?"*
Soft skills development	Soft skills development was used on all occasions as this institution uses the following student graduate attributes, that is, these are what they have to have achieved when they graduate. Knowledge of discipline—the virtual world added to their knowledge base for their future teaching. Computer skills—the use of a virtual world will either enhance skills or enable students to learn new skills. Global perspective—students meet with international guests and are able to put their learning in perspective with the rest of the world. Information literacy—students are able to learn a new medium in the information world through the use of virtual worlds. Lifelong learning—through the use of a virtual world students are able to learn new skills, network and collaborate with peers and academics to contribute to their lifelong learning. Problem solving—when in a virtual world students are given many opportunities to hone in on their problem-solving skills. Social responsibility—students are able to learn of their social responsibility through their experiences of learning in a virtual world. Teamwork—on many occasions students worked in teams to complete tasks. *"I think that the key to using online resources in teaching is to start small/safe and then when parents and students get enthusiastic you scale up."*
Research	Students undertook research as they explored ways in which they could use Second Life or another virtual world for their future teaching. Research was, and is, continuously undertaken by the author in all in-world sessions. *"one of them is to simply show teachers what can be done and hopefully inspire them to think about virtual world pedagogy as being something different to offline pedagogy."*
Virtual tourism and field trips	Virtual tours and field trips were a regular occurrence when meeting other academics for virtual "face-to-face" meetings. Students could visit places that were unfeasible due to costs and security reasons or because they do not exist in real life. Examples were the Sistine Chapel where students can view replicas of Michael Angelo paintings, or Collab, the National Science Museum, which has replica NASA rockets where they can visit and learn about the solar system. *"Would it be possible to swing by Intel Island if we have time, you can pick up a great jet pack and laptop for free, and I thought it nifty to show everyone Intel's set up."*

(continued)

Table 8.1 continued

Virtual World Usage	How it was used in Second Life by the author
Social device	Second Life is a social space where in-depth in-world discussions are only able to occur due to ice-breaking social activities so that students can feel comfortable in the environment. They are continually introduced to social activities where they can have fun. These are often held at the conclusion of an evening as a wind down from the educational activities that they participated in. *"I love these discussions Jass! I am going to miss them." "the learning was reward enough in itself" "this has been a life-changing experience."*
Create anonymity	Students were encouraged to be anonymous if that is what they preferred. Avatar names were usually quite different from the real person's name. This enabled honest opinions to be expressed, risks to be taken and fears overcome as anonymity could be assured. Students decided amongst themselves whether to share their real-life information with others. Often, in a real-life situation, students were not as open with their opinions due to people knowing who they were. Second Life enabled them to be more open in expressing their ideas, beliefs and opinion. This may change as people have the opportunity to choose their real-life name for their Second Life name. *"They had a Y11 boy want to quit HSC music this morning, because of nerves, but I see Second Life performance as a good bridge between practice and Real Life performance for kids who are nervous." "Remember—they don't know who you are."*
Create anonymity machinima creation (video filmed inworld)	Machinima and screen shots are used so that current and future students can view the videos as a resource to understand how to do various tasks in the virtual world. Many machinima created by the author can be found at http://www.virtualclassrooms.info/machinima.htm. A visual journey of all sessions is available for students through screen shots. These can be found at http://www.virtualclassrooms.info/slsessions.htm. *"we should all do tai chi and take photos for Jass." "find a spot and we'll take a photo." "I took a photo before you raced off!" "I have taken about 1000 pics . . . great record."*
Recruitment	Recruitment has been an ongoing feature to encourage students to participate in virtual world sessions. Each year there has been more and more acceptance in this type of learning. Over time, many students have asked to bring along a guest, fellow teacher, friend or family member to share their experiences in Second Life. *"Ben was my Head teacher where I did my Prac." "I'm just a gatecrasher but this is fascinating thanks! Danke!" "Thank you everyone for making me feel so welcome as I was only a guest."*
Build awareness and/or promote an event	For the past 3 years students have given a joint presentation with the author at virtual conferences. This gives them the skills in talking to large audiences but also how to promote the event and build awareness of what they have been doing in the virtual world. Each week awareness building occurred to promote their learning. Special events where the students performed were held at the end of their learning sessions and were promoted to others to attend. *"Today I told my music department what I was going to do here tonight and they said something about it not being a real performance. It made me sad that they saw it that way. I had them convinced by the end, but that was their initial reaction."*

(continued)

Table 8.1 continued

Virtual World Usage	How it was used in Second Life by the author
Building for the sake of learning how to build	Students are always given at least one lesson on building as this is a skill they may wish to use in their future teaching. The brief lessons have already been utilised where one student built a stage so that other students could perform for teaching, giving a lecture, dancing, singing or demonstrating skills they had learnt in the virtual world. *"maybe we could have a session . . . to learn how to build a stage—building a stage—promotes team work."*
As an open learning environment (virtual action learning)	Learning takes place through a variety of interactive and collaborative tasks where Second Life is used as open learning environment. Students participate in the decision-making process to decide what learning they want to take place over the learning period. They decide when they want to meet (time and day) and what they want to achieve from each session. If a student felt that they had not learn something, they would just ask for it to be considered and it could be incorporated into a future session. *"Right through all Stages of learning, ICT is part of the cross-curriculum. I believe that Second Life will be useful for most subjects and that subjects like Ancient History could really come to life in here. Last night I went to "Roma" visited the Colosseum and even went to the Sistine Chapel."*

Table 8.2 Student attendance in Second Life sessions

	2008	2009	2010
Average time spent in the virtual world each session	2 h, 50 min	3 h, 20 min	2 h, 27 min

8.2.6.4 Comparison of Grades

A further comparison was undertaken of results of students who were studying as either undergraduate or postgraduate who participated in Second Life sessions. There were a total of 1,622 students enrolled in the seven Education subjects, with 96 volunteering to study in Second Life and 1,526 opted not to. Figure 8.4 shows a comparison of grades between the two groups of students at the end of their study.

The darker shade in Fig. 8.4 shows that the Second Life group of students received higher grades than those who chose not to study using Second Life. High distinctions were received by 29.2 % of the Second Life students compared with 5.6 % of those who chose not to study using the virtual world. Second Life students also received 54.20 % grade of distinction as opposed to 36.0 % of other students. Overall, the group that studied in Second Life performed at a much higher level.

8.2.6.5 Comparison of Mode of Study

There were 71 undergraduate students who chose to study Second Life and 25 postgraduate students. There were 1,099 undergraduate students and 427 postgraduate

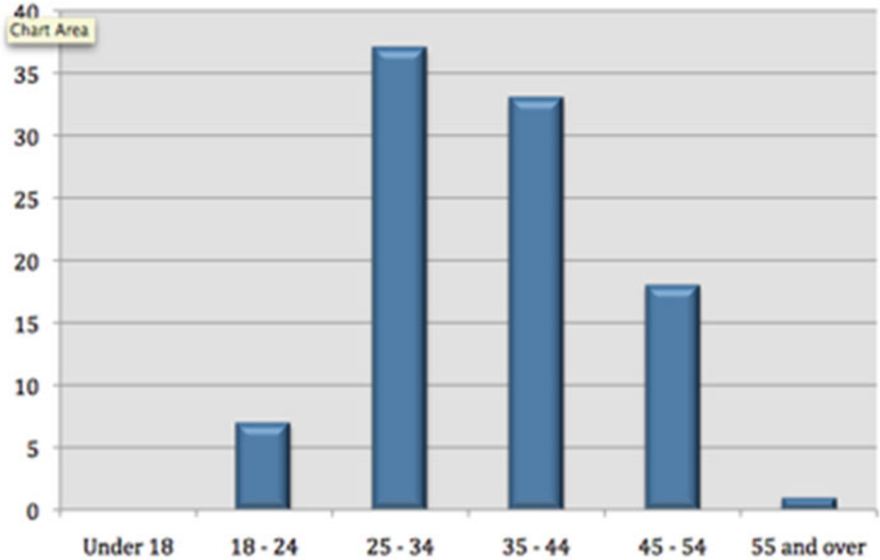

Fig. 8.3 Age of off-campus students 2010 who were studying Second Life as a component of one assessment task. These results were only available from those students who completed end-of-semester surveys

students choosing not to use Second Life as a component of their assessment tasks. Outlined is a comparison of grades between undergraduate and postgraduate students who chose to study using Second Life compared to the grades of undergraduate and postgraduate students who chose not to use Second Life.

The postgraduate students received the best grades overall with more than half receiving a high distinction. It cannot be concluded that these students were able to achieve higher grades because of using Second Life as part of their assessment tasks as there may have been many other contributing factors affecting these results, such as age of the students, motivation of the students, or time constraints.

Once again, it can be see in Fig. 8.5 that the group who chose to study using Second Life as a teaching and learning tool had higher grades than the group that chose not to. It did not matter whether the students were in undergraduate or postgraduate mode of study. They still received much higher grades than the group that chose not to use the virtual world as a teaching and learning tool.

8.2.6.6 Communication Tool

Discussions were available through the LMS or Second Life. Students were given the choice to use both, either or neither. These are broken down in Table 8.3 and this data was made available by those students who completed end-of-semester surveys in 2010.

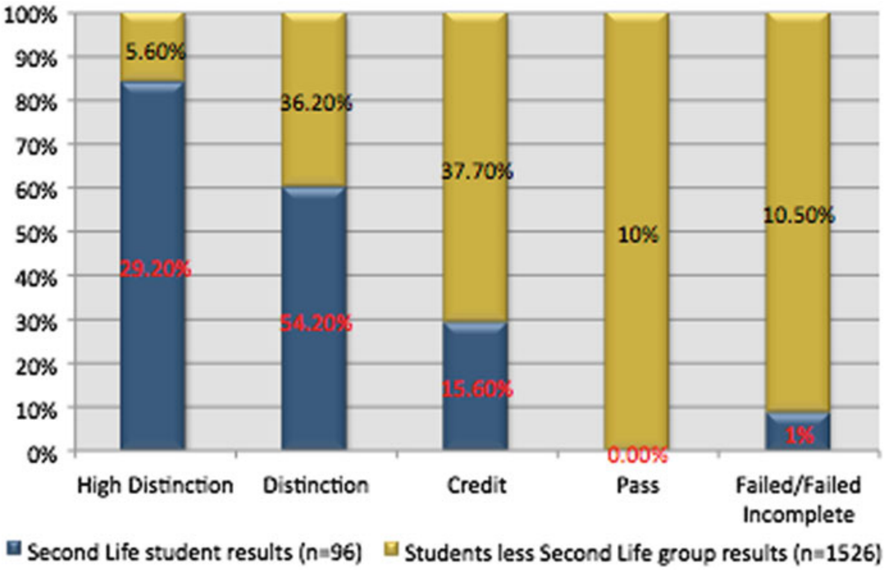

Fig. 8.4 Comparison of grades in 2010 in seven Education subjects between students who chose to study using Second Life and those who did not ($n = 1622$)

Table 8.3 Tools used for synchronous online discussions ($n = 59$)

	Count	Percentage (%)
Chat room	11	18.6
Second Life	19	32.2
Both	25	42.4
Neither	4	6.8

Many students chose to study using both the chat room and Second Life as a teaching and learning tool.

From three years of research, it can be stated that students find their experience in Second Life both engaging and effective in enhancing their learning. Student's perceptions of using chat rooms or discussion boards often have the same responses; however, the following are not stated about any other tool other than Second Life:

I enjoyed using Second Life more than on discussion or chat rooms. I like that you can see who is typing so that you are able to wait your turn to speak. I also liked the 'personal' contact of the avatars. The use of Second Life also provided the motivation and engagement we are all striving to attain for use with our students.

8.2.6.7 Measuring Engagement in Second Life

Engagement was found to be a major factor from student's perspectives on their learning in a virtual world. These are outlined below and broken into the three

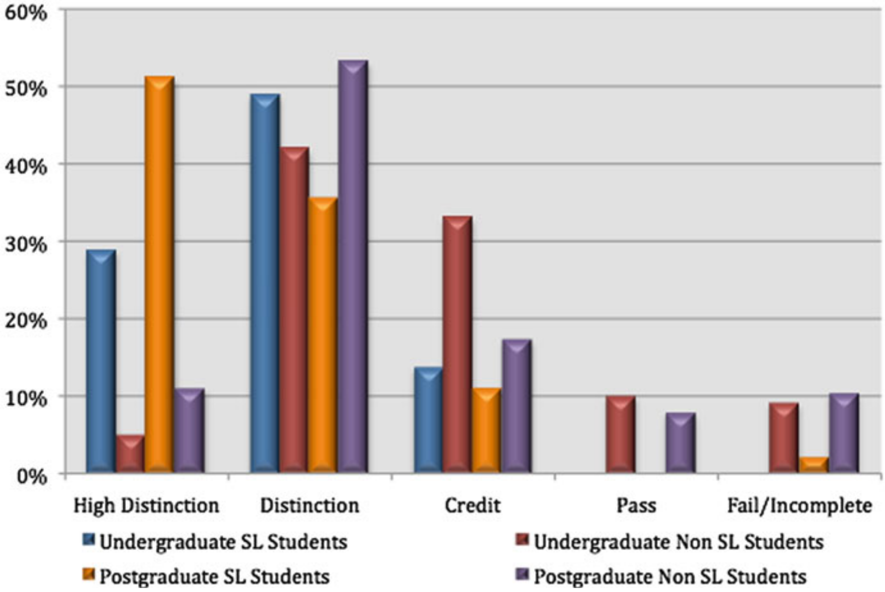

Fig. 8.5 Comparison of undergraduate and postgraduate results in 2010 across seven education subjects: those who chose to use Second Life as part of their studies vs those who did not

forms of engagement: affective, cognitive and behavioural. Words that depict the engagement are in italics.

Affective Engagement (Feelings)

- Everyday I am more and more *intrigued and excited and bewildered* by the wonder of Second Life and its possibilities.
- I enjoyed using Second Life more than on discussion or chat rooms. I like that you can see who is typing so that you are able to wait your turn to speak. I also liked the "personal" contact of the avatars. We would get to know what we all look like and wonder what colour hair we will all have. The use of Second Life also provided the *motivation* and *engagement* we are all striving to attain for use with our students.
- At first I could only see problems with using it as a tool in a classroom; however, as I have learnt more I can see a huge benefit for students especially the quieter ones or even ones with a learning difficulty who may be able to be engaged through this type of learning. As we aim to engage all students this is very important.
- I think as a learning tool, very impressive. In that, it gave a general feeling of welcome; students were not all aware of each persons own identity, so talked probably freely—more than they did in chat. I would love to explore more of what the site is capable of. Genuinely enjoyed the experience.

Cognitive Engagement (Perceptions/Beliefs)

- Students will be having so much fun that they will not even realise they are learning.
- Second Life has been a surprising discovery and has exceeded my expectations. Initially I was cautious and chose to join partly out of curiosity but found with each visit with Jass more possibilities for use in education were introduced to me. It is very exciting and I intend to continue visiting and learning in Second Life.
- I had my first visit to Second Life on Wednesday and it was a blast. I can see the students engaged in this environment and developing understanding in life skills and applying these to real life.
- Your ... work ... doesn't just recreate classrooms and lecture halls but seriously uses the creative potential of Second Life of teaching.
- The use of Second Life in both units was a great resource. It was more motivating to see the movement of the people (even though it was their avatars), but I felt like I was in the room with everybody. The chat rooms were great also, but Second Life, being visual, impacted my learning a lot more.

8.2.6.8 Behavioural Engagement (Observable Actions or Performance)

Lagorio (2007) finds that students hold after-class discussions about their courses when in Second Life and prefers classes to be discussions as "things pop up in a less linear fashion (in Second Life) than they do in a regular classroom". It was found that this was the case in sessions outlined in this chapter and represented in Table 8.4. In-world discussions were recorded and each line represents a statement from a person. These could be short but, very often, could be more than a paragraph long. Conversations were constant in the virtual world, even though they were via text.

Table 8.4 In-world discussions (pages)

	2008	2009	2010
Pages of in-world dialogue recorded over the semester	190	306	189

Finally, students also discussed their perceptions of what they felt a virtual world had to offer them as a distance student. They felt a virtual world enabled them to be flexible and learn in their own time and at their own pace, anywhere/anytime. Discussions continued with "What does distance education mean to you when using a virtual world as a teaching and learning tool?" Students outlined various opinions on what distance education means to them as a student:

- Using a virtual world in distance education means that although people can be from all over the world it gives the feel that we are more face to face.
- By using a virtual world, distance education seems more real, like a part of the class and room.

- You get the feeling that you are not studying alone.
- You can get that from reading articles, but by being in a virtual world you are using more senses so likely to retain more info.
- You can talk to each other and discuss things, whereas reading an article you cannot do that unless you have other people around.
- Motivation is higher as you feel connected.
- Less sense of isolation as you can see fellow members of the class.
- You feel as if you know your classmates have a sense of identity.
- It is like a class but I find it more personal than a class too.
- In virtual worlds we can experience all sorts of situations, some unique to virtual world, that enhance our learning.

These statements demonstrate that students really felt like they were in a face-to-face learning environment where they were more motivated and felt less isolated than they did usually as a distance student. Finally, a student felt strongly about their feelings of studying through a virtual world, "This is great . . . love the change almost like face-to-face with lecturer." Students also felt that they got to know their peers much better and this is something that is seldom seen with distance students.

8.3 Conclusion and the Future

There is limited research on the effects of using a virtual world as a learning and teaching tool. The research draws conclusions on adult learning theories of connectivism, constructivism and transformative and how they can be applied to the use of a virtual world for higher education students and it also explored pedagogical approaches in the virtual environment. Studying through the use of a virtual world brings distance students closer to their peers and academics. One thing that was clear from student online dialogue and reflections was that even though they were mostly distance students, Second Life gave them the perception of "being there", being in a real, face-to-face discussion. Virtual worlds provide engaging and immersive alternatives to face-to-face learning.

A quote that is often used by the author depicts how students feel about their study in a virtual world, demonstrating that a virtual world can be used as an alternative to face-to-face communication (Lagorio 2007).

> *I had a defining experience last week when we sat down in that open-air lecture space and I sat on one side and the rest of you sat on the other side. Suddenly I felt lonely and, without thinking, got up and moved to where you were all sitting. And then, I thought, that felt so real!*

Students were immersed and engaged in their learning in a virtual world. Because these students chose to study using a virtual world, they may be more motivated students who are therefore more engaged in all their subjects.

The results of this research indicate that not only are students engaged in this form of learning (through the use of virtual worlds), but their results are also indicating that they are achieving, on average, higher grades than those students who are not using virtual worlds. As mentioned in the discussion, as these were voluntary students, it cannot be determined whether the students achieved higher grades because they were the more motivated and therefore these are atypical grades or that the learning that they achieved in the virtual world assisted them to receive the higher grades.

More research must be undertaken to determine whether a virtual world is indeed a space for higher levels of learning. Presented here were qualitative and quantitative data that suggested that students were engaged in their learning in a virtual world. They achieved better grades than those who chose not to study via a virtual world and they felt that studying in a virtual world brought them closer to their peers and academics to give them the feeling of "being there".

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Biography

Sue Gregory (aka Jass Easterman)

Sue Gregory is a long-term adult educator and lecturer in ICT in the School of Education, Research Fellow with the DEHub research institute as well as NSW SiMERR-ICT Representative at the University of New England. She is Chair of the Australian and New Zealand Virtual Worlds Working Group and project leader of an Australian Learning and Teaching Council-funded project. She is responsible for training pre-service and postgraduate education students on how to incorporate technology into their teaching. Since 2007 Sue has been researching Second Life with her students with respect to the various learning opportunities that virtual worlds provide and has been involved in many projects on the efficacy of virtual worlds.

Chapter 9
Pedagogical and Psychological Impacts of Teaching and Learning in Virtual Realities

Andreas Hebbel-Seeger

9.1 "Constructing" Knowledge in 3D-Space

Expectations and hopes are pinned to the use of virtual realities in training and further education which especially relate to optimizing the process of learning through dealing independently with the object of learning in question based on self management of the learning process besides an improved access to learning resources (especially independent of location) as well as the increased possibilities of visualization through multimedia (cf. Konrad and Traub 1999; Kraft 1999). Self-managed learning is characterized through the participant who can seriously and consequently influence the decision if, what, when, and how he wants to learn (cf., e.g., Weinert 1982, p. 106).

The basis of the expectation is based on a constructivist presumption that the understanding of learning is an active process of constructing knowledge (Gerstenmaier and Mandl 1995) and learning surrounding also plays a role which makes such an active learning possible. They should stimulate and support learning (cf. Friedrich et al. 1997, p. 7).

This is pinned to the assumption that there can be no horizontal transfer between a learning situation and an application situation since this is hindered by the structure of knowledge: Knowledge is in its structure identified as "inert knowledge" (cf., e.g., Krapp and Weidenmann 2001, Chap. 13), which is continuously connected to the situation in which it is acquired. Accordingly, learning is described as a process of constructing knowledge in authentic learning situations which is based on and tied to (already existing) experiences (cf., e.g., Steinmetz 2000). The situatedness of a learning process (cf. Schulmeister 2003, p. 84) does not only include the construction of a concrete application but also always includes the concrete context of the

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learning situation: "learning in a meaningful and relevant context is more effective than outside that context" (Susi et al. 2007, p. 9). Methodical options in using virtual realities mainly bear on presenting things and facts for receptive learning which are not directly accessible to humens senses: because in reality they are, for example, either too big or too small or they happen too fast or too slowly for the human eye to recognize them (cf., e.g., Winn 1993). In this aim knowledge can bei visualized, scaled and schematized in virtual realities (cf. Fig. 9.1).

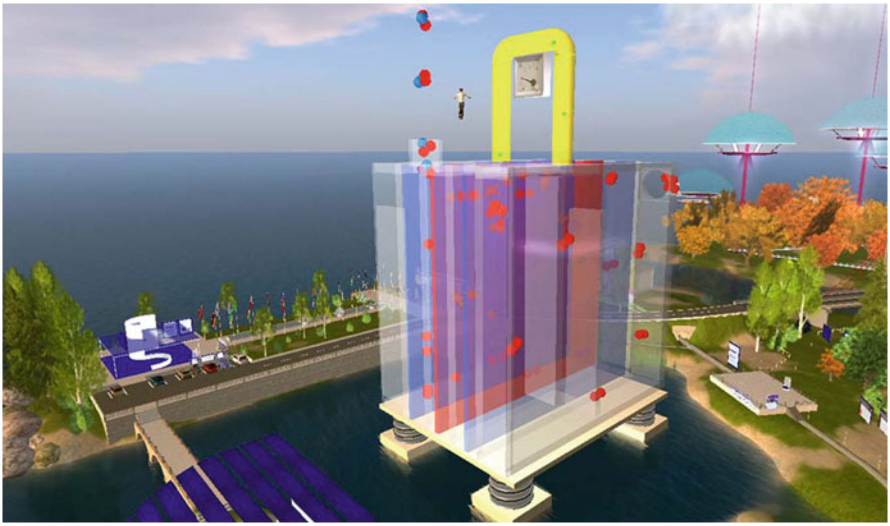

Fig. 9.1 "Accessible" fuel cells on the terrain of the TÜV-Nord (German Technical Inspectorate) in Second Life (http://slurl.com/secondlife/TUV%20Nord/126/140/49)

Corresponding installations in virtual realities also permit an approximation to generic learning through which the cognitive process can be understood through an abstract reality. In the world of exploration the process of understanding is in the foreground. In worlds of training's aim the process of understanding which is constructed upon on the idea of reaseach-based learning (cf., e.g., Schwan and Buder 2006) is the imparting of procedural and practical skills. Thus, the learners often receive innovative forms of feedback or a feedback complementary to reality (cf., e.g., Rosser et al. 2007).

An example for such a training world is the interactive simulation and learning aid for sailing "e-törn" (Hebbel-Seeger 2006). The application, a single-user offline available virtual reality, basically shows an expanded cognitive tool which attempts not to represent knowledge but to actively support the user with the active construction of knowledge. A virtually moving boat is influenced by the direct manipulation of situational parameters. Moreover, the software registers the user input in different program components and deduces from this a specific feedback to the system which can be shown to the user in various degrees of abstraction either acoustically or visually or both (cf. Fig. 9.2).

Fig. 9.2 Virtual reality as a cognitive tool: the simulation and learning aid for sailing "e-törn"

Different methodical-didactical concepts are implemented within the software (cf. Bruner 1961, 1974; Schulmeister 2002). The user is introduced to explorative learning in the field "sailing course": Based on a task such as maneuvering a virtual boat only with the control field "weight" through a course of buoys (cf. Fig. 9.3) the learner has to investigate the influence of one or more control fields (as in the example mentioned here) on the movement of the boat (direction, lateral inclination, speed) and integrate the collected "practical" experience into subjective theory.

The concept of research-based learning (cf. Bundesassistentenkonferenz 1970; Fichten 2010), assuming that the user indeed does want to learn something, is implemented in the field "outdoor sailing." There is no task included operating the virtual boat. Instead, the learners can navigate the boat independently through the predefined area and thereby obtain a quite different insight into, for example, how far the boat's speed is influenced by the position of the sail to the wind, how far a boat can be inclined before it capsizes, or which other different moving types of water vehicles on the virtual terrain your own boat seems to swerve away from under specific (and which) characteristic conditions—or not (cf. Fig. 9.4).

Fig. 9.3 Task-based problem-orientated learning

Fig. 9.4 Explorative learning via independent investigation

A combination of problem-orientated and explorative learning is implemented in the rubric "race." The user has a clearly defined task, namely to sail the virtual boat as quickly as possible across a given route, thus placing emphasis on the competence of the user in solving a given problem. Once the task has been solved at least once, independent of the quality of the result, all other further attempts are accompanied by a shadow boat which represents the up until then most successful (being the fastest) solution. Now the user has the opportunity to investigate, in terms of explorative learning, which changes in steering the boat can lead to an even more successful solution. Different methods and combinations can hereby equally lead to the objective (cf. Fig. 9.5).

In contrast to (fore)programmed virtual realities with no (e.g., the aforementionend simulation e-törn) or only partial modification possiblities for the user (e.g., the adapted virtual reality Twinity[1] of real cities such as Berlin, London, Miami oder Singapore), virtual realities such as Second Life,[2] Blue Mars[3] or Open Wonderland[4] (formerly Project Wonderland) offers the user ideal-typical learing opportunities in which the learner can become active as well as literally constructive as a (co-)architect of the respectively relevant object of learning. However, it is remarkable that this potential has hardly been implemented in a university context. Thus, universities have initially constructed virtual realities in Second Life which more often than not are focused on the original in the real world (cf. Fig. 9.6).

Conventionalized spatial metaphors cause cognitive relief and high immersion; however, in these settings the learner "only" has the task of "animating" the virtual reality they cannot usually shape or form it. The significant added value hereby is the overcoming of the spatial limits and less didactic innovation. Lectures are offered; congresses are organized. However, even if the applied options for designing and forming in the virtual reality are not taken into account within the teaching-learning

[1] http://www.twinity.com.

[2] http://www.secondlife.com.

[3] http://www.bluemarsonline.com.

[4] http://openwonderland.org.

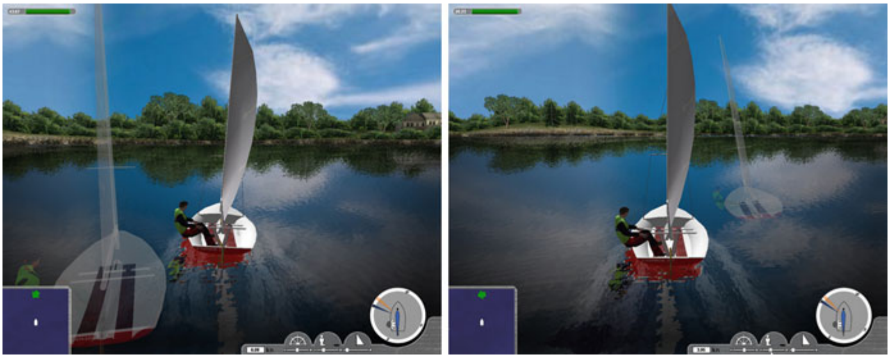

Fig. 9.5 Combination of problem-solving and explorative learning

setting, this does not mean that this can only be seen critically. The “classic” academic formats of oral reproduction of knowledge are still relevant if reception is not just understood as a passive process but quite the contrary when recipients are expected to argumentatively understand and retain the facts (comprehensive listening) as well as being able to classify and critically evaluate them (critical listening) (Reinmann 2009, p. 260).

Fig. 9.6 The main building of the University of Hamburg in the real-life adaption (http://slurl.com/secondlife/University%20of%20Hamburg/123/135/27)

Even for the ideal-typical format of receptive learning, listening to a lecture, original structuring measures in virtual realities can be developed in face of the real situation of the lecture. These, however, fail to compensate the system-related limits which lead to a reduced communicative complexity because there is no mimic or

Fig. 9.7 Virtual auditorium of the MHMK, Macromedia University of applied sciences Media and Communication, at the Hamburg Campus in Second Life with interactive tools on the *right-hand side* of the picture (http://slurl.com/secondlife/Campus%20Hamburg/68/204/23)

no gestures or they are greatly reduced. Additional to that, spatial and media barriers separating the communicating partners. In virtual realities original structuring measures essentially relate to the "interactive" and the "visual form" of a lecture (cf. Reinmann 2009, p. 257f.). Thus, in Second Life it is possible to activate the auditorium over simple interactive tools and to integrate into the lecture (cf. Fig. 9.7).

It is also possible in Second Life to increase not only adapted 3D models but also by using practically fully scalable and also easily exchangeable and expandable (and even) dynamic 3D models which increases the possibility of showing facts and issues for real-life events which have already been established in normal procedures such as accompanying a lecture via large-sized visualizations (OHP-transparencies). Visualization reaches a new dimension when rapid changes where the lectures take place happen instead of models. The immersive experience of the lecture situation is pinned to an orientated immersion with the objective of the lecture; it is the technological implementation of the vision of the "flying classroom" (a children's novel by Erich Kästner).

The biggest potential options for action open up in virtual worlds when it is possible to intervene into the virtual surroundings by modeling objects and giving them functions. It is quite comparatively simple to model simple, easy objects in Second Life. However, the user has to be the owner of a region or has the necessary construction rights, or he receives these from the owner. Modeling objects in Second Life is done using implemented editors made out of basic geometric forms, so-called prims (primitives) which are combined and linked. Functions are assigned using a specific script called Linden Scripting Language whose syntax is similar to the object-orientated programming languages "C" and "Java." Users without any previous knowledge can find many ready-made modified scripts in the necessary required parameters in the Second Life programming library. As a matter of fact, students in my lectures have been able to construct functional objects such as vendors (output devices) or vehicles after a short introduction of two to three sessions (cf. Fig. 9.8). The students usually work in groups so that the construction element is pinned together with communication and cooperation to the ideal-typical (learning) unit. Knowledge must be conventionalized in exchange with others because each of these elements favors an intrinsic motivation (cf., e.g., Deci and Ryan 1985, 2000).

9.2 "Playfully" Gaining Knowledge in 3D-Space

At the end of the 1990s, it was especially the aspect of novelty as a motivational driving force in connection with digital teaching and learning applications which was emphasized. This aspect can still be seen in the term "new media" which is still frequently used today. In the meantime computers and digital learning media based on them have entered into nearly all aspects of daily life. Even if up until now in hardly any field of application be it school, university or continual vocational education has a systematic use of digital media been sustainably anchored into teaching (cf., e.g., Schulmeister 2001, p. 44f.) the application and use of digital media is no longer a unique characteristic which deserves special attention.

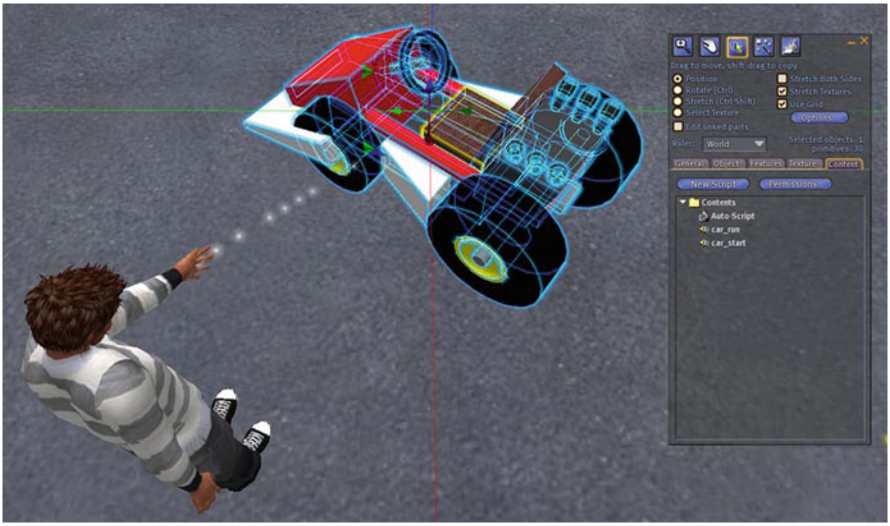

Fig. 9.8 Constructing in Second Life

If, however, as a result a special motivation potential is attributed to digital teaching and learning applications, then it is usually in observing specific formats such as "game-based learning" the base of which forms the greater intersection in implementation with virtual realities. The learning content is embedded into a game in these types of application which is used for its own sake and the learning aspect is a side effect. The learner, looking at the learning content isolated from the game, might find this boring but within the context of a complex game might be presently surprised by giving them a function for the continuation of the game:

> Oftentimes students are motivated to learn material (e.g., mythology or math) when it is required for successful game play—that same material might otherwise be considered tedious. (Oblinger 2004)

Concentrating on the intended learning content is a necessary requirement to carry on playing the game. Motivation, as Oblinger describes it, does thus not relate to an analysis of the learning content pinned to the game but to the continuation of the game. Learning in this scenario is a side effect of the game and the analysis of the learning content is at the best accepted for what it is. With this in mind, Klimmt (2006) critically declared: As a rule the prospect of learning through playing probably has no motivational relevance for the user because the fun element takes center-stage (Klimmt 2006, p. 31). Thus, it seems to be only consistent when Prensky (2001) proclaims a form of learning which during the (digital) game goes fully unnoticed by the user:

> The learning would happen almost without the learners' realising it, in pursuit of beating the game. We would give them "stealth learning." (Prensky 2001, p. 24)

Prensky, as does Oblinger, assumes that game-based learning must be equally motivational for all players, a thesis which is hardly supported by current research. Whitton (2007) comes to a completely different conclusion:

> that it is clearly not the case that all individuals find computer games-based learning to be motivational, even in a key demographic of game players. (Whitton 2007, p. 1066)

Moreover, in Prensky's description of "stealth learning" (Prensky 2001, p. 24f.), a conception of man is revealed which seems to be incompatible to current teaching theories which emphasize aspects such as autonomy, self-determination, and self-directed learning on the learners' part (cf., e.g., Reinmann-Rothmeier and Mandl 1998, 2001).

> Even if it could be assumed that games are motivational, the belief that learning can be undertaken as an incidental additional effect of game play seems to be wholly inappropriate to adult learners, for whom an understanding of and engagement in the learning process is fundamental. (Whitton 2007, p. 1066), original from (Knowles 1998)

However, it is not only here, using the example of "game-based learning," which in my opinion clearly shows that all attempts to attribute a motivational additional value per se to virtual realities in the context of learning which results from the medium itself can only end in an argumentative dead end. This does not, however, mean that using and learning in and with virtual realities cannot be motivating in any way whatsoever. Yet the same aspects which are to be found in an analogue teaching and learning context are also valid for the use of virtual realities for teaching and learning aims. Additional value, even if motivational, does not result from the used medium but from the specific use thereof (cf., e.g., Clark 1994).

9.3 Motivation for Gaining Knowledge in 3D-Space

Psychology in general understands motivation as being those processes which try to explain the instigation and sustainability of goal-directed activity. Whereas Pintrich and Schunk (2002, p. 4) above all emphasize the aspect of target orientation ("Motivation is the process whereby goal-directed activity is instigated and sustained") Wegge (1998) points to the character of motivation as a complex construction: Not only the direct state which results in the actual motivation (to be "motivated") but also the continuing processes are described by motivational psychologists with the word "motivation" (Wegge 1998, p. 29). Even if in differentiation to traditional theories (cf., e.g., Cannon 1939) more recent approaches with a biogenic motive expressly exclude physiological needs such as deficiencies like hunger, thirst, and sleep, the concept of motivation is still a collective name for varying processes and effects whose essential core that exists in a living being chooses and directs its behavior according to direction and energy expenditure with the expected consequences in mind. The goal-directed activity which can be seen in behavior, the start and finish of an overlapping behavioral unit, its repetition after an interruption, the change to a new pattern of behavior, and the conflict between various aims in behavior and their solution all can be "attributed" to the key area of motivation (Heckhausen 1989, p. 10f.).

So, according to this definition, motivation includes cognitive as well as emotional processes. Motivation activates human behavior, directs the activities of a person to a particular aim, and defines the intensity as well as the endurance of the target achievement. If motivation is directed towards learning activities, then we are speaking of "learning motivation"—a further "umbrella term" for all emotional and cognitive processes which ensures that the learner (purposely) learns something new in order to be able to reach or prevent the expected results which more or less have to do with learning (Wegge 1998, p. 47).

Learning motivation is generally understood to be the willingness of somebody to actively and more or less permanently and effectively deal with certain content matter to increase knowledge and to improve personal skills. Research into learning motivation especially deals with intentional learning which is deliberate and target-orientated (Müller 2006, p. 48).

It depends on motivation to identify the learning objective and to begin the learning process. The intensity of motivation defines how much time and material is invested to focus personal attention and to give preferential treatment to the concrete individual learning project in opposition to concurring aims and objectives. However, this still does not tell us about the reason which motivation results from.

Motivation is differentiated from the term motive which defines a lasting individual disposition and attitude. These underlie the development and forming of motivation. They are a reason for the genesis of (conscious) motives (Wegge 1998, p. 26). In this sense is a motive a frame of reference in which motivation can unfold.

Motive and motivation are not only constructs on different hierarchic levels but also differentiate in their temporal dimension. Whereas a motive is a temporal enduring potential willingness to take action, motivation is understood to be the relevant tendency to implement a certain action.

With regard to "motivation," the willingness to execute a certain action with a certain intensity or rather endurance in a concrete situation (Stangl nd), we generally differentiate between an intrinsic and an extrinsic motivation even if the differentiation however is less clear-cut than a definition of both terms at a first approach would lead one to expect.

Intrinsic motivation is then an action when someone executes it for its own sake. In contrast, extrinsic motivation describes the effect of outside influences on behavior when rewards or threats, for example, are the incentive for an activity.

Even if intrinsic and extrinsic motivation can both equally lead to a target, intrinsic motivation does enjoy a special role in the context of learning since it is supposed that intrinsic learning motivation and interests correlate positively with performance measures. Thus, it is advisable to support intrinsic learning motivation and wake interests within the learning surroundings (Mandl and Krause 2001, p. 9).

Craik and Lockhart (1972) amongst others deliver an argumentative basis for this assumption with a reference to research into learning strategies. Within this research a differentiation is made, in regard to the general approach and attitude to learning, the so-called Learning Approaches, between deep strategies and surface ones (cf., e.g., Pask 1976; Entwistle et al. 2001). Craik and Lockart conclude on the basis of their own research that intrinsic motivation is seen to be a prerequisite for deep strategies which is based on the search for meaning, the development of new knowledge, and the active integration of these new insights into one's own competence. However, extrinsic motivation focuses on surface strategies which influence a learning which remains on the level of just simply memorizing facts without a concrete focus of application.

Inquisitiveness ("curiosity motivation") is often designated as a perfect example for intrinsic motivation (cf., e.g., Edelmann 1996, p. 364). Here is the underlying idea that people are active creatures with continual and distinct desire to explore which at the same time has the aim of holding its physiological and psychological state of arousal which results from the clash with its environment in a balance between under- and over-challenging (Berlyne 1974).

According to this theory, inquisitiveness is defined on the one hand by a number of task incentives and on the other by the quality of stimulus. According to Berlyne (1974), monotone situations with a low level of task incentives lead to a diverse, disorientated inquisitiveness which leads people to deal with information which really has nothing to do with their real interests (motive disposition)—e.g., flipping through magazines in a doctor's surgery.

More relevant in a learning context is directed curiosity which initially requires a basic interest in the topic. If this is available, then inquisitiveness will arise in those learning situations in which the value of information shows an optimal discrepancy to previously gained knowledge (Edelmann 1996, p. 361). If there is no possibility of discovering something new and the learner does not set his aims high (enough), then the motivation in dealing with the topic in question will sink. The same is valid for an over-challenge which, for example, can result from a lack of orientation on the learner's part and/or from excessive levels of freedom and tasks for their own level of knowledge.

Learners who move around in virtual realities for the very first time are confronted by a double challenge. On the one hand, they need to develop a general competence of action in virtual realities and on the other hand they have to deal with specific learning tasks. Thus, it can hardly be surprising that especially at the beginning of such a project the dropout rate on the learners' side is relatively high. General help in access such as "Welcome Island" in Second Life (cf. Fig. 9.9), which aims at controlling the complexity of virtual realities for the new user by an initial reduction of possible levels of freedom, limits the autonomy of the user significantly. Then, independently of any possible previous knowledge, entering the "right" virtual reality is only then possible if predefined entry qualifications can be managed successfully. Thus, implicitly an over-challenge is just as possible as an under-challenge through a lack of adaption.

Furthermore, it is necessary to maintain, in the terms of self-efficacy (Bandura 1997, cf.), the conviction of success in the project and in the necessity of general preparations for the purpose of the subordinated acquisition of competency striven for. On the basis of motivation psychological considerations, it does seem therefore to promise more success if the development of general competencies in using the medium is pinned to the processing of the "real" topic of learning in question from the very beginning.

Fig. 9.9 Welcome Island in Second Life: learning for "life" in a virtual reality as a necessary prerequisite for a confrontation with the "real" intended learning object

With this in mind, we have offered, for example, the classic format of academic transmission of knowledge in a lecture and have brought the learner directly into the auditorium via "Welcome Island" without detours. The learner, in his analysis

Fig. 9.10 Personalization of the own avatar as a component of a "staged" learning opportunity

of the striven object of learning, can initially acclimatize himself in the usual way in the virtual reality in regard to using hardware and software in an inactive format. Repeating this learning format with success means getting used to the virtual reality as the medium of learning and enables the learner to act increasingly with more daring and assuredness through the virtual space by, for example, increasing his reactions with his own avatar at the end of a lecture using gestures and noises (clapping, cheering) or using known modes of behavior from real life such as coming up to the lectern to ask the speaker questions through his own avatar.

We have gone into the increasing acceptance of an own representative in virtual space further in the following passage by broaching the issue of the personalization of one's own avatar. We have pinned primary simple modeling tasks to possibilities of modification already set out in the software: creating one's own clothing (cf. Fig. 9.10). Added to this are tasks required for using integrated communication possibilities in the virtual reality in order to exchange the created clothing amongst each other as well as with outsiders. A connection to the learning content is indirectly created as the clothing should establish a reference to the central context of learning (university teaching) and/or to the topic of the lecture.

Whereas in most cases extrinsic motives are usually the (primary) confrontation with virtual realities for a learning purpose, for example, in the context of university lectures and seminars, the intensity of the confrontation as well as the sustainability are affected by the stiumulating character which proceeds from using a virtual reality.

Theories to views of incentives in motivation usually refer to the fieldwork undertaken by Lewin (1963) which describes behavior as a function of person and environment. Motivation results on the one hand through individually distinct motives in a person and is on the other hand conditioned by the facts of a concrete situation. Accordingly, it depends on the simulative nature of a situation in how far an individually distinct motive of a person can be stimulated and be transferred into a state of motivation (cf., e.g., Wegge 1998).

Incentive theories are insofar relevant for observing virtual realities for learning aims as that they offer a possible explanation for the acceptance on the part of the learners which has no primary character as regards content: Thus, in terms of McLuhan and Fiore (2000) programmatic postulate that the medium is the subtext, expectations from the daily use of digital media by the user arise, especially towards "Look and Feel" in virtual realities which are transferred unfiltered onto the teaching-learning context. If a virtual reality does not correspond to a current creative common sense, then the expectations towards the quality of content sink, and despite the possibility of a disposition for a motive being present for the topic of learning in hand, the stimulating character to seek the learning challenge is reduced.

In the context of virtual realities which enable the production of user-generated content, this is a further argument to actively include the learner in the production of content. A high stimulating character not only results in an attractive and also in complete digital learning packet but also in the scope and type of integration options in the productive commitment of the learner.

9.4 Conclusion and Outlook

All in all, virtual realities offer a great deal of supporting functions for teaching and learning: These can especially simplify the organization of learning by overcoming time and space limits through supplementive forms of presentation which expand the possibilities of learning as well as establishing alternative forms of learning especially in a well-situated communicative and collaborative process. Successful learning does not "happen" on its own. Rather, it needs the structuring of the learning process, the specification of meaningful options for action, and a supplementary support for learners (cf. Bowman et al. 1999; Salzman et al. 1999; Roussos et al. 1999; Youngblut 1998).

With regard to the use of virtual realities for teaching and learning aims, this means that this is not to be left to the ductus of an innovative use of media for its own sake but also in regard to its additional value, to critically examine it. Teaching and learning in and with virtual realities do not function differently to the analogue dependant nor "on its own": "Virtual realities can only be used sensibly in teaching if media use is coordinated to the learning content in question, to those persons involved and to the organizational and technical framework conditions" (Schwan and Buder 2006, p. 1).

Whilst the simple adaption of real life cannot be much more than the best possible compromise in order, for example, to enable communication across spatial limits, user scenarios specific to the domain have to be developed which go beyond real-life possibilities or which substantially expand and supplement them. Thus, self-activity on the part of the learner not only plays an important and central role in terms of constructivist comprehension of learning (cf., e.g., Krapp and Weidenmann 2001; Schulmeister 2003) but equally also derives from motivation psychological assumptions.

In reference to superordinate skills such as the skill to develop creative ideas, to abstract one's own thoughts, and to communicate as well as to coordinate a joint approach in social processes and to reflect on concrete actions, generated and collaborative virtual realities such as Second Life open up users to manyfold possibilities. In these surroundings learning can develop into "scientific work":

> It's a way to help students learn in a way that is not lecture-based, but exploration based. You can be presented with a problem, then hypothesize about the problem, and it all can be built. You wind up having a process that's a lot more like science than memorizing formulas and facts. (Toto 2007)

The efforts put into this are, however, high, just so the dangers of a diversion from the real topic of learning (Schwan and Buder 2006, p. 11), if, for example, whilst working on a project details of the graphic design are lost or the training period with the system is not proportional to the desired learning objective.

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Biography

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Chapter 10
Virtual World-Building: Implications for Education and Training

Suzanne Aurilio

10.1 Introduction

At the heart of creativity is some form of desire, and that desire—a strong feeling of wanting something—compels a person to learn (Csikszentmihalyi 1996). Second Life, a recreational, online, three-dimensional (3-D) world imagined and created by its users, engenders all three impulses through recreational world-building. From the process of creating one's imagined world emerge new desires, which in turn compel users to learn a complex array of technological and social skills and knowledge to fulfil them (Aurilio 2010). World-building is not only afforded by the platform but also indigenous to its culture (Boellstorff 2008). In addition, a majority of Second Life users are over 30 years of age (Frost 2008), raising questions about adults as learners and the circumstances under which they engage in purposeful learning. The aim of this chapter is to familiarize readers with examples of world-building and consider its relevance to education and training.

10.2 Background

For the purposes of this chapter, world-building is defined as creating a world in a networked computing environment. It involves building and manipulating objects and terrain. The term comes from science fiction and game design and means authoring, designing, and developing the imagined context in which a story line unfolds. This chapter highlights recreational world-building done by everyday users of

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Second Life. Recreational means that these users were world-building for fun, not for work or school. This section addresses learning online and adults as learners.

10.2.1 Learning Online

Learning online has existed since the advent of networked computers in the late 1970s, when technically minded college students began building online communities and instinctively sharing their expertise (Preece et al. 2003). Indeed, the computer science community has amassed its expertise by and large in informal networked knowledge exchanges (Glot et al. 2007). Informal, self-regulated, and directed learning is now indigenous to learning online, with everyday Internet users seeking out information and engaging in communities of practice for personal and professional growth (Estabrook et al. 2007).

Being online has come to be known as participating in an online community (Rheingold 1993). These gatherings of people in networked computing environments rendered textually or graphically have been studied extensively. Key findings suggest that these environments engender psychosocial experiences (Kendall 2002; Markham 1998; Taylor 2006; Turkle 1996; Yee 2006b) reified by the presence of others (Schroeder 2002; Slater and Steed 2000) as well as by doing things online alone and with others (Smith et al. 2001; Spante et al. 2006). Put in educational terms, a virtual space inhabited by even a few people amounts to what Bruner (1996) described as having a culture of education, whereby both formal and informal practices of learning and teaching arise out of inhabitants' need to create and maintain their communities.

Another relevant body of literature, educational research of virtual worlds, takes them as cultural contexts. These seminal studies have sought to first articulate and then theorize learning in virtual worlds (Aurilio 2010; Black 2005; Steinkuehler 2005). Of these studies' findings, the most compelling center on learning as developing platform-specific *habits of mind* (Dewey 1938), that is, ways of thinking, being and behaving in situ. Successful learning is evidenced in successful game play (Gee 2003; Nardi et al. 2007; Steinkuehler 2005), world-building, and citizenry (Aurilio 2010; Black 2006; Neulight et al. 2007).

Learning online as it is presented here is both an established and an emerging phenomenon. It is established in online communities in which members naturally share their expertise informally and formally. It is emerging in formal forms of education and training in which the idea of learning online is fairly recent in comparison. The role of education and training professionals then includes connecting these paradigms productively.

10.2.2 Adults as Learners

The European Commission Education and Training (2010) defines adult learning as all types of learning after one's initial education or training regardless of the level achieved. It includes personal, social, civic as well as job-related learning and happens in formal and informal settings. Adults increasingly use and learn in MMOGs (massively multiplayer online games) and virtual worlds, a phenomenon unheard of 20 years ago. In these recreational spaces, enjoyment and social relations drive learning (Quandt et al. 2009; Yee 2006b). This is a particular set of conditions quite different from those found in workplace and higher education settings. It is not only the motivational factors that distinguish recreational from workplace and college learning but also contextual factors. Whereas adult education literature suggests that adults are self-directed and intrinsically motivated learners (Merriam et al. 2007), these characteristics take on meanings and applications specific to their context. For example, to be self-directed in a college course may only involve managing one's time effectively. To be motivated to attend classes because one's job is dependent on upgrading one's skills is not quite the same kind of intrinsic motivation that drives leveling up in a game. In addition, workplace and classroom learning are structured and constrained by contextual factors such as semester schedules, and course syllabi, deadlines, and product rollouts, each of which also influencesSS one's approaches to learning. On balance, Parsons and Johnson's (1978) analysis of adult learning theories suggested that what *adult learning* actually describes is the contexts in which adults typically learn, not adults as learners.

To put this point in contemporary terms and for the purpose of this chapter, research of online spaces in which youths and adults participate side by side does not evidence differences between adults' and youths' learning (e.g., Nardi et al. 2007; Steinkuehler 2005; Yee 2006a). In addition, studies focusing on adults specifically (Aurilio 2010; Gibson et al. 2007; Pearce 2008; Quandt et al. 2009) reiterate the notion that the context, not one's age, dictates motivations and approaches to learning. Similarly, in higher education, the "nontraditional" student, who in the past was characterized first by age, is now understood to be characterized by a configuration of demographic characteristics including having dependents and a full-time job (National Center for Educational Statistics Special Analysis 2002). While it is necessary for education and training professionals to understand learners' characteristics, it is more important to understand them as learners in context. Context must include the notion of culture, which by definition includes all the artifacts, attitudes, ways and means present. Context also includes the specifics of teaching and learning, such as learning goals and objectives, affordances and constraints of the physical and virtual spaces, and personal and organizational opportunities and barriers to successfully achieving learning goals. In addition, context includes the experiences (technological and otherwise) individual learners bring with them. More diversity exists among individuals than is often assumed. This is particularly important to acknowledge given the claims that an individual's technological expertise is marked by his age. A young adult is no more likely to know how to use a wiki or Blackboard than an older adult. Access and exposure to technology, personal interests, and gender are among the factors influencing an individual's attitudes towards and use of technology, not one's birth date (Bullen et al. 2010).

10.2.3 Conclusion

World-building in an online 3-D environment is for practical purposes well suited to adults and the ways they appear to learn online. However, in formal contexts, such as in higher education and the workplace, it is fraught with challenges because of these contexts and the cultures in which they are found. The platform-specific habits of mind demonstrated in studies of informal learning cannot be extracted from the culture in which they arise and then infused into another, nor can a recreationally motivated activity be easily mapped onto a non-recreationally motivated goal. What is called for is a more practical understanding of 3-D virtual worlds as contexts and cultures onto themselves and embedded in larger contexts.

10.3 The Study

For this chapter, I draw data from users (residents) of Second Life engaged in world-building. The data have been drawn from a virtual ethnography (Mason 1999), a methodological orientation that takes online human endeavors as constituting legitimate cultural contexts in themselves (Markham 1998). Avatars, not the people controlling them, were the subjects of this study. As a resident myself since 2005 and a researcher I viewed the study participants I interviewed as sources of the questions, answers, and hypotheses of my inquiry (Spradley 1979). In my field notes and subsequent narratives, I prioritized their verbatim language, thus de-emphasizing my disciplinary interpretations as an author (Spradley).

While I focused on avatars and their lives, every avatar always occupies at least two or more social and technological locations simultaneously (Aurilio 2010). It was then necessary to account for this phenomenon methodologically by collecting basic demographic data of the individual at the keyboard at the close of data collection. That data included gender, age, marital status, highest educational level achieved, and self-rated comfort levels with computer technology. Seven female residents were the main study participants (pseudonyms are used for identifying names of people and places). One identified as a faerie (Arieaa), two others identified as fairies (Star and Celia), three were humanoid females (Jules, Suz, and Kat), and one (Aurora) identified as an otherworldly, humanoid female. In real life, they ranged in age from 33 to their mid-50s; four were in their mid-50s. All but one were women in real life. They spent on average 30–40 h per week logged into Second Life, or in-world, and are among the most engaged types of users (Ortiz de Gortari 2007). On the whole, they considered themselves to be more comfortable with computer technology than their real-life peers, family, and coworkers. In addition, I observed and interviewed approximately 20 additional residents engaged in world-building.

Data collection took place over a 6-month period in 2008 and 2009. It consisted of semi-structured and unstructured interviews, observations, journal entries, and gathering artifacts focused on the research question: How do residents learn to create Second Life?

10.4 Findings

10.4.1 World-Building Tools, Techniques, and Practices

10.4.1.1 Tools

First and foremost Second Life is software which itself comprises world-building tools for 3-D modelling, and scripting interactivity and functionality. Users can also manipulate (terraform) the terrain of landmasses. And while these tools may meet many users' needs, some users also use external applications to extend their toolkit. These external programs include general-purpose graphics editing programs, such as Photoshop, and 3-D modelling programs, such as SketchUp and Maya. Programs designed specifically for Second Life include 3-D modelling programs for sculpted prims, such as Rokuro and Tatara, intermediary programs, such as Sketchlife, and animation programs, such as QAvimator. Finally they use audio and video production and editing applications for adding sound and music to in-world experiences and for creating machinima (videos filmed in-world) that can be shown on the Web. The tools described here include consumer and professional grade applications. Some are free and some cost hundreds of dollars.

10.4.1.2 Techniques

Patterns and templates abound in Second Life and in addition to creating objects from scratch with them users modify and use bought objects to world-build. Each avatar has a default inventory of these building blocks (i.e., basic modifiable objects, textures, scripts, and animations as starting points for creating their own furniture, landscaping, and avatar parts.

Building blocks are bought and sold and often come with directions for use. Contact information of the creator is in its metadata, and some creators offer one-to-one help using their objects. Residents also freely exchange building blocks and tips with others, a practice which happens effortlessly among friends and as members of groups dedicated to world-building. An ethos of freely sharing ideas, support, and building blocks is widespread in Second Life.

10.4.1.3 Practices

Users learn by doing whatever comprises their virtual lives. Learning-by-doing includes trial and error, asking for help, and using the knowledge base in-world and surrounding Second Life. Trial-and-error learning is sometimes called "tinkering," "practicing," "messing around," and "experimenting." One participant described her experimental process as follows: "You set values in there and observe the output. If it isn't what your [sic] after you try different values. After a period you learn what changing the values does. So you have learnt [sic] from it" (Kat, 11 November 2008 interview).

Asking for help meant asking a friend, a person close by in the sandbox (a place to practice building), or instant messaging the creator of a bought object. Some residents belonged to building groups and would instant message the group or the teacher, like Star, who preferred building in a sandbox because someone was around to answer questions. The knowledge base included video- and text-based tutorials, wikis, discussion forums, and resources Second Life residents created; all of the residents I studied used these resources.

On balance, these practices amount to learning that required a high degree of personal agency. Residents decided what they wanted to learn and how they would learn it. Learning-by-doing was another affordance of this environment, as well as a cultural practice. As mentioned earlier, the platform is technologically complex and infinitely configurable; residents are always tinkering with their builds or learning how to create the next thing, and in the course of the process, they figure out what they need to know. Suz put it this way: “[You] don’t need to know everything, just how to find the answers and ask for help” (Suz 11 October 2008 interview). Finally, building groups, tutorials, wikis, and discussion boards were products of residents’ knowledge and illustrated a spirit of everyone being in it together, learning and helping each other learn along the way.

10.4.2 Home Is Where Inspiration Resides

10.4.2.1 Having Creative Control

More than any other customizable feature of Second Life, having a place of one’s own generates a desire to be creative and learn. Residents can buy or lease a parcel, already built up or as a blank slate, or use public spaces like sandboxes to be creative in. Arieaa, Jules, Suz, and Kat owned their parcels and talked about the importance of having a place of their own to do with, as they liked. They commented that having control over their environment had become an important part of their Second Life creative experiences.

Arieaa made what she called her fairylands, bucolic landscapes, and skyboxes in which she could meditate and feel peaceful and happy and hang out with friends (Figs. 10.1 and 10.2). Her avatar was a custom character, she said. With a close friend, Elaine, she leased two adjacent parcels. Named Binewood and Savon, each housed what she called Lakeside Rentals—plots with a house and the ability to take canoe rides, fish, listen to music, watch videos, and build. Arieaa had created Angela Davis Park on the Savon parcel, where visitors could slow dance on the gazebo, sit by a waterfall or campfire, canoe, or fish. Above her land parcels, she built her Fairy Princess Sky Castle, Fairyland, and Feyland (the term fey is another spelling of fairy).

Arieaa lived a fantasy virtual life. A 44-year-old man in real life, Michael described Arieaa as an aspect of himself and a companion.

Fig. 10.1 Arieaa fishing with her friends in fairyland

Fig. 10.2 Arieaa's Feyland

> It’s relaxing for me, Arieaa likes to go to her specific places, like meditating on a mushroom or something and listening to mediation music in her lands, because I can do something in real life, while she’s there relaxing and look over at her from time to time and she’s really peaceful there and happy, and I dunno . . . it just makes me peaceful and happy, too. (Arieaa 11 October 2008 interview).

Jules saw her avatar-self as a representation of her real-life self and her creative endeavors as creating an extension of her real life—not a fantasy world, as she described Arieaa’s creative pursuits. She spent time and real money finding high-quality clothing, hair, and objects for her creative endeavors and prioritized creating an atmospheric and aesthetic experience. She created her island parcel, Wild Haven (Fig. 10.3), in the likeness of the mountains and beaches she was fond of in real life. In January 2009, after managing a 1920s jazz club in-world, a friend offered her two entire clubs to do with as she wanted. She gave up Wildwood Haven and took over one club, The Mae West Club (Fig. 10.4). She turned it into a frequented burlesque club, complete with employees—a bartender, a master of ceremonies, and dancers—and regular “international” clientele. Jules saw the club as having the stresses and joys of pursuing one’s real-life dream. It was fun but it was work, she said, and I noticed an attitude of professionalism in our conversations about it. “I haven’t worked out what my budget will be but my employees will walk away with something every shift. Nobody is walking out of here without being paid for the work they do” (Jules 25 January 2009 interview).

Jules’ virtual life represented an idealized version of her real life, except that the ideal was an authentic experience: She was the gorgeous owner of a nightclub and residents whose real lives were located in Europe were some of her patrons. The juxtaposition to her real-life conditions of being a hobby burlesque dancer and single parent working six days a week in a retail industry did not detract from this experience. In Second Life, it was a fact.

Suz and Kat had created an idyllic beach island Heart’s Cove (Fig. 10.5) from scratch and a shop (Fig. 10.6) they named Inseparable Stuff where they sold the greeting cards, tattoos, sea plants, and posters they made. Suz and Kat were officially partnered and their creative endeavors revolved around their romantic partnership—the names they chose, “Inseparable Stuff” and “Heart’s Cove,” reiterated their bond. They called their island their home and emphasized their relationship in each of their profiles and in text-based speech. Suz would sometimes type “US” instead of “us” when talking about herself and Kat. They were usually in-world together, although they lived in time zones 14 h apart. When Suz logged on at 6:00 a.m, it was 8:00 p.m. that evening for Kat. In real life, Suz was married and homebound with grandchildren and Kat was single and had been unemployed long term. They communicated almost exclusively in the written word.

When I asked if their virtual existence was a kind of fantasy, both giggled and joked about sexual fantasies. Suz addressed Second Life as “the game” and joked that she was “addicted” to it and loved that she was. She appeared to be serious about her relationships, and besides getting up at 6:00 a.m. to be with Kat, she had many friends and eventually brought real-life relatives into Second Life “to play.” Suz also seemed to be emotionally invested and psychologically immersed in the authenticity of her experiences.

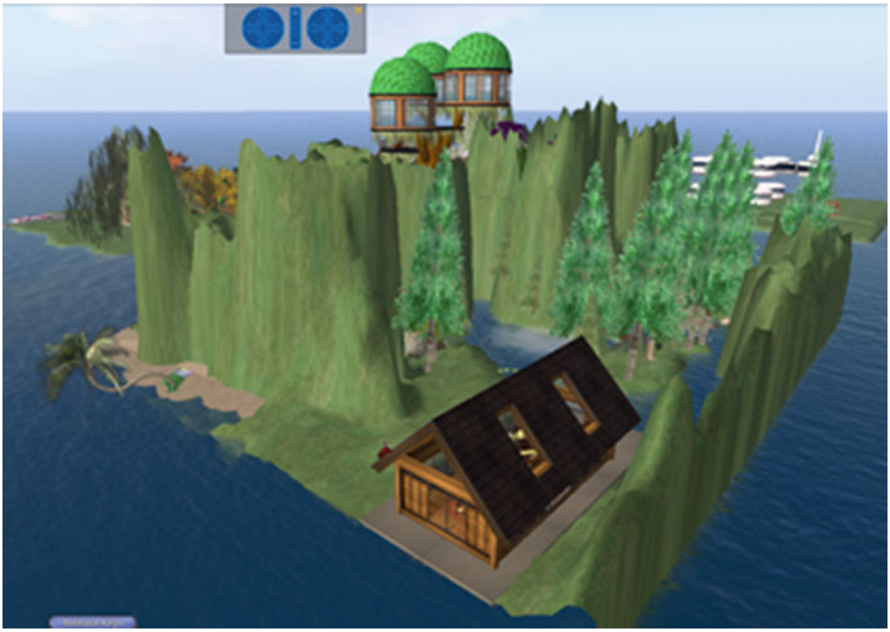

Fig. 10.3 Jules' wild haven Island parcel

Fig. 10.4 Jules' the mae west club

The emotionally invested and psychologically immersed experiences my study participants demonstrated and talked about indicated an authenticity to their experiences. This authenticity was at the heart of their desire, creativity, and learning, whereby these real experiences provided personally and socially meaningful contexts. From a cognitive psychology perspective, experiences are always authentic. The brain registers emotions, regardless of the origin of their sensory input

Fig. 10.5 Suz and Kat's island heart's cove

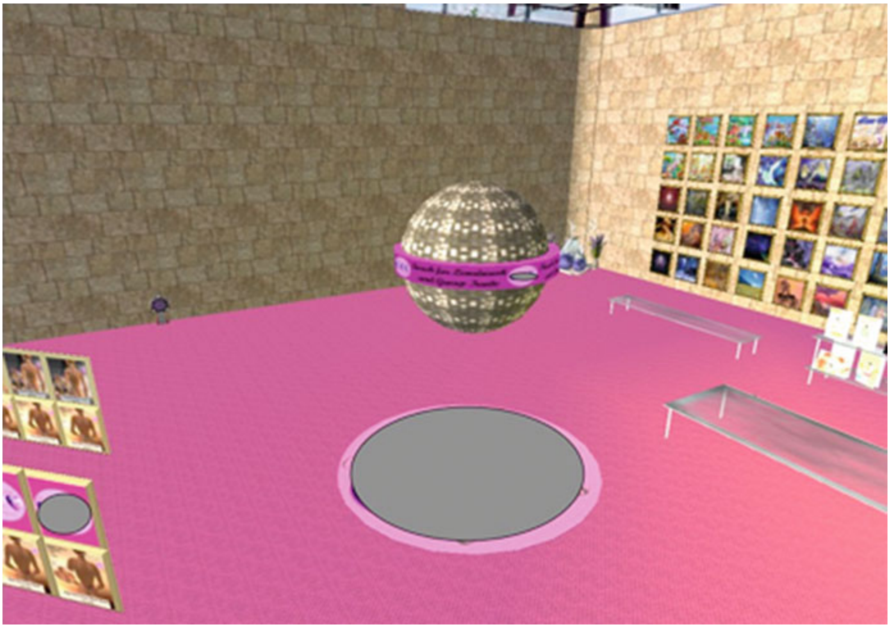

Fig. 10.6 Inseparable stuff shop

(Gilbert 2007). And as an early online researcher put it, experiences are always real, online or off; they cannot be anything else (Markham 1998).

What is more, authentic experiences were reified by the presence of others. Arieaa's fairyness was as much a product of her friends' experience of her avatar's look and her fairylands, as it was of Michael typing fairy like sounds, such as "eep!"

into the text chat. After the only voice-based interview I conducted with Michael, both of us agreed that his voice disrupted our experience of Arieaa.

For these users, creativity and fantasy were mutually validating human experiences. The social theorist Baudrillard's (1994) suggested that with our everyday lives increasingly made up of mediated experiences, "reality" has lost its meaning.

10.4.3 Having Creative Structure

I found a different type of creative place at the sandbox and building school, Serenity, where Star, Aurora, Celia, and other residents participated in structured practices such as classes and building contests. These endeavors were project-driven. Classes typically lasted an hour and were led by someone. I observed classes on building objects like a bird-feeder and a Chinese lantern. The teacher gave each participant the needed building blocks and then called out step-by-step procedures in the text chat. Star and Aurora said they took classes to learn how to build objects they would later like to teach. Classes were a way to share building blocks and tips. They also said that teaching was a vehicle for improving their own building skills. Teaching building was for each of them a pathway to personal empowerment. Similar to the seriousness Jules infused into managing her club, Star and Aurora took their roles as teacher seriously, evidencing this in the time they invested in preparation and the language they used to talk about their experiences.

The remainder of this section focuses on contests. Contest projects were framed by several criteria. For instance, weekly texturing contests lasted an hour; participants received a prebuilt, identifiable object (Figs. 10.7 and 10.8) as rules were announced in the text chat. The goal was to texture the object.

Theme builds took place over several weeks and happened, on average, once a month. Rules were spelled out in a notecard that any interested resident could pick up at Serenity. The following paragraphs are excerpts from the notecard for the December 2008 theme contest at Serenity.

It begins with:

> When I was young, the department store in town would decorate their big windows, not with merchandise, but with holiday scenes. Though this isn't as common anymore, there are still places in some big cities where this tradition continues. And for this year, we will bring the tradition to Serenity. The Challenge: Dress a window for the holidays. (December Theme Build Contest Rules, December 2008)

The competition timeline is given in detail, then followed by the "rules and regulations" which included detailed steps for participating, beginning with what participants may not do (e.g., no mega prims, no physics, no items set to sale), then what they must and can do.

> What you must do: a. Create a winter scene inside of the window. It can be an outdoor or indoor scene, holiday or just winter. b. All prims must be new prims, created by you and on site. This includes trees and flowers. c. Keep your build behind the actual window glass.

Fig. 10.7 Beginning of a texturing contest

Fig. 10.8 Texturing contest in progress

> If it does extend through the walls or ceiling, it may not be visible from the outside of the building or it may be in someone else's build.
>
> What you can do: a. Use sculpted prims, if you make them from a sculpted map. b. Use scripts. If they are lagging the sim, you will be asked to remove them. c. Texture the window glass. (December Theme Build Contest Rules December, 2008)

Judging criteria were laid out explicitly; builders were judged by their peers for creativity, building and texturing skills, overall appearance, and relatedness to the theme. Finally, the notecard concluded with "QUESTIONS I THINK SOMEONE IS GOING TO ASK" and a list of questions and answers such as "I am confused. What are you talking about? Google Christmas Windows to get an idea." and "Do I have to do all the building inside the window? No, you can build in front of your window and then move it inside" (December Theme Build Contest Rules, December, 2008).

These notecard excerpts illustrate a sophisticated instructional practice similar to what educationalists call project-based learning. It involves authentic activities that are designed to answer a question or, as in this case, to address a challenge. Other instructional strategies evident in the notecard include gaining learner's attention and motivation in the opening story, providing clear timelines, and using personalized, easy-to-understand language. More importantly, however, regularly scheduled contests were an essential element of Serenity's teaching and learning ethos and embodied a world-builder's desire, creativity, and learning. As Star put it, "I learn some new technique every time in the process of trying to complete my vision" (Star 3 January 2009 interview). In relating her contest experiences to her desire to make and sell hats, Celia said, "Peopel [sic] tell me they like my builds, and since I have been doing well in the competitons [sic] it must be true, so I might as well build some things and sell them and see what happens" (Celia 12 January 2009 interview). Participants in the December theme build said that the contest theme inspired them. Each talked about elements of the planning and building process that led them in a particular direction where ideas emerged from other ideas. Star started with a conceptual piece of the build. For instance, in her December theme build, building snowflake gears led to the idea of a snowflake factory. Another participant said that she usually started with "a big idea," then when she realized she did not quite have the skills to follow through on it, she downsized her project.

Serenity's contests are powerful because they serve multiple roles. They are publicly situated, goal-driven practice sessions, as well as finely articulated and executed instruction. Participants engage in authentic world-building, not an approximation of it. Contests at Serenity are compact forms of situations designed for learning, creativity, and desire.

10.5 Discussion

The findings above begin to paint a picture of breed of contemporary adult learner who comes into existence as a result of the affordances of this virtual world. Through a high degree of personal agency and self-directed learning, she is a product and a producer of this virtual environment. In order to exist, she must master the platform mechanically and then creatively. An adult engaged in this process is also engaged in recreationally inspired learning of a sophisticated and novel nature. She invests time, emotional energy, and resources into understanding and using the platform because she derives and contributes pleasure and purpose from it.

The platform-specific desire, creativity, and learning evidenced here can be thought of as the merging of human and technology (Haraway 1991) into a new form of socio-technical knowledge (Sørensen 2009). Lave and Wenger have suggested that knowledge is embedded in the materiality of learning, that is, in practice, and practice is necessarily a shared experience (Lave and Wenger 1991). Sørensen goes on to suggest that practice like this has spatial and temporal qualities that make transferring knowledge possible. This is evident in the ways the knowledge space of world-building is ever extensible as users create objects and make them part of the environment. Robbins (2008) put it in terms of a quality or facet of the virtual environment. In creating a taxonomy of virtual worlds facets, she observed the quality of stigmergy, the technical capacity of an environment to leave traces of users' interactions with it, whereby users and other users return to these traces over and over again. Time stamps embedded in objects' meta-data also create stigmergy and temporality. Both of these qualities should be viewed as integral to the learning process in that the learners' environment is comprised of emergent, interactive learning objects.

In addition, once familiar with the mechanics of the platform, she pursues forms of ownership. Ownership can be understood as empowerment through expression. The places and objects residents built came about because of a sense of dedication and pride in one's creative endeavors and the more the user built, the more she wanted to build. Since owning land afforded a resident more creative opportunities, it followed that from owning land emerged another level of the merging of human and platform, whereby as the user interacted more deeply and broadly with her digital realm, the more deeply and broadly she identified with it. Although Star, Aurora, and Celia did not own land, they also experienced ownership through their affiliations with Serenity's community and activities. In these cases, the social context of learning was important.

Also, the psychosocial capacity to claim ownership of one's digital life and creations in what appears to many onlookers as a cartoonish, fantastical game should be perceived as empowering to the individual who risks engaging in what is stigmatized as age-inappropriate activities, as Quandt et al. (2009) found in their study of adult gamers. Whereas Baudrillard's (1994) notion of reality as obsolete is evidenced in this study, it is nonetheless a challenging perspective to take. Virtual worlds are still largely seen as recreational spaces, which in effect legitimizes keeping fantasy separate from reality. In other words, by not taking Second Life seriously, outsiders perpetuate the fiction that what happens in-world is simply not "real life." As this study and those mentioned earlier have shown, this is not necessarily the case.

Each of the four points discussed above describes a culture of education indigenous to Second Life. In this culture, a new breed of contemporary learner comes about in an avatar, a merging of human and technology through which digital ownership of places and objects are empowering forms of self-expression. In this culture, stereotypes of adulthood are challenged and notions of what constitutes "real life" are questioned. In the next section I discuss the relevance and value of world-building to formal education and training.

10.6 Implications

In the preceding sections, I provided background research, findings, and a discussion on world-building as a recreationally situated cultural phenomenon. I argued that the vast majority of online learning is of an informal nature and takes form through individuals developing habits of mind specific to the platform or virtual location they occupy. I also suggested that a more practical understanding of 3-D virtual worlds as cultures of education onto themselves and embedded in larger cultural contexts is needed. This understanding belongs in the boardrooms of decision-makers who must be able to access expertise and research in fields such as education, instructional design, organizational development, and change theory, to name a few. Without applying an understanding of how people and organizations learn and change, innovation and trailblazing lead to atheoretical conclusions and conjecture. The danger is that 3-D virtual worlds will remain on the periphery of education and training. Returning to the notion of learning as developing habits of mind, there are several clear lessons to be learned from these findings that can be applied to formal educational and training settings.

10.6.1 Business as Usual with Minor Changes

Taking an organization development perspective to change and the infusion of ICT in higher education and corporate culture, I suggest the following approaches. First, encourage habits of mind through seeding and growing a learning culture that embraces trial and error, and experimentation, particularly where learning technology is concerned. In a corporate setting this could mean embedding in the workday time for employees to play around with technology. In a higher education setting, create opportunities for faculty to come together to play around with new technologies and learn from one another.

Second, create an organizational culture in which it is ok to not know the answer and consider how an organizational culture inhibits playfulness around learning. For example, high-level administrators and executives, or senior faculty members, are extremely competent in their area of expertise and unlikely not used to being seen as incompetent with what they perceive as merely tools. Third align technologies with learning goals and outcomes and tasks at hand. This amounts to training the trainers on sound instructional design principles. Second Life and virtual worlds generally are still far too time-intensive to learn simply to hold meetings in, when other easier platforms are available.

Fourth, for the majority of formal educational and training contexts, learning is necessarily rationalized. Technologies are seen primarily as time- and cost-saving strategies. However, an instrumentalist orientation to technology is not new. Distance education and training has historically been implemented primarily as a cost and convenience measure (Saba and Shearer 1994). IBM uses Second Life first and foremost to save money on travel costs, and they are explicit about this in their public relations and internal literature. Be explicit then about the reasons why a student or employee should invest time in learning and using the platform. If the organization is not clear about the platform's usefulness and value, it will be difficult to get buy-in from key stakeholders and users. At the same time, consider a grass-roots strategy as a way to explore the platform's potential in an organization in order to gain buy-in over time. Exploit individuals who have a natural interest in the technology and are willing to experiment and share their experiences.

Finally, I have argued for understanding virtual worlds as cultures, not tools; however, in most professional settings technologies are understood as supporting the work to be done, not in terms of new cultural phenomena. Changing organizational culture takes time and resources and should be seen as an ongoing process. The following paragraphs briefly describe such a process at San Diego State University. It happens within the context of program (pICT-people, information and communication technologies) dedicated to infusing ICT into the curriculum using principles and strategies of organizational development, change theory, and instructional design. The pICT program has employed a grass-roots-up strategy and successfully changed the university culture around teaching and learning with technology (Aurilio and Atkins 2007).

Lead by pICT, San Diego State University has been involved in virtual worlds since 2005. Employing a long-range strategy, the program has invested modestly in investigating Second Life and 3-D virtual worlds for education. This has also included exploring Project Wonderland, Teleplace, ActiveWorlds, and ReactionGrid, each for their unique affordances. With the establishment of the pICTsl Farm in 2007, they began to introduce faculty and instructional staff to the Second Life platform. Opinions about its usefulness were mixed, although the majority appeared to enjoy being introduced it (Aurilio 2008). The pICTsl Farm also investigated survey instruments used in Second Life in order to ascertain the quality of the instruments most often used to collect feedback from learners. The investigators found only a handful of survey instruments in 2007 and 2008. Most were extremely limited in their functionality and thus put doubts on their reliability and validity. Aurilio (2010) observed, beginning in 2007, that conjecture and opinion more than theoretically based pedagogy plagued the Second Life educational community. Indeed, Hew and Cheung's (2010) review of the research of virtual worlds for formal education found 470 papers of which 455 were position and conceptual papers and nonempirical descriptions of programs.

San Diego State's current virtual worlds' project is Aztlan Island, SDSU in Second Life. In this project, students predisposed to using such a technology are encouraged to do their own world-building. The project lead works with select faculty members in the design and creative fields to fashion opportunities for individual students to world-build. The project lead acts as a virtual world mentor and guide and the faculty member as the subject-matter expert. The student is in full charge of his or her project and becomes the expert in coupling the subject matter with the affordances of the technology. The university's involvement in virtual worlds for learning has been successful in that it (1) keeps abreast of trends, (2) experiments, (3) invests modestly, and (4) relies on established knowledge bases in relevant domains to inform its direction.

10.6.2 Business Unusual: Major Changes

As mentioned above, Aztlan Island, SDSU in Second Life, attempts to foster world-building habits of mind in students by exposing self-selected faculty and students in design and creative disciplines to experiment with the platform as modelling software. The relationship between the faculty member, the virtual world mentor, and the student is a novel one. It is fundamentally collaborative and interdependent, with the student at the center. This degree of student-centered learning happens rarely at the undergraduate level. It requires the faculty member to have a level of trust in the collaborative process and partners. He or she must be willing to be a learner and nonexpert too. It requires the student to take more control over his or her learning and its outcome. Aztlan also does outreach to various student organizations. The intention is to promote the island as a virtual location for their organization or personal use and to encourage them to make the island their own, by providing them with a minimal infrastructure and only basic building guidelines. There exist few opportunities for undergraduates to have such free creative reign of space in their academic careers.

In the Discussion section, I addressed the spatial and temporal qualities of world-building practices as unprecedented because virtual worlds conjure a sense of physical space and culture in which learning is indigenous, not contrived or prescribed. For these reasons, virtual worlds should not be seen as educational technologies for delivering instruction and training but for soliciting learners' creative agency. The example of Aztlan is particular to a university setting dedicated to infusing ICTs into learning and may not be relevant to a corporate setting. However, it is important to note that in 2004, before the pICT program began, nothing like Aztlan Island could have been conceived. In other words, it took 3 years for the culture at SDSU to change enough so that such an endeavor could be considered. Therefore, I again turn to the promise of taking a long-term approach to major change. As IBM has evidenced, business decisions drive change, and as the technology changes so does our understanding of it.

Taking a long-term view of a rapidly changing landscape involves developing the following habits of mind. First, as a change leader, think in terms of fluidity rather than flexibility. Flexibility implies that a state of inflexibility exists. People do not like to be considered inflexible and organizational change takes place when people change. Using the metaphors of fluidity is less threatening. Fluidity connotes a dynamic state, water flows and contours to its surroundings. Second, develop sensitivity to hype and hyperbole, seek out data-driven evidence, and exploit it both tactically and strategically. Hype and hyperbole erode trust and undermine credibility. Without it, the excitement it produces which in turn instigates change may never occur. Finally, develop a culture of assessment by building measures into various levels of a program. This lets stakeholders know what is and is not important and in doing so helps them focus their attention and resources.

10.7 Conclusion

This chapter familiarized readers with several Second Life residents' recreational world-building practices as comprised of their desire, creativity, and purposeful learning. I suggested that these individuals are a new breed of contemporary learners who learn and use a complex array of technological and social skills and knowledge afforded by the platform and indigenous to its culture. I pointed out that the majority of virtual world-builders are adults, many of whom are over 30 years old, and noted with this that context, not age, is important for developing education and training programs. I furthered this argument by addressing the issue of context with an organizational development lens and by drawing on experience infusing technology into a university curriculum.

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Biography

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Chapter 11
Game-Based Elements to Upgrade Bots to Non-Player Characters in Support of Educators

Lincoln C. Wood and Torsten Reiners

11.1 Introduction

The use of virtual worlds within education and entertainment has been on the rise in the last decade. While many elements have been considered and studied carefully, one component that appears to have been underappreciated is the humble *bot*, or software robot. We contend that bots are an important component within virtual world environments; however, considering current technology and approaches, they have been underutilised. New, rapidly developing tools effectively support the emergence of a new class of bots that will be valuable within virtual worlds for educational purposes by embodying greater autonomy and becoming complete *characters* within the virtual world but without any human controlling them, i.e., a non-player character (NPC). We envisage the intensity of interactivity as an increasing scale, differentiating between appropriate investments of effort in creating the right type of bot to suit different pedagogical requirements. Appropriate levels of investment in various elements of virtual worlds will increase the opportunity to incorporate them into other, existing, educational structures and approaches, extending the overall reach of virtual worlds and transforming traditional (i.e., face-to-face), blended, and online learning approaches.

We see a future where the bot will evolve and become more a NPC, using artificial intelligence that has advanced adequately, ensuring that the new NPC responds capably and in a complex manner with learners, whether these learners are acting as individuals or as groups. This will improve learner interactivity within virtual worlds and form an important component within gamification and education frameworks in virtual worlds.

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Gamification elements have been shown to be effective in many situations, where they can be used to improve engagement with learners in situations ranging from educational through to business applications. These elements are carefully incorporated into the design of the system in a way that will promote an intense and immersive experience. Control technology, once limited to the use of a keyboard and mouse, now includes touch screens, voice recognition, and motion and gesture sensors, making control more natural, fluid, and easier to learn. Coupled with the use of the bots, gamified elements and new control technologies are able to significantly enhance immersion within the virtual world environment in a way that promotes educational elements. These technologies are intersecting and colliding in a manner that will enable virtual world developers and instructional designers to propel their use of bots from clunky, limited features of the virtual world landscape to engaging NPC, able to ensnare learners within virtual environments and promote learner immersion to support educational objectives.

11.2 Virtual Worlds in Education

Virtual worlds play an increasingly important role in education. They've been used to take the distance out of distance education, increase engagement with online learning students, and blend the new environment with the traditional learning approaches from the classroom environment. Widespread use of virtual worlds in education has been held back by the lack of authenticity, the clumsiness of the use from the students' perspective, the difficulty of establishing and using the virtual environment from the instructor perspective, and lack of integration within existing learning management system infrastructures. We examine the elements of gamification and game-based elements within virtual worlds to determine how student engagement can be improved. Virtual experiences to support real-world situations have been used in education in several areas such as teacher education (Gregory et al. 2011), engineering (Bresciani et al. 2010), and health sciences (Thompson and Hagstrom 2011) and would be valuable in other areas, such as the simulation of hazardous situations for training purposes (Reiners and Wood 2013).

The benefits of virtual and game environments in an instructional setting have been acclaimed for their value. However, their use is not clear, with some studies showing that game-based environments in learning can increase students' intrinsic motivation, while also decreasing their extrinsic motivations (Tüzün et al. 2009). Extrinsic and intrinsic motivation can be segmented into psychological profiles, where self-efficacy effects both intrinsic and extrinsic motivation; synchronicity is closely related to perceived usefulness, driving extrinsic motivations; and empathy plays a role in creating an enjoyable experience, increasing intrinsic motivations (Shin 2009). Games have used both motivation types, with adventure games primarily relying on intrinsic motivation, where players must solve a particular problem before progressing, in a scenario where the problem and game are tightly coupled or interwoven (Pivec et al. 2003). A classroom environment with activities and simulations carefully incorporated can be used to engage with a class (Wood and Reefke 2010), primarily through enhancing intrinsic motivation.

11.2.1 Gamification of the Virtual Worlds Concept

The research community focused on virtual worlds has struggled with a sense of identity as they sought to separate the study of virtual worlds from the study of (serious business) games. As such, education researchers have invested significant time and effort on the pedagogical elements of virtual worlds, investigating and experimenting with a range of virtual world and virtual reality environments to understand how learners can use these resources effectively to support their educational objectives. While the community has continued to assert that virtual worlds are an important tool that can support existing pedagogical implementations, we contend that game-based elements and gamification can be used within virtual environments to great effect and this is an important area for further research. Indeed, in many situations game-based elements can be more easily incorporated into a virtual world, resting on an information system, than into a real environment. As Wood and Reiners (2012) assert, the ability to implement many gamification concepts is largely dependent on the presence of an underlying information system, such as an effective learning management system in a university. These systems allow rapid compilation of results, analysis, and presentation of feedback to learners. It is this nearly instantaneous provision of feedback and progress information to learners that enables self-directed learning and improvement over time.

A virtual world, coupled tightly with effective information systems, should allow simple implementation of gamification elements that are supported within the graphical user interface. This would allow the creation of structured lessons with integrated, game-based elements. These game-based elements are not an attempt to regress virtual worlds research to the level of a *game* or *playing games*; we propose that understanding the concept of game design (which ultimately plays a significant role in the success of any game), and its principles, can and should be considered and applied during the development of virtual world scenarios intended to support educational objectives.

Appropriately developed gamified elements will create a compelling environment for learners to act within. The design must encourage repeated attempts at completing tasks, the development of a sense of inquiry and curiosity in the learner, and induce a lack of satisfaction with the status quo that will result in the learner extending themselves. Considering these elements during the design stage allows relatively simple integration within most virtual environments; in contrast, the later adaption and *bolting on* of gamified elements to existing systems turns out to be either impossible or creates solutions that lack suitable depth of integration to be beneficial for learners. Some basic concepts include the following elements:

Small quests provide easily accomplished, clearly defined objectives for a learner to undertake. After the successful completion of one quest, a new quest is presented; this engages and compels learners to continue working within the environment. The use of quests can be integrated so that the material about the quest is seamlessly presented and incorporated within the environment.

Gamespace is the aggregation of quests, creating a map for the learner to follow the explorative task of learning, tracing back the success, and pinpointing the current location. Each of the quests can be seen as islands, while an overall storyline builds bridges and landfills; this metaphor sees the learner discovering all parts of the map and gaining an understanding of the whole world. The storyline, not necessarily a stringent line of quests but free of any order, becomes the space in which the learner navigates (Wark 2007).

High-intensity reminders of tasks, goals, objectives, and precedence (relating to the order in which tasks must be completed before others are attempted) must be integrated into the virtual environment. This increases immersion and reduces the need for a learner to refer back to notes or other prompts elsewhere within the environment—all information is retained and made available to a learner when it is required.

Feedback should be virtually instant. This is supported by the underlying information systems which are used to develop and run the virtual environment. Feedback from the environment and the learners' actions must be analysed, evaluated, with immediate feedback presented to the learner. It is important that in this context the feedback isn't seen as an academic report on how the learner has done; feedback can include mere evaluations, ranking, or scoring of the learners' attempts so they can gauge any progress and make comparisons between their efforts on the efforts of others within the cohort.

Increasing user engagement through the adoption of gamification and incorporating game-based elements has seen rapid growth in many applications. Gamificaiton has been considered to improve co-creation of content in online adventure travel services (Swift and Nitins 2011); to change behavioural elements of the use of electricity in the Opower application, based on social networks, feedback, and gamified elements (Han 2012); to encourage users to become involved in image-based social searches in Ubi-Ask (Swift and Nitins 2011); to work towards CO_2 reduction through social pressures and interactions in EcoIsland (Liu et al. 2011); to use a *tree* metaphor to combine several recognised gamification elements in the support of learning in a formal environment (Landers and Callan 2011); to improve student engagement in a formal university environment with a heavily gamified course (Cronk 2012); to improve user engagement with tasks that are necessary but seen as routine and boring, such as the calibration of equipment (Flatla et al. 2011); and to increase the value of self-directed study over a long mission for astronauts (Cornelissen et al. 2012). Game-based elements should not be entirely excised from virtual worlds; rather, these elements should be craftily woven into the fabric of what the users will experience, in a way that supports other pedagogical objectives. This requires investment of time and effort in the overall design of the experience and careful consideration of the role of bots, interaction, and the immersion that the user will experience. Gamification is capable of supporting increased active learning and engagement in class and structuring extrinsic motivations to support learner experiences.

11.2.2 The Evolution of Bots

Traditionally, virtual worlds offer the user an environment with basic functionality to build individualised scenarios. Especially open virtual worlds like Second Life offer manifold opportunities to create or import static and dynamic (including extended functionality by integrated scripts) objects, often without any restrictions to defined spaces. The given freedom is contradicted by limited opportunities to enliven the space by computer-controlled, autonomous, intelligent characters, often referred to as NPCs in games or bots in virtual worlds. The importance and benefit of bots is demonstrated by the following example: If we compare a real-world city with its virtual counterpart, we are often impressed with the details, shiny surfaces, and the *deja vu* and intimate familiarity of the setting. But even a Sunday evening stroll through the real-world downtown shopping area would provide us with a much deeper immersion than any virtual world is currently capable of. It is not about interactions or animations; it is about the missing society around us. In virtual worlds, there are often no other people (avatars) walking by, standing in front of show cases, or causing the constant background *buzz*, all of which combine to give the person 'a sense of being alive' (Ullrich et al. 2008).[1] Bots, computer-controlled avatars interacting with the environment, can fill that gap and become the needed background: the society. These wanderers (Reiners et al. 2012) may be simple by themselves as they do not have to interact but instead execute a previously defined series of rules, e.g., walking along a given path, demonstrate particular objects, or sit next to the user in a bar.

Bots being active in learning scenarios cannot usually be based on simple behaviours, as learners also require feedback on non-expected actions. Let's assume a lecture in logistics, where students are required to learn about the processes on a container terminal, i.e., about how containers are discharged from the vessel; see Fig. 11.1 for a visualisation of the scenario in Second Life. In a self-study setting, the learner might control the container bridge (the fixed-position infrastructure which removes the containers from the ship and puts them on the terminal), so that the straddle carriers (the movable vehicles that pick up containers to move them around, organise, and stack them) must be controlled by bots rather than by other learners, to facilitate the self-study opportunity. Further workmen, with the role undertaken by other students, are on the vessel controlling the discharge process, which would increase the level of realism.

[1] This scenario is valid for most major cities. Unless you live in Perth, Australia, where the CBD area at night is a perfect representation of the average location in virtual worlds; in 9 out of 10 occasions you do not see any human life form; while in the remaining case the other person is surprised to meet someone as the expectations targeted for reclusiveness.

Fig. 11.1 A simple simulation of a container terminal used for educational purposes

Simple bots can be incorporated up to a certain point. Nevertheless, if the learner must be exposed to a critical situation, the bots should observe and react properly. For example, the perfect scenario for the daily activities on a container terminal is the monitoring and controlling of routine tasks without exceptions, i.e., catastrophes. In real life, it is not possible to create an authentic simulation of such scenarios as it will involve far too great a risk for workers and extensive financial damage, due to interrupted operations. The same is often true with role-playing in virtual worlds, as it requires well-trained actors to be present at the same time. Therefore, virtual bots can be used to simulate dangerous situations where, e.g., straddle carriers are stopped at the wrong location or a worker on the deck is getting too close to the container being discharged, or where other actors are simply unavailable.

With respect to bots, we use the terminology of soft and hard technologies as described in Dron et al. (2011). In our perspective we have to recognise both in parallel as humans enact on soft technologies and require the restrictive nature of hard technologies that may have far-reaching and undesirable sociological effects (Ellul 1964). In brief:

- *Soft technologies* are filled with latent possibilities and potentials, enabling many creative and flexible uses, whether they are human processes or embodied in machines.
- *Hard technologies* are concerned with efficiency, replicability, and the elimination of errors.

The difference is best illustrated using OpenSim as an example. The first appearance in OpenSim (after a new installation) is within an empty space that can be freely transformed and enriched with any imaginable object. This soft technology offers the widest range of flexibility to a creative user but might leave others feeling isolated and unsure about how to proceed, a situation that will therefore scare at least a proportion of users away and prevent them from continuing the in-world experience. The extreme opposite is *guidance* taken to an extreme, where all decisions are predetermined and the user is merely following instructions. An example for a non-extreme hard technology is the introductory island in Second Life, where the user can neither build nor leave the area before finishing certain learning units while enjoying limited freedom such that they can achieve this goal by choosing the order, time, and process by which they will undertake the required tasks.

Bots are generally capable, depending on their programmed behaviours, to harden the technology for the user. In the case of being in the background to simulate the society, the influence is minor and the user is only affected indirectly. This increases the authentic immersion of the learner and supports to keep the focus on the task, increases engagement and motivation, and transfers the lesson learned into the real world (Heller and Procter 2010). A further hardening of the technology is achieved by having the bots interact and communicate with the learner or directly influence the environment (Paper 2009). Heller and Procter (2010) asserts the importance of bots for distance education, where multiple roles must be filled within learning units, but cannot be filled with learners or teachers. In the previously described logistics example, bots can provoke an accident or request a specific container, compelling a sequence of corresponding actions on the part of the learner. The flexibility is reduced and the learner is guided—even though by his own reaction.

11.2.3 Intensity of Interaction

Role-play is an important concept in teaching but is mostly restricted by the need for multiple actors to be in the same space at the same time. However, it is possible, using modern software tools, to develop bots (or so-called NPCs) further. The development of bots permits increased interaction as it is possible to have the bots reflect behaviours shown in role-plays where avatars have been controlled by the real-world users. This interaction can occur either by recording such role-plays or by writing scripts about how to react to certain events. The depth of interaction depends on the underlying systems and their capability of interpreting modifications to the environment and approximating the best possible reaction. The stages of interactivity are visually outlined in Fig. 11.2.

In general, five stages can be distinguished reflecting the degree of interactivity of bots with the environment. The stages are:

Stage 1: On the lowest level, bots would not be directly aware of the environment, receive no information about changing parameters, and merely reflect characteristics of a background actor without speaking or acting parts. Regarding the

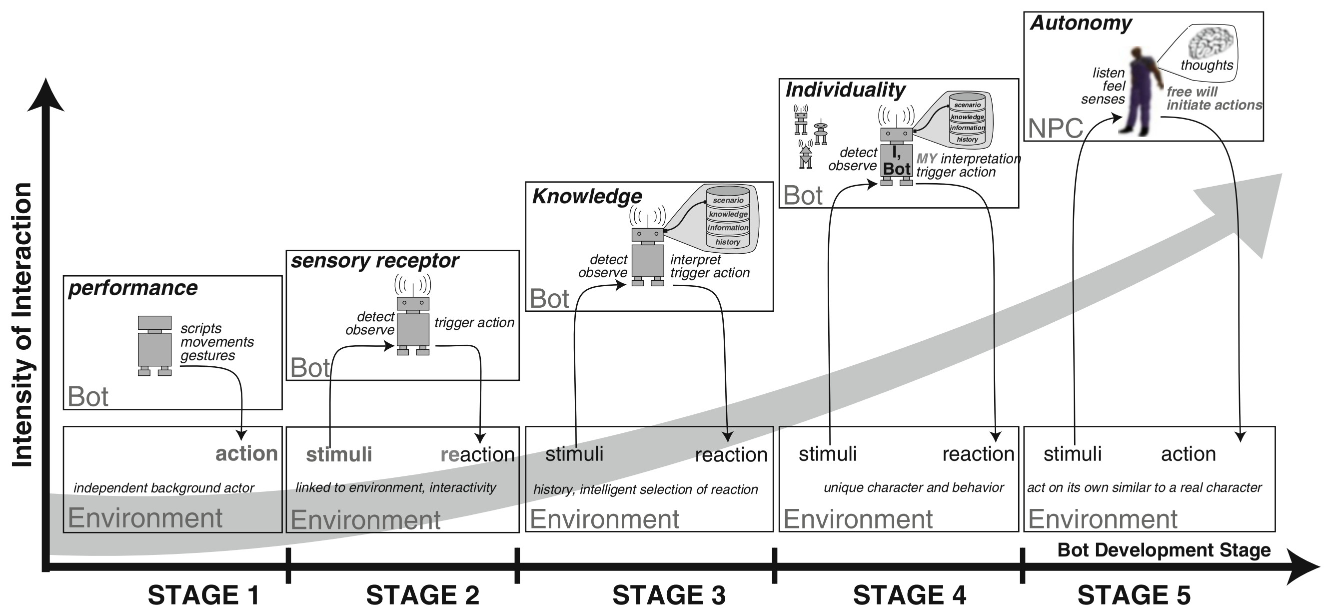

Fig. 11.2 Stages of increased intensity of interaction for bots

container terminal, a possible candidate for such a bot could be the captain of the vessel who is able to observe but not control the unloading process. The performance of the bots is accomplished by scripts controlling the movements and gestures of the bots. The bot performs actions, e.g., the captain can use binoculars to get a better look at the unloading process, even though it would not affect any other activity on the terminal. Actions are independent and should not result in a changed environment. Another example is the background dancer in a club, used to simulate a busy night.

Stage 2: At this stage, the independency of bots and environment reflects adversely in the authenticity and immersion for the learner. The perception of a captain who fails to take action when a container accidently falls off the vessel would conflict with the learners' expectation of the captain's behaviour in the real world. Bots have to be aware of stimuli from the environment and provide relevant detection (at defined points in time) and observation (over a longer period) opportunities. The given sensory receptors define which stimuli can be detected and which predefined action should be triggered, reflecting in a similar reaction being performed in the virtual world. Bots at this stage are modest to be implemented as it requires merely the direct mapping of stimuli to predefined reaction, including possible other objects, avatars, or bots in the virtual environment.

Stage 3: Bots require knowledge and experience from previous scenarios being stored in form of scripts that are triggered and executed in response to given stimuli. While bots at Stage 2 have a predefined set of sensory detectors and the corresponding actions to be triggered, bots on this level have the same process in receiving stimuli yet do interpret the source and cause of it against an advanced database containing past experiences and external sources of information to decide on the best possible reaction given a specific scenario. The same stimuli could therefore result in a completely different reaction, for example, seeing a snake in a zoo (expected and occurring in a safe environment) as opposed to seeing a snake in the outback (unexpected, danger to self). Updates in the database allow improvement over time. The behaviour increases the authenticity of the bots and the environment as the reaction resembles first artificial intelligence, i.e., with reactions being based on experience, learning, and the current situation rather than just the stimuli. If bots are responsible for picking their own route for the container transport on a terminal, the required time vs. distance benchmarks the quality for later selection.

Stage 4: In the real world, we generally perceive humans and animals as individuals demonstrating a certain uniqueness to the character, behaviour, movements, and, most important, their reactions. On a basic level, individuality could imply a style of appearance, set of typical gestures, emotional reactions on stimuli, or actions performed with higher frequency. Even with a unique look, the past experience would result in a (slightly) different reaction. Thus, the next stage for bots, which demonstrate an artificial intelligent behaviour, is to become aware of themselves. The overall logic of the bots is similar to those ones at Stage 3, but keeping track of parameters to describe skills and characteristics as it is done in most role-playing games. Even though bots start with exactly the same setting, they can develop differently over time so becoming unique bots. For example, bots evaluate each stimuli-reaction for improvements; interpretation of stimuli relates to the experience rather than just a database. In addition, individuality allows creating bots with unique starting parameters; providing a stronger immersion and authenticity to the real-world human user as the environment is not filled with identical clones but reacting individuals.

Stage 5: If users are emerged in environments where a non-guessing distinction between real-world users and bots is not given, bots achieve the highest intensity of interaction. Their behaviour seems to be detached from any predefined script, their reaction becomes an interaction with the environment, where not the stimuli cause the reactions, but the bot is able to initiate actions by its own means. Bots will have skills (scripted programs), but their appliance does not depend on the stimuli but on the fulfilment of an overall objective. Good examples are modern games, where bots have to prevent the player from achieving a certain target, such as preventing the player from stealing an object. Scripted bots, even with artificial intelligence, would follow a certain pattern that can be derived from reactions according to given stimuli, e.g., following a defined walking pattern to protect a building. Autonomy could imply that the bot just knows about the protection objective, and selects the most appropriate skill and action to pursue this, e.g., covering potential paths, setting traps for others, and increasing awareness for changes in the environment (movement, lights, and sounds). In repetitive games, autonomous bots can learn about attacking patterns and include this in their protecting strategy.

While in computer games bots are regularly used as components for single-player modes, most virtual worlds focus rather on user-controlled avatars than on bots. For example, Second Life has no native bots and the programming language allows only basic automation, which would be far from being a bot. Friedman et al. (2007) assert that scripts can only be used in objects and not avatars; therefore, direct control of all interactions with bots is not possible. Table 11.1 gives a short overview of major projects with bots in 3D spaces (mainly Second Life) and demonstrates the versatility of bots.

The use of the NPC is something that we perceive to be an evolution from the present state of bots. Even the name denotes greater interactivity and draws upon the old game in the traditions of Dungeons and Dragons where an NPC was usually controlled by the dungeon master, or game controller. This enabled a wide range of responses and higher levels of interactivity with the actual players. We perceive that a similar situation will occur with more advanced NPC being built into virtual worlds.

Table 11.1 Overview of the use of Bots in virtual worlds

Project	Bot functions	Reference	Description	Stage
TeachLive	Bots that look like classroom students talk, look, and act like students from real classrooms	(Dieker 2011)	Pre-service teachers can practise their teaching skills with bots being puppeteered by humans or scripted avatars	1; puppeteer behind it
PRESENCIA	Wandering around to find interesting locations to interact with human-controlled avatars	(Friedman et al. 2007)	Analysing the social behaviour in Second Life	
QoE	Crawler to gather information about the virtual world and a player to play back the collected experiences	(Varvello et al. 2011)	Exploring Second Life to measure the quality of experience	
Improv	Real-time behaviour-based animated actors	(Perlin and Goldberg 1996)	The system consists of an animation and a behavioural engine to create actors in virtual worlds	
Emotion	Extending Second Life bots with emotions	(Slater and Burden 2009)	Adding emotions to already existing bots using an AI engine	
MPML3D	Specifying communicative behaviour and interaction of bots using MPML3D	(Predinger et al. 2011)	To improve the usability of the scripting language for bots, MPML3D is used as an interface to write XML-based control scripts	3; AI is effective for text-based chat only

11.3 Framework Elements

11.3.1 Authenticity

In a highly authentic environment the learner expects to be able to interact with objects or people and have these interactions reflect what they would expect to occur in the real world. Technology enables us to immerse in virtual spaces recreating a certain degree of authenticity, even though the authenticity is about (static) objects and physical attributes. Creators are supported, e.g., by enhanced tools to develop any kind of objects, even identical replicas from real-world objects, and integrate functionality to animate the virtual world; even new users with a relatively small amount of training are capable of programming basic objects (Hebbel-Seeger 2013). True immersion and authenticity is not just about the objects but how real the feeling of being in this space is; an empty space is an empty space. For example, authentic learning is about employing pedagogical strategies to enable students to act as if they were operating in a real environment and provides opportunities for them to think and act as if they were experts in that field or discipline (Herrington et al. 2010). Experiencing authenticity in real-world settings that might occur in field trips, apprenticeships, internships, and practicum is not necessarily required to get the immersion. Within some areas the use of interactive and immersive simulations is valuable as they enable learners to practise and engage in a safe, consequence-free environment. These circumstances enable the learner to develop cognitive mastery over a range of tasks and challenges prior to experiencing similar situations in real-world challenges: much as a pilot trains on a flight simulator in order to crash-land a plane on a river, before being required to set down a real plane in a real river. Expert performances can be captured, allowing a learner to comprehend the requirements to meet industry standards. Learners are able to iteratively hone their skills and demonstrate this through improvements in their performance over a range of tasks in a virtual environment. Overall, these environments benefit from their sustainability; they avoid the risks associated to the organisation should the teacher with required skill sets leave, as students will still be able to benefit from expertise that is captured within, embodied in the virtualised expert performances already recorded.

As mentioned before, bots are one key ingredient to improve the degree of immersion. To achieve this, we do not require having complex artificial intelligences (Stage 3 bot), as long as the instructional design incorporates the restricted functionality in the design of the storyline. The learning outcome defines the minimum functionality required for a bot, whereas the training of defined skills or the repetition to meet a set standard is often about going through well-structured and guided units with little flexibility in the range of tasks or actions that a learner may take. Here, it often is about tasks allowing for no deviation from a protocol as it might cause risk or health issues. The bots are mainly in this setting to improve the social environment and are therefore not required to undertake tasks more complex than reacting to given stimuli.

Within the university environment, however, the emphasis is not just on the training to undertake a limited set of actions effectively but also on the students' education and learning and ability to apply a framework or theory to a range of situations. Here, knowledge is created or developed by the learners through their interaction with the environment. Thus, the learners' interactions with the environment are much more complex and will be more difficult for an instructional designer to predict, limiting the ability to preprogram or script a bot with a restricted series of responses to stimuli while creating a bot that may still be able to respond appropriately. As a result of this, it becomes very difficult for a bot to be preprogrammed so they can respond appropriately to what appears to be an almost endless possible input from learners.

11.3.2 Gamification Elements

Hebbel-Seeger (2013) has presented the encoding and replication of previous results as a shadow boat. This allows individual learners to compare their performance regarding previous attempts or against other learners. Such an approach allows an individual learner to strive against their own levels of attainment but fails to engage with the learner in an intensely competitive manner. Similarly, many initial attempts at creating virtual world learning environments focused on single-player experiences and semi-structured formats. However, these approaches lack the intensity and interest that can be encouraged with multi-person collaborative experiences. The unsatisfactory results that have frequently been reported have been often due to players feeling isolated within the environment, their difficulties to self-regulate, the ease of procrastination rather than activity, and the limitations imposed by few communication channels (Bernhard et al. 2000; Guetl 2008).

It is possible that the incorporation of bots may improve several gamification elements, particularly those relating to levels of attainment. The gradual inclusion of more advanced bots capable of dealing with a wider range of inputs positions these bots as being more valuable at higher levels of attainment, where they may be expected to react appropriately to a much wider variety of learner-created stimuli. At lower levels, learners' tasks will be more straightforward and instructional designers will require less advanced bots to accommodate this. The following list states some game mechanisms:

Challenges or quests are a crucial component of most human desires. Most importantly in gamification, the use of challenges provides a mechanism for a player to develop a *sense of achievement* when they complete the challenge.

Points provide a mechanism to *keep track* of success to monitor personal progression and also provide an objective benchmark for inter-learner comparison. Furthermore, they provide a mechanism that allows the allocation of rewards, recognising success, to individuals. It is important that characters only progress in a positive way and cannot lose their skills or capabilities. An exception might be temporary elements, e.g., short-term punishment to increase the level of difficulty or demonstrate disabilities in a scenario.

Levels are crucially seen as a measure of attainment and a way to display an objective level of status. They can also be perceived as levels of difficulty. It is possible to rank and evaluate one's self against others in terms of levels of attainment, while challenges can be designed to be testing, but not impossible, to players that have attained particular levels.

Leaderboards are an objective construction of the competition that all humans feel when working through challenges that others also work through. The leaderboards allow instant tallying and records of success, that individuals can compare themselves to, and use to monitor their own successes as well as their success relative to others.

Virtual goods (or the use of *badges* that recognise success, to a limited degree) allow the self-expression of a sense of individuality. While immersed in a learning environment, it is important that, as well as rivalry between factions, there is a sense of what makes a faction, even if the faction is defined as an individual. Some level of distinctiveness is necessary, and the use of virtual goods, which can be acquired or traded, allowing an individual to *brand* themselves and appear distinctly different.

Gifting and charity are supported by the use of virtual goods, where acts of kindness and charity can be used to enable players to express a sense of altruism and enjoy the pleasure that comes from generosity.

Each of these gamification elements can heighten the intensity and immersion of the learner's experience within the environment. Careful design of learning experiences at the course level can improve relevance for students by carefully ensuring structured changes in the authenticity of the experience and the degree of real-world skills or incorporated academic theory (Reiners and Wood 2013) and can allow different levels of immersion of the learner in the tasks. This is also supported by the careful analysis of needs requirement and design of NPC to support the learning activities. Advanced bots may be required to respond to a wide variety of learner input and generate an outcome or move the learner 'back on track' in the overall learning programme so that education advances. In this way, the bot 'absorbs' the variety created by a learner. At a skills-training level, learners have a limited range of actions to undertake and bots require little sophistication to respond appropriately and ensure the learner is positioned to advance their training. In contrast, advanced levels of learning may encourage a wide range of responses from learners, requiring sophisticated bots to accommodate this variety of response. In this way the bot design exemplifies Ashby's Law of Requisite Variety (Ashby 1956), which states that the achievement of control requires a variety of the perturbations less than the variety in the control system. Examples of extensive and effective gamification of activities remain uncommon; most applications of gamification involve only a few elements. The overall result of many of these applications is the creation of an ungainly semi-immersive environment.

Other game-based elements that are useful within the virtual environment (Reiners et al. 2012) include:

Multiple lives allow learners to explore the line between safety and danger more recklessly and experientially. Rather than being required to undertake special training and take precautions, as would be required in a real-world setting, the learner is able to experiment and learn from the outcome. This means that a learner is able to experience, for example, how fast they can drive a straddle carrier on a container terminal, by purposely exceeding safety guidelines. The use of virtual worlds enables the learner to re-spawn a new avatar and attempt an activity again, with no repercussions.

Save points are traditionally, in a computer game, associated with the completion of a stage, or the start of a new, challenging quest. They allow a learner to progress beyond the save point with a *safety net*, secure in the knowledge that they can recover their past achievements should they make an error of judgement beyond this point. They explicitly enable a learner to restart at a point following failure after that point, or revisit an earlier moment so that they can reuse a sequence as part of their learning activities. They also provide a natural *break* in the learning activities, in a way that can enable the explicit recognition of achievements, while also encouraging the option to *take a break* before re-immersing themselves in the virtual world environment once more later.

Rewind allows a learner to progressively build confidence, with the ability to *return* to a previous state in a given scenario for (annotated) review or to experiment with other methods to solve a given challenge, e.g., loading objects in an optimal way on a truck might require a special order. Rewinding would automatically unload objects up to a certain point, from where the learner can pick up the process again. A rewind often allows to take a different perspective during a replay, thus gaining further insight and doing a more robust analysis; see Fig. 11.3.

Time and space control allows the understanding of a given process that may be too fast in real life and, therefore, difficult to observe, or which may be hidden due to the limitations of the technology [e.g., the inner workings of a fuel cell; Boerger and Tietgens (2013)]. Virtual worlds can be used to *slow down* a process or to expand a process that occurs on a microscopic scale, to allow learners to immerse themselves in the activities and processes involved.

Ghost images, as used by Hebbel-Seeger (2013), allow a user to gain knowledge from their own learning activities and can also enable an expert to undertake a single demonstration which may be retained using machinima (i.e., a video clip depicting interactions within the virtual world) as an archive to support future learning experiences with a range of students. In this process, bots can interact within the environment and the expert demonstrator, enabling the later analysis of a set of rules that is accepted to provide a *good* outcome. Data could be further mined to extract a simplified exemplary method to respond to a given set of environmental challenges to achieve a stated objective.

Fig. 11.3 Multiple perspectives on the same scenario on a container terminal: (**a**) supply manager decides on order quantities to be ordered; (**b**) the controller on the container terminal receives the information and decides on shipment orders; (**c**) operations managers analyse the performance of the movements on the terminal; (**d**) engineers plan on improving equipment to increase performance (Wriedt et al. 2008; Reiners 2010)

11.3.3 Technological Progression

Other challenges that are linked to our current technological state include the equipment that can be used to control and manipulate the virtual environment. Students find it simple to pick up a pen and paper or building blocks in a face-to-face environment as part of active learning exercises, exhibiting a high level of *ability to jump in* with immediate payoff through being able to achieve something. In contrast, learning to manipulate an avatar and the virtual environment often takes practice and a degree of dedication; the virtual environment therefore provides a steeper learning curve that may lead to some learners feeling dejected and overly challenged before they even attempt a learning exercise. While current technology seems to be *holding us back*, the next few years should see an explosion of new methods that will allow learners to engage with virtual environments in a more natural manner in a way that will increase the immersive sensation and lead to improved engagement. These include the development of effective 3D goggles, where the image displayed will change as the viewer's head shifts position; the use of motion sensors is becoming commonplace and has been incorporated into existing entertainment systems such as the Microsoft Kinect system, which may be extended in the future to take the place of keyboards or pointing devices such as the mouse or track pad. Voice recognition, semantic analysis and processing capabilities (i.e., analysis of the meaning of words, phrases, and utterances of users given the existing context in the virtual world), artificial intelligence, and text mining/semantic retrieval are also improving, resulting in the ability for a NPC to interpret words spoken by the player (voice recognition), analyse the meaning of what was said (semantic analysis), then respond appropriately (artificial intelligence) while drawing on appropriate data (text mining/semantic retrieval).

11.3.4 Framework Development

Throughout this chapter we have talked about the various elements required to increase immersion and engagement in virtual worlds in a way that will support educational processes. We see that there are two key elements in this process: game-based elements that will increasingly motivate students and bots that are transitioning to NPC, as they are able to support complex interactions with learners. Together, these crucial elements are able to engage learners and ensure that learners are able to meet carefully designed learning outcomes.

Additional elements include gamification, technology, and authenticity. These are required to support the use of game-based elements and bots or NPC; see Fig. 11.4.

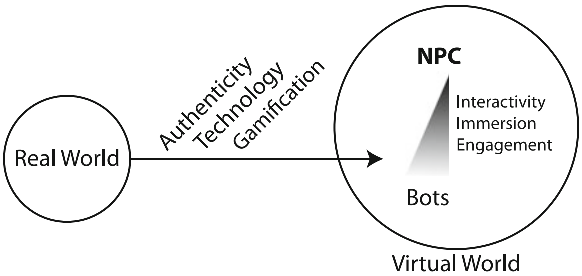

Fig. 11.4 The transition from real-world scenarios to the virtual world can be used to actually extend the learning space by increasing authenticity and integrating technology and gamification elements for a higher immersion and engagement; generally not possible in a classroom environment. The enhancement needs to be matched by the level of interactivity of the bots, i.e., empowering their functionality and behaviour to the one of NPC

Gamification incorporates a range of approaches and techniques that have been adopted directly from game design but which may be used in non-game settings in a way that will motivate individuals. These are a more narrow subset of game-based elements but are crucial due to their psychological impact. Technology plays a role in supporting both game-based elements and bots or NPC. Effective use of information systems is required to analyse information and performance, provide feedback, and adjust the environment to respond to stimuli; the use of effective information systems is clearly required for effective use of game-based elements. However, rapid advances in control technology also support the interaction with and value that may be delivered by bots and NPC. Natural control of avatars (voice commands, motion and gesture sensors) enables a more immersive environment, while the ability to understand spoken dialogue coupled with the ability to understand the meanings of learner utterances enables advanced bots and NPC to provide significantly more value in a supporting role in educational processes.

Authenticity is required before the bots or NPC are fully valuable and must be carefully considered at the start of the design. Congruence in design elements to create an appropriate level of authenticity is required, as is matching bot requirements to the design requirements and what is portrayed in the virtual world. Taken together, these elements must be carefully considered by instructional designers before they commence a project. Early consideration in the design process makes it simple to adapt and incorporate these elements; however, retrofitting these elements into existing projects may prove more difficult and fail to deliver the advantages that were anticipated.

11.4 Conclusion

We perceive that the gamification element of incremental levels of difficulty, leading to incremental levels of achievement, will become increasingly important in the virtual world environments, where they are used for educational purposes. A key distinction between training and education as a constructivist approach in education where knowledge is constructed and built upon by the learners themselves, while training is the *repeat, do, and learn from* approach.

As we move towards using virtual worlds in educational settings, particularly universities and other higher education institutions, we will be forced to develop NPCs, which are increasingly advanced, sophisticated, and capable of interacting with learners in a meaningful way. This will require an underlying level of artificial intelligence and semantic processing capabilities. The use of small, incremental levels of adjustment will require very clear learning outcomes for the structured activity presented in the virtual environment. This will allow small adjustments to the level of difficulty as the learner progresses through the learning exercise, building towards achieving more substantial learning outcomes in a step-wise fashion.

A virtual world as a truly immersive environment will support authentic education by drawing on game-based elements, gamification, effective design of bots, and current technologies. However, for this to be achieved an individual learner must be able to engage with the environment effectively, find themselves compelled to keep on learning, and wonder at the options and range of learning experiences available. This can be supported through the development of NPC bots, effective scripting, and the use of a gamified environment.

We present the *Stages of Increased Interaction* (Fig. 11.2) as a key outcome. This illustrates the various levels of interaction that bots can be designed at, resulting in a highly interactive NPC as the fifth stage. This categorisation provides a framework for instructional designers so that they expend an appropriate amount of effort on each bot so that it can accomplish a given task in a virtual world and invest adequate resources into others, where greater complexity is required; they invest only enough effort as is required by the bot in that context and do not over-engineer the bot. We are aware that the term NPC does not accommodate non-person animated *machines*, such as a driven straddle carrier (or other equipment as shown in Fig. 11.2). These are still *stuck* at a lower level of intensity of interaction, at an appropriate level. These elements should be reused where possible and little instructional designer effort should be invested in these beyond the basic requirements.

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Chapter 12
Collaborative Learning in Virtual Environments

Dennis Schäffer and Jörg Heeren

12.1 Introduction

John is hurrying down the corridor, as he does not want to arrive late to his course again. The last time he went to "Arabic for Beginners," he barely got a seat, so this time he left work a bit earlier than usual to arrive on schedule. He opens the door and enters the room: a modern place with a whiteboard, multimedia equipment and a beautiful view of the city skyline. He enters the room, his gaze travels around him and he is startled, for every space is already taken. But no! There is one seat left – right next to Lisa. This time, John is really lucky. Lisa is quite a nice bunny he often took a glance at in class. With her huge plushy ears, her little black nose and her strong white fur, she is quite a sight. This might turn into a great evening for John.

But wait a minute!

White rabbits in Arabic lessons?! That sounds quite like a scene from Alice in Wonderland or a weird dream. But it is not. It is a description of a serious education event that takes place hundreds times in the virtual world of Second Life. Lisa and John are only two of the attending avatars – their virtual selves – at an e-learning course. They all sit at their personal computers at home or at the office and interact, in this example, with their teacher who is seated somewhere in Dubai. They all use the chance to learn from a native speaker while staying in their home cities of Berlin, Prague and Madrid.

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Looking at this example, at least four interconnected issues emerge:

- The learners attend a learning session independent of their location.
- They benefit constantly from an expert whom they would have had to go without if there were no connection via a virtual setting.
- They are a part of a group of specialised learners that possibly would not have congregated if dependent on meetings at a fixed place in the physical world.
- Some of them seem to be part-time learners, who also pursue a profession.

These observations are associated with the paradigm of lifelong learning: nowadays, lifelong knowledge acquisition is regarded as an important component in occupational careers. Professionals are encouraged to control their learning efforts autonomously. From the increasing demand for specialised skills and flexible knowledge acquisition follows an increasing demand for flexible learning settings that facilitate self-directed learning. With regard to this ascending demand, the Department for Educational Sciences at the University of Bielefeld in Germany initiated the project E-Learning 3D (EL3) in 2007. The project was assigned to develop a virtual learning environment (Fig. 12.1) in which students as well as lecturers could interact without being actually on the campus. It was expected that such a learning environment could serve as a complementary component of the university's schedule of lectures.

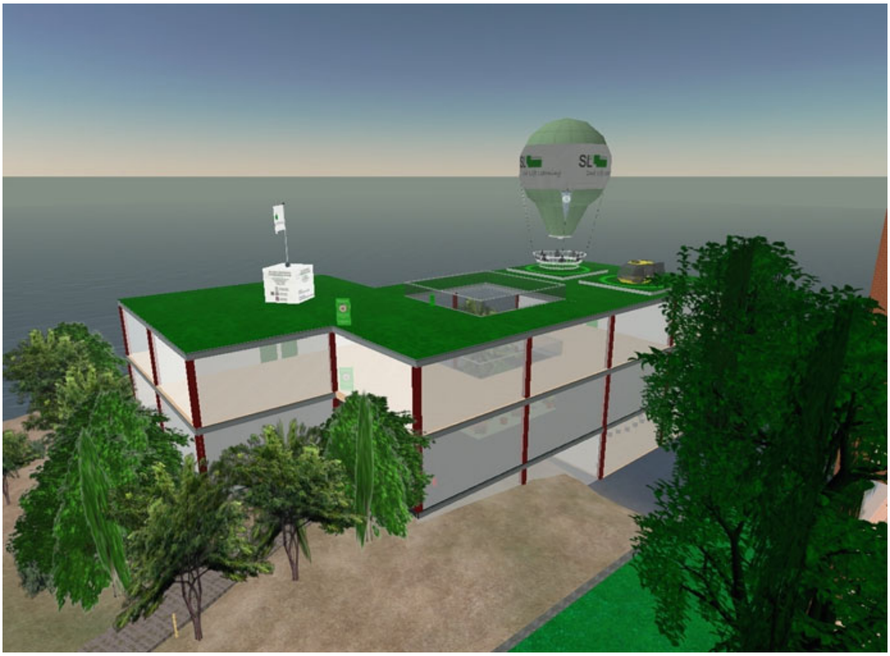

Fig. 12.1 The E-Learning 3D campus in 2007

The project EL3 chose the virtual world Second Life (SL) as the infrastructure for the establishment of the required learning spaces. SL is an online-based system that allows the users to move and act in a seemingly three-dimensional space. At the outset of EL3, Second Life was a ubiquitous phenomenon across different media. Today, though the medial omnipresence of SL is gone, the number of users is nonetheless still rising. Worldwide, 18 million participants are registered for the multi-user virtual environment (Linden Lab 2009). As the worldwide web evolves to the third dimension, EL3 tries to evaluate the potentials and possibilities of multi-user environments for learning purposes. Furthermore, it designs scenarios and best practice models for the use of these environments. This article covers the genesis and decisions made during the process as well as a description of the employed and adapted learning environments and tools. A learning environment is thereby understood both as a compound of knowledge that is organised according to didactic principles and as a setting designed according to didactic principles in order to facilitate knowledge transfer and knowledge generation between persons (Swertz 2004, p. 27).

12.2 Aims and Genesis of the Project

The project was based on the idea that students are increasingly receptive to self-directed learning, inter alia due to the intense use of electronic learning media. Thus, it seems to make sense to shift a part of the traditional course programmes of universities into self-directed learning phases. Moreover, there are a rising number of part-time students who work alongside or are constrained due to personal reasons (e.g. parenthood). They maintain a day's schedule, which resembles that of long-distance learners. There also emerges a demand for courses that are independent of time and place, i.e. that allow participation outside of the walls of a university (Schulmeister 2005, p. 240).

The aim of the project EL3 is the scientific evaluation of the virtual world Second Life as a learning instrument and the creation of a direct benefit to the students. As a main outcome of the project, a large virtual campus was created. It facilitates communication on the background of various room structures, which are equipped with several virtual media-like video screens, podcast players and interactive notice boards. The project team initiated and offered lessons and classes in auditoriums on the virtual campus. Likewise, students were counselled in virtual meeting rooms (E-Learning 3D 2009) (Fig. 12.2).

Apart from the technical design, the project is concerned with the formulation of didactic concepts in terms of the utilisation of virtual environments. By conducting seminars and developing and collecting learning tools in SL, the EL3 team created a base for critical reflection that rests upon the results of continuous development and adjustment of the virtual study programmes. Associated with the theoretical work, the EL3 team collected and analysed empirical data that sheds light on the potential of virtual worlds as learning environments.

Currently, the project starts the general implementation of virtual environments as a standard tool for academic seminars at the Bielefeld University.

Fig. 12.2 A classic lesson at the EL3 lecture hall

From a pedagogical perspective, SL offers a wide range of possibilities for the development of virtual learning settings. First, there is the sensation of staying in a three-dimensional room with others – designed analogously to rooms in the physical world. The adoption of the room metaphor allows an easily comprehensible way of synchronous interaction with the other participants. The similarity of SL communication and everyday communication seems to allow a high degree of emotional involvement of participants. Second, the learners can connect external web 2.0 applications like wikis and blogs with SL. Second Life combines a great variety of learning activities: users can watch clips in SL, they can read online articles on their particular topic in SL and discuss afterwards and they can illustrate ideas and concepts by building three-dimensional objects in Second Life (Mersch 2008).

12.3 Underlying Theoretical Assumptions

The project EL3 follows the assumption that interactivity among learners fosters active learning. In contrast to the approach of instructional design, by which learning is organised linearly, task-oriented EL3 proceeds from the constructivism perspective on learning: learners are active participants in the process of knowledge acquisition. They process knowledge on the background of their personal experiences, i.e. they structure it and they modify it. These assumptions are suitable to lead the design and the cultivation of a virtual learning environment. Inter alia the following goals were (cited in Pivec and Dziabenko 2004, p.18): “to provide an experience with the knowledge-construction process”, “to provide experiences encouraging appreciation of multiple perspectives", "to embed learning in realistic and relevant contexts" and "to embed learning in social experience".

In this respect, the EL3 project operates with the following definition of collaborative learning: a group of individuals communicates and operates jointly in order to acquire and generate knowledge and hereby the group follows a collective aim of knowledge acquisition (Wessner and Pfister 2007, p. 22).

Three styles of collaboration can be distinguished: generic, spontaneous and intended collaboration (cf. loc. cit., p. 26). Second Life allows the accomplishment of each of the three styles. Generic collaboration comprises activities in a digital learning environment that are not directly connected to learning sessions, e.g. the contacting of other participants. In SL users can contact each other via voice chat as well as text chat. Spontaneous collaboration refers to learning activities that are a part of a course but not limited to this set of learning sessions. In SL, this applies to the function that allows writing messages to members of a certain group. Intended collaboration refers to learning activities that are bound to a certain point of the course structure. This holds, for example, in group work when the learning facilitator determines the size of the group, the duration of the group work session or when he hands out a set of instructions and documents as a basis of the group work (cf. loc. cit., pp. 26–29).

As shown above, Second Life as a computerised analogue of the physical world that surrounds us is the basis for the learning sessions offered by the project E-Learning 3D. This is mainly due to the potential of SL as an extension of learning activities in the physical world. The possibilities of collaboration in SL go beyond the scope of traditional learning activities in one particular aspect: it releases learners from physical constraints. These constraints usually bind the perception of collaborative learning experiences to encounters of a learner with other learners that happen at the same tangible spot.

It is assumed that virtual worlds like SL are additional contexts in the world we live in. Walber (2008) postulates that a distinction between real and virtual worlds is untenable. Users are able to incorporate these additional contexts as new parts of their reality (loc. cit., p. 75).

Therefore, users perceive the surroundings in SL and in similar Multi-User Virtual Environments (MUVEs) as "real". This includes the perception of social presence, which is due to the simulated physical presence in SL. Each user is represented by an avatar, his virtual agent, and via his avatar he can interact with other users, meaning he can communicate via text input (chat), talk and act towards other persons in the virtual environment. The avatar can be seen as an additional part in the personality of the user, of course still controlled by the person who it represents (Graeßner 2008, p. 2).

Furthermore, the sensation of immersion can attach the users to SL. The effect is often ascribed to virtual worlds and can evolve when a user engages, absorbed in thought, with the simulated environment. The user then blocks out his actual surroundings and focuses on the "in-world" activities (Heeren 2009, p. 254).

Products that are created by users of SL stay preserved even if their producers are offline. This continuance also nurtures the sensation of immersion (Schmidbauer 2008, p. 52).

Fig. 12.3 Social interaction in Second Life

Compared to text-based e-learning platforms, which usually are limited to a visual presentment SL bears not only the perception of a higher degree of social presence but also the advantage that it allows to address a whole range of channels of perception. With regard to the multichannel approach, it can be assumed that learners absorb information better when it is offered in several means of perception (Falk-Frühbrodt nd). Learning environments in SL should take into account this need for different channels of perception (Fig. 12.3).

Although the virtual collaborative learning experiences a leap by the implementation of Second Life, lecturers still need to consider traditional didactic principles when it comes to learning in that environment. A virtual world does not "automatically" function as a professional learning environment. The provision of space for learning does not necessarily ensure that collaborative learning does actually happen. Nonetheless, virtual buildings, rooms and places can be designed with a didactic intention as well as schools and universities in the physical world that can be designed with the same intention (see paragraph 3b "Learning Spaces of EL3"). Nonetheless, for collaborative learning to happen, it is necessary for people with a common orientation towards a topic to gather, in order to generate, distribute or receive knowledge. Also, it is essential that they perceive a physical or virtual proximity to other learners (Städtler 2008, pp. 207–216).

The Berlin model of didactics can serve as a perspective to discuss the process of collaborative learning, regardless of its emergence in physical or virtual reality. The model starts out from the idea that facilitators of learning act in a structured field of interaction in which certain decisions are to be taken concerning intentions, content, methods and media (Heimann 1965, p. 10),(Schulz 1965, p. 23). From this, it follows that when a facilitator prepares a learning session he can set his intended learning objective, he can set the topic and he can decide about which ways to use to activate the knowledge transfer between the participants. He also determines which media to use to accomplish his learning objective, e.g. books, blackboard, computer, beamer or audio device. These aspects that are dependent on the facilitator can be defined as the facilitator's spectrum of decision-making (Schulz 1965, p. 37f).

To take suitable decisions, the facilitator needs to clarify the conditions that influence the learning situation (Heimann 1965, p.10). These determining factors concern anthropogenic conditions (the perception of the participants formed by disposition and previous experiences) and sociocultural conditions (the setting in which the learners are located during the learning session) – a general setup that is not controllable by the facilitator. These antecedents can be defined as spectrum of conditions (Schulz 1965, p. 36).

Within that didactic perspective, the space in which learning occurs can be seen as another condition of learning when it is allocated by higher authorities or when it is dependent on organisational guidelines as is usually the case in schools and universities. Consequently, the facilitator is not able to change such conditions by his didactic decisions (Swertz 2004, p.13).

The usage of a virtual world like SL turns this view upside down: unlike a physical learning space (e.g. a classroom or a library), a virtual learning space can be modified in a few steps by the teacher respectively facilitator.[1] By that, the learning space turns into a part of the didactic decisions, i.e. conditions that can be organised in a great measure by the facilitator (Swertz 2004, p.20).

Following this idea, Second Life can be didactically considered on two levels: first, within the physical world it serves as a medium that is used by an organiser of a learning session to foster a certain learning objective. Second, within the virtual world of which SL is part, the organiser of a learning session acts under the scope of his learning objective and takes decisions on content, methods and media inside of the medium Second Life (Fig. 12.4).

The decision to use SL as a medium for learning sessions generates a new spectrum of conditions that influence the learning situation. This spectrum is partly similar to the spectrum of conditions in the physical world (e.g. the intellectual competencies of the participants still play a role). However, the involvement with SL also entails specific conditions. For example, it becomes crucial to consider how familiar the participants are with the handling of the instruments of SL (e.g. the voice chat or the control of the avatar). A low familiarity with the medium can induce a disturbance of the knowledge transfer and generation. This would mean that it is not the intended content but the medium that becomes the topic of the learning session (Schulz 1965, p. 35). Therefore it can be required to either offer introductory lessons before applying SL or set the familiarity with SL as an entry requirement for participation.

Referring to the aspect of familiarity with SL, the team of EL3 decided to confront the participants preferably with didactic elements that are common in physical

[1] A consequent application of this possibility is the rather versatile holodeck on the area of EL3 (see below).

Fig. 12.4 The usage of whiteboards in Second Life

face-to-face workshops and lectures. For example, the procedure in the virtual EL3 forum on further training corresponds with a conventional colloquium. Furthermore, it was agreed upon to choose mainly media in SL that originates from the repertoire of physical face-to-face events (like video clips or on-screen presentations). To avoid the "boredom factor" (Dearling 1992, p.58), which arises often in large groups, the length of presentations was limited. This measure was also due to the circumstance that the speaker does not receive the same feedback that he would receive in the physical world: the natural gestures, mimic and body language in general are missing. Thus, to reduce the likelihood of divagation, presentations in the EL3 forum were restricted to a maximum of 20 min, followed by a discussion that involved the audience.

Notwithstanding, such arrangements are still seen as variable, since the EL3 team assumes Second Life and the learning spaces within it as an experimental ground for didactic procedures in virtual worlds.

12.4 Deploying Second Life as Learning Environment

12.4.1 Fields of Action

In 2009, the EL3 team offered a course on the "Designing of Virtual Learning Environments" which took place entirely in virtual space. The course was part of the regular course catalogue for students of the department for educational sciences.

As the learning environment has a great impact on the learning process, the participants had the possibility to build their own learning environment. These environments reached from common classrooms, as we know them from daily work, to treehouses high up in the clouds, to a setting at a lonely beach with a great sunset. After the phase of exploration and building, all participants reflected and discussed the learning areas on the basis of scientific criteria. Virtual worlds like Second Life offer possibilities for designing and building learning environments – a matter that is unfeasible on a campus in the physical dimension (Fig. 12.5).

Furthermore, the course was also aimed at the participants of the e-trainer qualification at the department. This qualification proceeded in modules and takes one and a half years to complete. The participants dealt with the question on how to didactically design and to realise online learning processes. During the first semester, the students learnt to handle modern e-learning platforms like Moodle, Elias and StudIP virtual worlds like Second Life. Within this phase, the focus is put on the usage and administration of such platforms, so that the students can later handle them as means for their own courses. In the following semester, the students dealt with the didactic and educational questions about e-learning and blended learning courses. In the final third of this semester, the students designed a course for the upcoming third module, in which they acted as e-trainer for other students of the department. After completing this part of the qualification, the students offered their results to all students at university as a regular course to practically experience what it means to conduct online lessons in virtual worlds and other modern e-learning environments. This phase is also supported by the lecturer, in order to ensure learning efforts and fruitful results for the e-trainers and their participating students. When the next qualification cycle starts, the new students can fall back on the results and locations that are built in virtual worlds by the preceding courses, improving these buildings or taking them as examples for their own work

Participants of two programmes for non-traditional students at the University of Bielefeld employed SL in order to build their own virtual representative rooms.

Within the framework of the programme "Women's Studies" (Frauen-Studien), a workgroup chose Second Life for their project work. Based on didactic considerations and theories, they started with designing a room at the E-Learning 3D area. During this phase, the participants were supported by the E-Learning 3D team, which organised and held the kick-off of workshops and advised them during the building and exploring phase. After some weeks, the students got familiar with the world of Second Life and they were able to build an area where the members of the programme could gather, talk and present their results to other interested parties. As a part of their project work, the students had to conduct a small scientific study. The group of Women's Studies students used the special opportunities of Second Life to conduct a qualitative study on the usage of virtual worlds for learning purposes. With the independence of time and place, they talked to people around the world. They also managed to establish contacts to other people involved in e-learning during their voyages in Second Life, which proved to be useful in order to strengthen their personal learning networks. The room and the findings of the participants were presented several times on occasions during official events at the university.

Members of the programme "Study for the Over-fifties" (Studieren ab 50) forged a study group that cooperates in SL. This programme is not limited to the Faculty of

Fig. 12.5 A learning environment designed by students

Educational sciences. These students can choose from many different courses distributed throughout the whole university programme. The Second Life group meets on a weekly basis to explore the world of Second Life and to become used to learning in virtual environments. They invite speakers from their fields of interest or visit cultural places in Second Life like museums or art exhibitions. They also travel to pleasurable virtual places like the Pyramids or the City of London to get a feeling for historical facts or the architecture of a certain time period. Furthermore, they also build up and design their own location where they can meet and talk to other participants of the study group.

This sort of collaboration proved to be helpful especially for older people, as they could easily attend lectures from their homes and need not come to the campus for their courses. Speakers from around the world were also invited, who often readily agreed on joining the meetings as they could lecture from the office desk with no need to travel to the University of Bielefeld. The broad learning experiences in SL reflect the deep interest of the members of the "Study for the Over-fifties" programme concerning virtual collaboration – and they do prove that e-learning and virtual worlds are not reserved for the young generation (Fig. 12.6).

Apart from lectures, presentations and workshops, the virtual campus was also used for consulting hours and meetings of study groups. This means that the students need not come to the physical campus and that these meetings could be held from a distance. However, contrary to the other projects, this idea was not adopted well by the students, as there were many concerns about security issues, i.e. the risk of

Fig. 12.6 Meet students at the area "Study for the Over-fifties"

being overheard (which in fact can be prevented by the use of the direct voice chat of avatars). Most of the students also preferred to meet their lecturers face to face, as there are some factors that are transported poorly by the avatar such as empathy and body language. Avatars lack most of the body language and facial expressions, but people tend to fall back on these resources when they talk about important topics like testing and grades. Another usage of the virtual rooms that were tested was the conduction of coaching sessions. For example, during a face-to-face seminar, a virtual office was employed to simulate an e-coaching. It appeared that the small size of the EL3 offices and the impression of its limited accessibility – there is only one office entrance for each office – foster the conversation on intimate topics, especially when the "one-to-one voice call" is in use (Heeren 2009, p.265).

Apart from these student-oriented fields of action, the project also organised several public education events in Second Life, which were most often attended by thirty to fifty avatars at a time. Starting in 2008, one series of events was the "virtual forum of continuing education" (Virtuelles Weiterbildungsforum) that took place on a monthly basis. The forum proceeded at the virtual lecture hall in Second Life. Its procedure resembled a conventional lecture in most ways. The project team invited speakers from the different fields of e-learning. During the two hours of the event, they could present their findings with the aid of charts and multimedia. Both scientists and practitioners followed the invitation and presented current results and trends from their field of work to the audience. After the presentation, there was always room for discussing the topics. As a service, the forum sessions where streamed to the E-Learning 3D website, for those who could not attend the event in Second Life. Moreover, the sessions where fully recorded for later use and are retrievable at the project website in order to convey an impression of how a virtual forum can proceed. During recent years, more than fifteen notable speakers, and more than five hundred avatars, attended the virtual forum for continuing education.

In autumn 2009, "Island Day" (iDay) – a virtual conference – took place for the first time. On this day, educational institutions and universities from all over Europe were invited by the E-Learning 3D project to come together in Second Life to present their current proceedings and findings. All exhibitors were virtual inhabitants of the "European University Island" (EUI), an area especially reserved for educational institutions from Europe. By iDay 2009, twenty-two educational projects resided on the EUI. The event was open for everybody who was interested in informing oneself and to get in touch with representatives of the different projects on the island. iDay took place only in the virtual world of Second Life and was completely free of charge for any participants. Only a registration at the virtual world of SL and the creation of an avatar was necessary. The conference lasted about eight hours, with three parallel presentation slots throughout. With an average of fifty avatars at a time, about 200 people attended this first iDay. Due to the particular setup of the conference, there were very low expenses. As there were nearly no fees for rooms, buildings and equipment, most costs were limited to opportunity cost for the attending speakers. The organisation beforehand was done by the speakers themselves through social networks[2] (Fig. 12.7).

12.4.2 Learning Spaces of EL3

In previous years, the virtual campus of EL3 was subject to constant alterations. One benefit of a learning environment like SL is that one can replace buildings and grounds simply via mouse-click when a certain occasion requires a new setting. For example, one can use an area initially for a speaker-centred lecture and in a next step swap the building to facilitate the group work of the students. Advanced users can design and construct those components of a SL learning environment. In the following, this article presents a selection of learning spaces developed by the EL3 team.

[2] http://islandday.mixxt.de.

Fig. 12.7 A conference in Second Life

12.4.2.1 Colosseum

This area resembles a traditional lecture room with whiteboard, presentation screens and benches for students. This place was constructed as one of the first buildings in 2008. It reminds the users of a familiar setting from the physical world. This place focuses on giving every novice user as much orientation in the virtual world as possible, which allows them to focus on the content of their lectures. In theory, the participants should not be distracted by unusual learning environments or eye-catching effects in this room. This area was the most frequently used area on the virtual campus, probably since most of the users seemed to feel attracted to such a simple structured learning environment (Fig. 12.8).

12.4.2.2 Skycenter

This facility hovers over the E-Learning 3D campus and at first sight it reminds us of a space station. The Skycenter contains a series of "theme cubes" – each of them a room with a certain didactic orientation. In each of these cubes there is the possibility to change the whole design and functionality without affecting the other cubes. Hence, the Skycenter can be used for several events or lectures at the same time. One example of such a cube is the so-called Philosophicum. It was designed

Fig. 12.8 The Colosseum – a classic lecturer hall

due to the need of a seminar on further education whose participants wanted to experiment with the Socratic dialogue method. The theme cube is characterised by its ancient Greek look: it is equipped with loungers, seat cushions, temple pillars and fire baskets that burn in the corners of the room. Every Avatar is offered a free toga at the entrance to further immerse oneself into the virtual place. Besides the Socratic dialogue, the comfortable-looking setting can also be used for group activities like brainstorming sessions or discussions. Another cube was designed as a didactic laboratory, where student and lecturers could experiment with new ideas or tools. This somewhat chaotic-looking area is filled with tools for communication, visualisation and feedback. Here also grow ideas for new three-dimensional models. The first instances of interactive presentations were also built and tested in the didactic laboratory. Moreover, the areas of "Study for the Over-fifties" and other study groups are located in the Skycenter (Fig. 12.9).

12.4.2.3 Conference Room

This place is concealed under water so that passersby do not easily see it. On principle, the conference room is accessible to all visitors of the EL3 area. However, an admission restriction can be enabled so that access is granted only to authorised users. This includes a barrier that hinders the spoken word passing across the

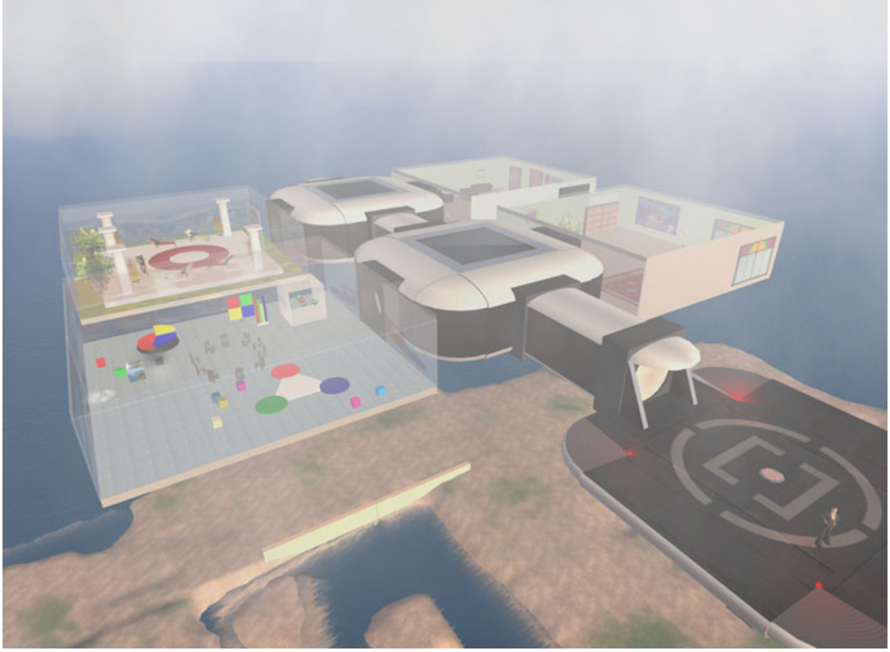

Fig. 12.9 The Skycenter on the EL3 campus – 150 metres above ground

walls of the room. In combination with the access restriction, this room is ideal for meetings and discussions that are not public. The room was constructed mainly for meetings of the EL3 team and partners. It is – like physical conference rooms – equipped with whiteboard and presentation screens. There are also means to view multimedia streams, and there are tools for collecting and preserving the results of meetings held in this room. The room was designed to be as flexible as possible, so the furniture and equipment can be removed to give space for 3D models or other room-taking activities (Fig. 12.10).

12.4.2.4 Holodeck

This is another special and very versatile area on the E-Learning 3D campus. Like in science fiction stories, this learning place can be altered by the touch of a button. Depending on the situation the lecturer can choose from a set of predefined learning scenarios that suit standard situations best. They can also design their own settings and save them for later use. Thus, a single area can serve the maximum amount of purposes and can be prepared for a quick change of settings.

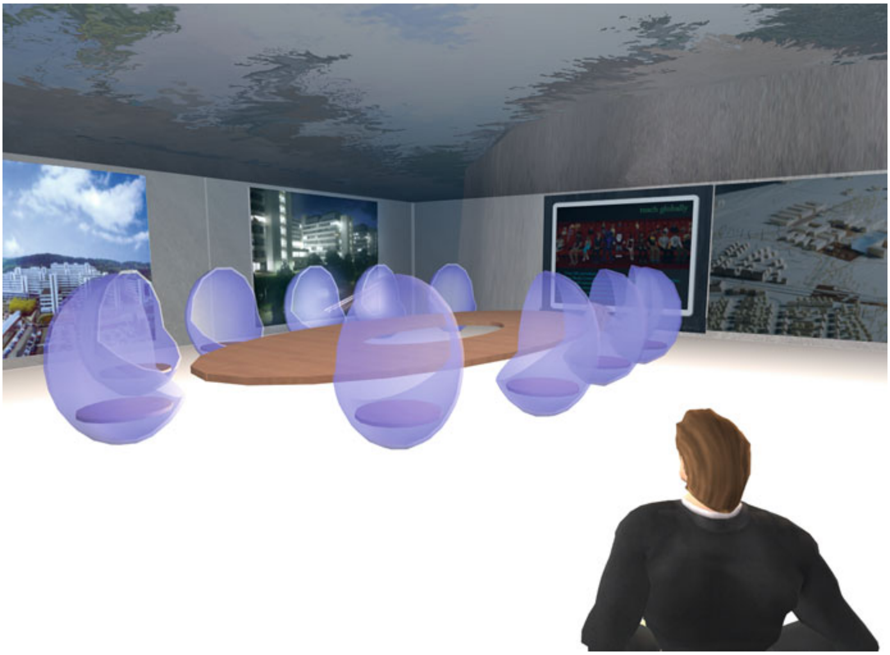

Fig. 12.10 A conference room on the EL3 campus

12.4.2.5 Representative Area

The ground floor of the EL3 main building presents a general view of educational providers and associations that are connected with the project. For example, posters inform visitors about the University of Bielefeld and the alumni association of the university (Fig. 12.11). Exhibitions from other activities at the university and other art projects can also be shown here, just like a short film festival.[3]

12.4.2.6 Counselling and Coaching Area

On the upper floor of the EL3 main building, the virtual offices of the EL3 team are situated. Each room is equipped with a desk and seats for the particular team member and his visitors. The offices are mainly used for consulting hours when a lecturer swaps ideas with participants of a seminar. They can likewise be employed for e-coaching sessions (see above) (Fig. 12.12).

[3] For example, in 2008 the project E-Learning 3D presented a cinema show with short films of students on its virtual beach on the European University Island.

Fig. 12.11 A representative area of the EL3 project and his associated partners

Fig. 12.12 A counselling area on the campus

12.4.2.7 Informal Areas

These areas are designed for informal talks or group meetings. Examples on the EL3 campus are a cafeteria at the beach and the "silent forest". Both areas are designed with the focus of fostering a good mood for the users in order to support their creative power (Fig. 12.13).

12.4.3 Learning Tools Adapted by EL3

There are a great number of means of presentation and communication in SL that can be applied for learning purposes. The generation of social spaces in virtual worlds in order to nurture and maintain interactions between the users is a task of the pedagogical discipline. The same applies to the encouragement for the formation of communities as manifestations of ongoing interactions (cf. (Pätzold 2007, p.7)). The EL3 team, as part of Educational Science of a Faculty of Educational Sciences, continually developed new learning spaces and examined a whole range of learning tools that will be described in the following.

Fig. 12.13 An informal area at an giant treehouse

12.4.3.1 Sloodle

Every Learning Management System (LMS), software applications that support individual as well as collaborative learning, has its strengths and weaknesses. While the popular LMS Moodle shows inadequacies concerning its communication opportunities and often needs to be combined with external applications, virtual worlds often lack the possibilities to distribute files and data properly. Sloodle is an approach to combine the strengths of both worlds. It was developed as part of an open-source project that tries to integrate the multi-user virtual environment of Second Life with the Moodle LMS. It provides an interface in both platforms and enables the EL3 team to use many Moodle features in the world of Second Life without leaving the virtual world.

12.4.3.2 Teacher Tools for Work and Collaboration

These are tools that come in handy for any lecturer in Second Life who wants to teach in a virtual world. As there are many different tools, only a few are named here that are highly recommended because "shopping guides" for SL tools can be found online . All these tools can be purchased at a very low price (about 20 dollars for a complete set) or are free of charge.

Fig. 12.14 A collection of learning tools

One of these tools is the "list of speakers" that proved to be useful during group discussions. Each participant who would like to speak simply clicks on a question mark that represents the tool. The name will be automatically signed on the list. Everybody can see this list and the moderator recognises easily who is the next speaker.

The Countdown Timer is a tool that can be used just as easily. During discussions or group phases, the lecturer can set an alarm. The timer displays a countdown for everybody in the room. At the end of the countdown, a sound also reminds the participants acoustically (Fig. 12.14).

After a session, there is often the need to get feedback. Here, the Feedback Boxes come in handy. This little tool can be placed at the exit of a room. Every participant can leave a note before leaving the room. The boxes also facilitate the distribution and collection of surveys at the end of a session. Afterwards, the lecturer can empty the box and examine the answers.

12.4.3.3 Visualisation Tools and Presentations

As a picture is worth thousand words, there is always a need for the audio-visual presentation of topics. Second Life allows a lot of ways to show charts, videos or other multimedia content. There are tools to get a quick and easy opinion image from the participants. Only a click is needed to vote and then a virtual object cumulates and shows the opinions as a pie chart or a bar chart. One can literally see how a mood or opinion changes as the objects alternate in the three-dimensional world.

Of course, there are many ways to show multimedia content to the audience. A classic tool is the multimedia board, which resembles a classic presentation screen. Here, images and charts can be presented, but also films and interactive websites can be shown (Fig. 12.15).

Fig. 12.15 The "Opinionater" – show your opinion by positioning your avatar

12.5 Challenges and Perspectives

The EL3 project developed a multitude of virtual learning spaces that turned out to be a support for traditional seminars as well as for the community of students that depend partly on distance learning settings. However, there are still a lot of challenges left. One of the greatest hazards is the technical problems and the dependency on Linden Lab, the provider of Second Life: to date, the system does not work totally hassle-free. Linden Lab is a commercial provider, so the general access to SL is free of charge, but the company charges fees for certain services in SL, e.g. for the upload of data and the occupation of virtual pieces of ground.

The commercial dependency on Linden Lab is also connected with copyright issues, e.g. the question in how far the company is legitimised to exploit inventions that users create within SL. Therefore, for universities and other educational providers, it could become worthwhile to launch their own virtual worlds on their own servers. By now, SL is confronted with competitors like OpenSim, which are programming systems that allow users to develop their environments using technologies that are attuned to their needs. Via intranet, these environments can be restricted to particular participants of learning sessions, so that they can work in "closed shops". Most importantly, OpenSim appears to be gaining increasing popularity since it is provided for free and since it is developed as an open-source project. The concept behind OpenSim includes the option to open a restricted network to external users if necessary: universities, for example, can connect their OpenSim server with the respective servers of other educational providers to create overall clusters between which participants can travel virtually. Educational networks could utilise this technology to connect their particular partners, whereby participants can benefit from the whole range of services offered by the network partners. Nonetheless, every partner of such a network retains sovereign control over its virtual learning environment since it can open and restrict access to each module of it anytime. Such a three-dimensional learning environment would be characterised by a high degree of openness and flexibility. It further saves the educational providers from the exposure of their know-how, i.e. the products and developments that are often expensively invented especially for the use in a virtual world.

Apart from the needs of educational providers that utilise virtual worlds, one of the main challenges is the practical application of such a learning environment: looking from the perspective of lecturers and students, the personal requirements of the users should not be underestimated. Although SL is a computerised environment, there is still a range of procedures that cannot be automated. The personnel expenditure for learning sessions in SL is comparable with the respective expenditure in physical environments and is sometimes even more complex. For example, in a usual session where a lecturer and a facilitator take action, there are associates who are responsible for the technical support, assistants sometimes care for the lecturer and, if required, another person records the event to save the discussions on video (Heeren 2009, p.260). The experience of the project E-Learning 3D has also shown that the use of an introductory lesson on SL in a face-to-face setting is necessary and that there is an ongoing demand for support during courses (Ojstersek 2008, p.297).

Fig. 12.16 The EL3 campus in 2010

Moreover, the acceptance of this new learning environment among students and lecturers can be a critical point that should be monitored very well. By now, it seems that SL is most suitable for learners that feature a high degree of media literacy and that are used to organise self-directed learning. One way to include learners that are not used to acting in virtual worlds is the adoption of learning settings that are known from the physical world (see paragraph 3b) (Fig. 12.16).

Trust is also an issue in SL: the identity of an avatar in Second Life cannot be doubtlessly associated to a certain person in the physical world. Although the user profile of an avatar can be assigned to a certain person, this does not verify that this person is in control of the avatar (Mersch 2008).

Apart from that, SL appears to be helpful especially for learning groups whose participants already know each other from face-to-face meetings, e.g. people that are connected via learning partnerships or learning networks (Graeßner 2008, p. 4).

Nonetheless, it generally appears that lecturers who aim to organise seminars in Second Life have to often be considerably convincing in order to attract greater numbers of students and to draw colleagues and superiors to their side. The acceptance of the web technology Second Life as a learning instrument appears to be far from being part of the mainstream (Shin and Kim 2008). One reason may lie in the enduring prejudice that regards acting as an avatar in an artificial world as playful, as lacking seriousness. One way to increase the acceptance of virtual worlds as learning environments can be the training of students as e-trainers for e-learning settings like SL (see above). As a part of their qualification, these students themselves can organise small study groups so that the inhibition level for SL access can be decreased. Moreover, lecturers who work with SL are exceedingly required to explain the concept and the procedure of their virtual seminars in preliminary face-to-face meetings with interested students. Because virtual seminars are relatively seldom in universities, the idea and the surplus value behind those courses need to be as transparent as possible. Other than that, the fixation of this learning setting as a mandatory component of the curriculum of the different courses of studies would be a strong boost to the value of virtual classes.

In the near future, learning spaces will most likely be appreciably more interactive than today (Pätzold 2007, p.17). This task is complex. In addition to the technical components, didactic concepts for the use of virtual environments are necessary, as these will no longer stand isolated but will be a part of a greater network to come (Mersch 2008). The extensive possibilities of learning in virtual worlds will gain a prominent role in the future of e-learning, which calls for further investigations.

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Biographies

Dennis Schäffer (aka Grindan Graves)

Dennis Schäffer is currently working at the Faculty of Educational Science at Bielefeld University. From 2007 until 2010 he was one of the innovating and leading heads of the "E-Learning 3D" project in Second Life. The project was assigned to develop a virtual learning environment in which students as well as lecturers can interact without being actually on the campus in an rich 3D environment. Currently his main work is focused on international adult education, virtual worlds, personal learning environments (PLE) and the Social Web.

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Jörg Heeren is a Research Fellow with the Institute for Interdisciplinary Research on Confict and Violence and with the Faculty of Educational Science, both at Bielefeld University. Since 2008 he is concerned with the issues of collaborative learning and didactics in Second Life, inter alia as staff of the research project "E-Learning 3D". Other research areas of Jörg Heeren are also linked to computer-mediated communication (CMC), e.g. he carries out research on online counselling. As a lecturer he is specialised on the topics group facilitation and coaching.

Part V
Use-cases and Scenarios of Integration

Chapter 13
Business Meets Community in Virtual Berlin

Jan Northoff

13.1 Introduction

The YOUin3D.com GmbH was founded with the vision to create a virtual world with the first station on BERLINin3D.com also known as newBERLIN in Second Life (Fig.13.1).

As soon as companies realized the existence of virtual worlds, the business focus was set on marketing and advertising. Virtual worlds had tremendous impact on the established advertising world. The investments dried out fairly soon, however, as the marketing strategies were not sufficiently tailored to the demands of the novel type of "in-world" customers.

Direct revenue and return on investment are a complicated task in virtual worlds. The connection and the valuation of the market, value proposition, resources, and community activities differ strongly from known business models. Most companies tried mild modifications of their traditional approach, but were not able to build up a long-term interest in this sector. A successful strategy to sneak inside this tight and self-centered market would require a long-term combination of direct user experience, user involvement, and true intense understanding of the virtual world peculiarities. The YOUin3D.com GmbH approach has yielded and developed inside this sector while monitoring and analyzing the development.

On the other hand, the demand for virtual goods and services is constantly rising and therefore breeding new types of astonishing services like virtual animals, content creation, event hosting, real estate, and even financial services. These services are mainly run by private individuals who got involved into virtual worlds and keep claiming and inventing new sectors rapidly.

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Fig. 13.1 Logo of YOUin3D.com GmbH: 3D Internet, Web 2.0 and Social Media Company in Berlin, Germany

Our approach was not a single, but a "circumspanning" and fuzzy business concept of gaining value with several layers of mixed reality information and service inside a virtual city. Thus, with BERLINin3D.com, we explored a wide range of combined services in a process of connecting and mixing community with business, educational models with technology offers, art with social components, and real with virtual information, products, and services. Today, the YOUin3D.com GmbH offers customized business-to-business services, focused on virtual world consulting and implementation. The fields range from 3D online conferencing and e-learning solutions to 3D design, 3D data visualization, 3D animation, and movie productions. Although every approach to fit existing products and services in between the virtual and physical world needs at least a major adjustment or even a new perspective, it can be very rewarding where this threshold energy is invested.

13.2 At the Beginning

The YOUin3D.com GmbH was founded on a chance acquaintance. The physician Tobias Neisecke stepped into the former gallery rooms of the artist and system designer Jan Northoff. Skipping small talk and jumpstarting into brainstorming of new possibilities, after intense 30 min the idea and conclusion to build the virtual city newBERLIN in Second Life (BERLINin3D.com) were agreed on and lead directly into a nonstop workshop until the first business plan was finished. The following years were an exciting journey of surprises, new business approaches, fun, failures, and a lot of pioneership and engineer spirit (Fig.13.2).

Fig. 13.2 Screenshot of the virtual city newBERLIN in Second Life. To see in the background, the virtual Weltzeituhr and the virtual Berlin TV Tower

13.3 The Idea of the Virtual City

The idea sounds simple: Monetize the virtual city by rebuilding real content and adding a similar adapted service. Because this true-to-scale interactive city can be experienced with a customizable 3D avatar, the virtual city can be used as a platform for representation, marketing, and event venues. The goal was to earn money by selling advertising spaces and offering real products and services to virtual visitors, real and virtual tourists, and locals. We started with the central landmark in Berlin City and created a new layer / map / grid where the TV Tower of Berlin was the center (Fig. 13.3). The rest of the city got cut into squares of the size of a Second Life Sim.[1]

[1] A Second Life or OpenSim 3D server, usually referred to as an island or region. Its virtual size is $256\,\text{m} \times 256\,\text{m}$.

Fig. 13.3 Comparing real and virtual place in Berlin / BERLINin3D.com

13.4 BERLINin3D.com

Unlike most other Second Life-based business models, we were focusing since the beginning on a cloud of real-life products and services bound to real locations instead of unlinked "virtual goods"[2] and virtual services.

Our first big project, after going public with the true-to-scale 368 m high rebuild of the TV Tower of Berlin, at one of the popular points in the city, was the reconstruction of the ALEXA[3] shopping mall. Luckily, the physical construction of the shopping center was not finished yet, so we were able to catch up with the virtual reconstruction. When it was finisched we had a simultaneous opening of the virtual site and the real shopping center (Fig.13.4).

To complete the mirroring effect, we opened a real show room / office inside the mall, covered as a regular store (YOUin3D.com GmbH 2007b). This was probably the first store worldwide, which only had free Second Life accounts in stock. In the following weeks thousands of avatars were born in newBERLINin3D.com.

With this amazing start we extended the concept and, copying from the real ALEXA shopping center, we created an advertising and special events area in front of our virtual ALEXA. This space was used to mirror "ALEXA on ICE"[4] or the annual IceALEXA Christmas-market (YOUin3D.com GmbH 2008a) (Fig.13.5).

It also has been used to extend real-life promotions like "Win a Trip to South Africa" with the s.Oliver Store inside the ALEXA where physical flyers were handed out for the same promotion (YOUin3D.com GmbH 2008f). To draw attention, the virtual site was turned into a small beach area with the sound of waves, a fitting video, and a direct link to the web site participation form. The "spawn

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[2] 3D object / item, sometimes scripted to be used in a game or in Second Life. In Second Life virtual goods can be created and sold by any resident (user-created content).

[3] Shopping center at the Berlin Alexanderplatz (www.alexacentre.com).

[4] An ice sculpture art show.

Fig. 13.4 From left to right: showroom at ALEXA, Jan Northoff and Tobias Neisecke, founders of YOUin3D.com GmbH

Fig. 13.5 ALEXA Wintertraum Christmas market in BERLINin3D.com

point"[5] was around the corner and in sight of the virtual ALEXA. Sonae Sierra[6] is still one of our customers and still has not only an outside visualization but also the inside has some representative stores where Freebies[7] from well-known brands are offered to "Newbies."[8] Of course there are several interactive panels where the official ALEXA web site can be seen and used (YOUin3D.com GmbH 2007a).

[5] A dedicated place where new avatars are born.

[6] The company owning the ALEXA shopping center and 50 other shopping centers (www.sonaesierra.com).

[7] Free virtual goods in Second Life. Usually created and given away by other Second Life residents.

[8] New Second Life residents.

Another real and virtual attraction point was the huge "Plus"[9] logo, promoting the real and virtual "Plus" merchandise. The real store location was taken as a model to rebuild a small virtual Plus-store. Mainly this was used as a "teleport station"[10] linking to the otherwise hard to find and separated "Plus Island," the official company representation in Second Life (meanwhile closed and has new owner). In this case and in several other cases we simply used the "high-traffic area" BERLINin3D.com as a traditional but neutral marketing platform to refer to other projects, brands, and products.

To complete our approach we were also offering a service, where real Berlin events were (and are still today) broadcasted live with sound and video into virtual Berlin. The "STAR FM" radio station stream could be found at the "Rocker's Corner" which is a well-known real hangout for punks and rockers at the Berlin Alexanderplatz. Unlike the obvious possibility of a real public disturbance in Berlin, the virtual STAR FM[11] site offers an additional service and 3D experience in combination with their traditional radio station service. Virtual visitors can lie down on a broken bench and get free virtual beers as well as a free Mohawk haircut while listening to classic rock. Also, in cooperation with "A/O Hostel," we offered a contest where avatars could win a night in real Berlin by laying down on one of the virtual beds, which were set up all over the virtual city. Both projects also used the traffic of BERLINin3D.com virtual visitors and tourists to advertise their products.

13.5 Electro Smog

Because Berlin is internationally known for its club culture, another vivid but more creative addition is the recreation of several virtual clubs and event locations. It happened that we had several discos, bars, and clubs inside the area we chose to rebuild. Probably the most famous one was the Kinzo-Club, which shut down in physical reality at the end of 2007. In comparison, the "electro smog" (YOUin3D.com GmbH 2010) built on the same spot in virtual Berlin lives on. It is one of the first virtual German electronic underground Second Life music clubs. It is still a secret tip for spontaneous high-quality Second Life music and a good virtual hangout place.

13.6 Event Hosting, Dance, and Chat

Visiting a virtual club is a lot more fun and smarter than it might sound to someone who is not involved in Second Life. By using webradio technology the visitor can enjoy actual live music produced by real Djs streaming their live set into the location, so the visitors can not only hear the live music, but they can also see and chat with the DJ as well as with the other visitors (Fig. 13.6).

[9] German discount grocery store chain, now owned by Netto Marken-Discount AG & Co. KG.

[10] A direct Link to a Second Life location provided with a SLurl (Second Life URL).

[11] Berlin-based rock radio station (www.starfm.de).

Fig. 13.6 ELECTRO SMOG: secret underground electronic music club in BERLINin3D.com with live DJ Zap Hax

Besides fancy dancing animations the avatars are entertained by special interactive features, like audio and visual effects like gestures[12] and particles and/or an additional live video stream or embedded interactive web sites.

13.7 Markting Cooperations

After meeting in the club and spending a night in Berlin, the virtual city also offers a unique service for bridal fashion. Next to the "Marienkirche"[13] is the "Brautmoden Haupt" location. It is possibly the only official usable 3D model of an actual bridal gown store. In 2010 we did come up with another innovation: Avatars can buy and wear a bridal gown in Second Life which is not even for sale in reality yet. A 3D online preview of the upcoming collection of high-class and well-known bridal fashion manufacturer is sold at the "Brautmoden Haupt" store (YOUin3D.com GmbH 2008b).

[12] A mixture of short avatar animation, text chat, and sound effects.

[13] Famous evangelistic Church in Berlin (www.marienkirche-berlin.de).

By extending touristic attractions, like the true-to-scale and fully functional rebuild of the world time clock,[14] we were also able to run almost traditional real-life mass marketing.

So we also sold public advertisement in the form of mega posters or kiosk-style information points with high user involvement. Also the virtual city allowed us to cooperate with several companies. For instance, the successful long-term relationship between the YOUin3D.com GmbH and the Dutch company "DX exchange B.V.," which was founded in 2006 as a currency exchange office. Their payment system (www.DXexchange.com) makes it possible to exchange Euros for Linden Dollars and vice versa in Second Life, using most accepted payment methods such as Visa, MasterCard, PayPal, and several others. As a Dutch company they were looking for a German partner in order to open up the German market. With the German virtual capital we created a win-win situation by enabling and initiating German customer acquisition.

Together, with exclusive and long-term cooperation, we managed a complete "German launch" including the web site www.DXexchange.de, a German company representation inside the virtual city and a natural fitting surrounding for several money exchange terminals. The result is that everywhere in newBERLINin3D.com are virtual ATMs where the visitors can buy or sell Linden Dollar in exchange for Euros. An additional effect is that these ATMs are completing the visual appearance of the virtual city, with natural-looking and useful advertisement for the visitor. Again the YOUin3D.com GmbH was a pioneer in connecting a community project with a service, and the successful cooperation led to a proof of concept and now gets adapted to other communities and services.

13.8 Supporting Art and Culture

Besides obvious commercial offers we always found it important to invest time and resources in culture and science projects, not only because it gives the user a much broader experience, it also is an important initiator in testing and implementing latest technology in actual case studies. Furthermore we offer our know-how and services with an adjusted price scale to help to realize art and science projects.

13.9 Art in Second Life

Architects, designer, and especially artists are gathering in Second Life, because it is a mighty and very contemporary medium to work within. Second Life is an easy, free, and fast visualization tool to create interactive space without physical difficulties. It offers the possibility to involve visitors in a multimedia installation

[14] Clock which displays the time for many places around the world. It is also a famous meeting point at the Alexanderplatz.

and to actually have a worldwide online art exhibition event due to the 3D avatar technology.

Besides a massive stream of hobby artists, the professional art market has started infiltrating Second Life with very little notice. The trend to save travel costs and to present art online is a fast growing market. Due to my artistic background, the YOUin3D.com GmbH is involved in several 3D art gallery projects and platforms.

The virtual city is a perfect spot to present art along with culture events. For example there is the annual virtual art festival www.newBERLINartFESTIVAL.com in virtual Berlin. At this event the whole virtual city is turned into an art sandbox. This means all Second Life artists can participate and grant rights to create and "rez"[15] virtual artworks. For several weeks the whole city turns into an interactive art installation, with surprising art pieces from more than 40 artists from all around the world. There is also always an accompanying physical art event.

A Second Life station as shown at the "Statens Museum for Kunst" (Copenhagen) at the "virtual moves" (Tagging Art 2008) art show enables a logged-in avatar visitor to experience the virtual exhibition with the help of large projection screen, a webcam, and sound system. The visitor could talk, chat, and interact with the online visitors and even the avatar artists. Also the planning and organization of physical space gallery rooms can be tested and visualized virtually before running into physical problems of mounting and rearranging physical artworks. Once a physical exhibition space is rebuilt in Second Life, the artists and gallery owners can meet up online to plan and arrange the exhibition, although the physical space might be already used by another art show. Also with some customized LSL[16] scripting work, the virtual rooms can store the former arrangements and so it is possible to switch former or even future exhibitions by pressing a virtual button. Other artworks even implement additional custom software into the system like the "BeuYs2.com"[17] installation shown at the "The World as Stage" Ovesen and Kunstverein (2009) group exhibition at the n.b.k. "Neuer Berliner Kunstverein" [18] in Berlin (Fig.13.7).

13.10 Religion

Another cultural aspect was also stated in BERLINin3D.com. The famous "Marienkirche"[19] situated at the foot of the Berlin TV Tower, was not only rebuilt true-to-scale on a high-detail level from inside and outside; it was also the perfect place to start a totally new approach. In cooperation between YOUin3D.com GmbH

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[15] Materialize premade grouped and/or scripted objects by putting them on the simulator by dragging them from their inventory onto the virtual ground.

[16] LSL, linden scripting language: Second Life programming language to alter Second Life objects and other interactions.

[17] An artwork with an artificial intelligence chatbot software, created by Jan Northoff, Frank Wittig, and the .0 artist group.

[18] Institution in Berlin with contemporary art exhibitions, discourse, publications, and Artothek.

[19] A famous Chirch in Berlin Alexanderplatz.

Fig. 13.7 The Joseph Beuys Second Life avatar reconstruction for the BeuYs2.com art project

and the evangelistic church we create life in the virtual religious architecture. The scientific project (Lindner 2008) was about answering the question of how virtual worlds can be used to examine religion online and what Second Life users might expect from the evangelistic church as an online service (YOUin3D.com GmbH 2008e).

13.11 Real-Time Movie Production: Machinima

Not only are fine arts represented well and might produce a decent revenue stream, but also the possibility to move the avatars and the virtual camera around freely as well as the fact that the surrounding can be scripted and changed instantly makes Second Life a cheap and fast way to produce movies. The so-called machinima[20] differs from traditional animation in that the movie is always shot and rendered in real time, which brings advantages as well as disadvantages with it. In traditional animation, the set, all movement and character animations are built in advance. Usually the data must be sent away for several days before the results can be seen. But with machinima the animations, the avatars, and the camera movement itself are in real time; everything has to be done just at the moment it is being shot. The visualization, the rendering, and the movement of the characters is done by the Second Life real-time rendering machine. Machinima can be a fast and cheap replacement for traditional 3D rendering (Fig.13.8).

[20] Artificial word of mixture machine cinema and animation.

The virtual set is similar to a physical set, and besides extras there should be a cameraman, a soundman, and of course a director telling the team what to shoot and when. Sometimes a skilled person can fit in most of these jobs and so Youtube is filled with bad-to high-class self-made machinima videos.

In our case we used a complete team of six persons working full time for several weeks in order to create a modern interpretation of "Rheingold-Vorspiel" which is the start-up sequence of Richard Wagner's most famous opera "Der Ring des Nibelungen" produced by YOUin3D.com GmbH and directed by Johanna Dombois in 2009. The multimedia movie production is shown in selected First Life opera houses, uses several kinds of selected and adjusted Second Life technology, and also visualizes the rebuilt Zürich Opera House in Second Life (Dombois & YOUin3D.com GmbH 2009).

Fig. 13.8 Screenshot of "Ring-Studie 01," directed by Johanna Dombois

Another case where Second Life was chosen on purpose as a media and a visualization tool was the film "Kinshasa 2.0" by Teboho Edkins YOUin3D.com GmbH (2008c) seen at the "Berlinale 2008"[21] in Berlin and more than 20 other international film festivals (YOUin3D.com GmbH 2008d). The political documentation shows how the virtual environment can actually be a media for political interaction and how the internet itself and the avatar interaction can become a political instrument creating a communication bridge into a physical exile. While this was more science fiction some while ago, it has now been proven to be reality.

[21] Berlin International Film Festival.

13.12 Science

We also did several educational projects in BERLINin3D.com. The "University of Potsdam" started in March 2008 with a 3D educational project with a detached island somewhere isolated in Second Life (Universität Potsdam 2008). The project leaders, the assistant professor for Corporate Governance and E-Commerce Prof. Dr. Christoph Lattemann and Dr. Stefan Stieglitz, decided to accept the offer from YOUin3D.com GmbH to be attached to virtual Berlin in order to start a series of scientific examinations Lattemann et al. (2009). For example, students of Bioscience who are trained in dealing with specialized and complicated devices had to do a crash course in entrepreneurship, thereby experiencing the difficulties in selling products in general at a free market. This was achieved by handing out three different "ready to sell" Products, professionally built by YOUin3d.com GmbH, under the instructions of the university professors. With these products, dropped to the students avatars' inventory, they were sent out to learn and experience a complete business start-up process. Although Second Life is a virtual world, the "in-world online market" follows similar rules and has almost the same problems and movements as the real free economy. It might be even a little rougher on newcomers, because of its fluency and high frequency of specific demand. There is no better way to teach economics in real cases, without spending a lot of money and without taking the risks associated with trying to penetrate the real market. Later on we will look closer at the potential of virtual goods and its phenomena.

The second example is the "Neubrandenburg University of Applied Sciences", and a totally different group of students. They are going for a master in "Social Work" and engaged in a project named: Social Work in Second Life, run by Prof. Dr. Northoff. In this case (Northoff et al. 2010) the virtual world is used to find out the potential for social services. Based in virtual Berlin the students first had to find a fitting social worker identity and outfit, and they noticed that also in a virtual world the sex, the chosen name and personality, the outfit, and the behavior must be serious looking to be accepted as a helping person. In a second step they opened a Social Service point and Second Life technology allowed them to try out different time lines and settings for the social work consulting. Finally they effectively did social consulting in the community, offering a wide range of topics as consulting for care giving in general or particularly on phenomena like being victims of aggression or drug addiction or even the addiction to Second Life itself. Though the acceptance of this offer is not yet perfectly analyzed, there are obviously users who need some personal distance to open themselves towards others. For example, the students talked to some female users who admitted that they were scratching their own skin intentionally and who did not dare to talk about that in a real-life situation, but who were open to listen to the students' advice.

13.13 The Confusing Avatar

Everybody does remember the confusion and the strange feeling of "being born," standing somewhere foreign, without a clue what to do, where to go, or even why all this. The path to understanding and using an avatar also forces the user to interact with others and demands a certain kind of self-reflection. After a while the user notices the prejudices he had, and dealing with other people in a 3D online environment sometimes even changes the state of mind. It is almost impossible to explain what exactly happens with the user when using an avatar on a regular basis, but it is a fact that nobody can do this without reflecting or at least noticing new aspects of social or personal behavior. The own avatar is the main feature and a key component of the success of virtual worlds, and this must be experienced by everybody's own. As complicated this sounds as easy is the natural evolution of the manifestation of human "contact profile" in the internet. Sometimes the avatar can just be a boring "3D email address." Even though most people will not admit it, there is a deep and undefined fear of "getting and using an avatar." Even if these people dare to "get one," nobody can help them with the questions they will have when logging in: "What am I doing here, and why? Where can I go, and why?" I personally love the aspect that creating a Second Life account somehow leads to asking yourself quite real philosophical questions (Fig.13.9).

13.14 Problems in Virtual Worlds

13.14.1 Technical Problems

Due to its complex structure, virtual world technology is a very resource hungry undertaking. Working professionally with virtual worlds also means dealing with technological boundaries. A fast processor and a good graphic chip are quite important as well as a fast internet connection. Implementing a system on a business level also means to deal with network, firewall and performance issues. On the other side, latency (lag[22]), bugs, regular updates, and even whole program crashes used to happen on a regular basis. Technology and software development of Second Life did improve massively lately, and with a moderately modern Computer these Problems are almost gone.

13.14.2 Immersion

One of the key advantages is also a disadvantage. The immersion of using a fully 3D environment and handling an avatar inside allows the user to have a high and intense

[22] Slow reaction or occasional freezing of the avatar.

Fig. 13.9 Screenshot of the avatar January Lightfoot in front of the virtual ALEXA. "I finished working, what do I want to experience now?"

and diverse experience. It also means the user has to "jump" fully into the media. Besides learning how to navigate, communicate, or just understand the software, the complexity and the tremendous size of the world takes a lot of time to explore and to understand.

13.14.3 Drama

Many members of the online community are permanently stressed out by self-sought social pressure and the need to communicate and to interact. Beside virtual parties, social games, and frequent online weddings and Rezzdays,[23] the so-called drama is one of the main hobbies of Second Life users. These social and well connected users are well-focused on their very own intersts, and it is quite impossible for a brand to get their attention without offering a social compatible interaction.

[23] Virtual brithdays: the date of the "birth" of an avatar.

13.14.4 Griefing

Other web 2.0 phenomena like "trolling"[24] also take place in virtual worlds like Second Life. The worst case scenario in 3D is known as "griefing". It is an attack by a self-defined "system enemy" who is constantly annoying and attacking other avatars. Griefers mostly declare themselves as part of the system, and for them it is a sort of a game to annoy others. Their final aim is mainly destroying Second Life by stopping others from using Second Life, which is ironic and somehow ridiculous. By using combat scripts like virtual weapons, or even special illegal software, avatars are abused by scripts and objects, like caching and audio-visual spam, for example, by flooding a whole area with porn or gaming pictures, combined with loud annoying sounds. This is just a visual effect, but a powerful and real reason and a common nightmare of traditional company management. One of the frequently asked questions of interested companies is. How can I protect my 3D online representation from being virtually attacked by offensive or possibly naked avatars?

To solve this problem there are several ways. Second Life simulators can have restricted access to only selected avatars or groups. A normal griefing attack takes place at "public areas" where advanced scripting and building is allowed by the owner of the land. In any case any avatar can be banned and all his objects and scripts can be returned. This can only be done by someone with administrative rights on the land or parcel.

13.14.5 Community Work

Furthermore the basis for all commercial offers and success in doing business in Second Life is a functional and fluid, active community. This is probably the hardest task and only possible with the help of a small army of virtual employees. It must consist of highly qualified in-world-assistance as well as builders, coders, event-managers, and greeters, to make it possible to offer an interesting attraction point for the picky visitors. The importance of good community management cannot be underestimated and is one of the key factors on social network projects and needs a constant and professional drive. The job "community manager" will become more important in the future. Maybe this factor is the main reason for making it so hard for big brands to be successful in Second Life and also for the hard task of revenue, because it is a time consumptive and resource hungry undertaking (Fig.13.10).

[24] Internet slang: a troll is someone who posts inflammatory, insulting, or off-topic messages in an online community.

Fig. 13.10 Screenshot of community event in BERLINin3D.com

13.14.6 Marketing

The marketing based on traditional structures was only succesfull at the Second Life hype time, when the new and traditional media were covering almost every story about real company representations in Second Life. The actual "in-world marketing" for virtual worlds is much more complicated than the rapidly growing much more attractive twin "in-game marketing."[25] Besides aspects like better and direct contact to the user, this has also to do with the individual freedom of the movement and the specific content an avatar chooses to experience. In Second Life, every teleport is done only because someone decided to go there. Nobody will visit a merchandising island just because the real company has a boring 3D representation, especially if there is so incredibly much other stuff out there on 2.08 thousand km^2 (Linden Research, Inc. 2011a).

Also it does make a difference for the users if the offer is from someone proven to be a member and part of the virtual world instead of an obviously randomly selected well-known brand without a particular Second Life offer or service.

[25] For example, putting car merchandising at the boundaries of race games or let them even sponsor an advanced race car.

13.14.7 Investment and Communication

Virtual worlds are still not main stream and are often critically observed or not being taken seriously by the public or businesses. Also user created content and user-involvement, must be part of the development of a business model for or with virtual worlds. This leads to a lot of monetization problems but can be done if the company is ready to invest in the future. It is essential to work on modern solutions like re-thinking the company's internal and external communication tools and policies.

Some projects have produced huge benefits and impressive cost reductions for companies doing it right. They use or create powerful tools in terms of market research, customer retention, customer satisfaction, support and product development, as well as data visualization and conferencing. Modern communication involves personal customer service, open and direct honest feedback possibilities, bug and abuse reporting, and direct involvement of the user.

With cooperation involving other companies and services, the user experience can be improved and individual products can be developed, manufactured, and sold in a much better way.

13.14.8 LindeX Exchange

Furthermore the Linden Dollar is quite a unique "virtual token." It reminds strongly on a real currency. Besides the obvious possibility to "buy" and "sell" Linden Dollar to exchange virtual goods, the Linden Dollars can be exchanged directly into U.S. dollars and other foreign currencies with a reasonable and relatively stable exchange rate. This is one of the keys to the success of Second Life. The possibility to earn real money by selling virtual objects or offering virtual services is fascinating and a fast growing quite real market. The overall LindeX Volume reached 30.5 million US$ in 2010Q4. Compared to 2009, additional US$ 4 million treaded hands on the LindeX in 2010 (Linden Research, Inc. 2011b). There are even quite funny exchange issue phenomena. Significant drops or heights of the USD take about two weeks to affect the Linden Dollar exchange rate. In fact the Linden Dollar is more stable than most other "real" currencies. After all the Linden Dollar system is owned by Linden Lab and therefore holds a significant risk.

13.14.9 Choosing the Rigth Platform

Besides these general issues, just choosing the right virtual world platform might cause problems for companies. For several logical reasons, Second Life—the mother of user-created free virtual 3D worlds—is still the main choice. Other, more specialized worlds are pushing into the market. For example, Mirror Worlds, city platforms, 3D apps, augmented reality, and more and more social and serious games are mixing into and entering the field. In my opinion, the best future solution is the "hyper grid"[26] connecting all participating OpenSim servers to make it possible to travel and explore all kinds of different Sims / worlds / projects with one avatar. The IBM and Linden Lab Interoperability Announcement did prove the possibility to even connect OpenSim and Second Life (Linden Research, Inc. 2008). Some see this as a big step towards the "Metaverse."[27] Another scenario is that Google continue its "we own the world" approach and finally implements avatars directly into Google Maps / Google Earth / Google Street View instead of experimenting into the obviously wrong direction like the quickly shut down "Google Lively" virtual world approach (Google Inc. 2009).

Whatever Facebook will develop for a 3D avatar adaption will also shake up the still relatively small market.

The specific Second Life and OpenSim problems and business possibilities remind us a lot of the problems and behavior of the beginning of the Internet itself. The technology is ready to use virtual worlds for work and free time. Fear and misunderstanding are still the normal feelings towards Second Life and 3D avatar-based virtual realities. Time will show how virtual worlds can be used.

13.14.10 Virtual Goods and Services

Meanwhile, virtual worlds (especially Second Life and OpenSim) are evolving towards a healthy and self-sufficient online society. In these worlds there are social and economic interactions; the main drivers and residents can run global businesses in real time, with very little investments. This interesting and almost evolutionary self-fulfilling market seems to follow real-life product rules but is indeed a business world on its own with its own rules and exceptions.

The market is growing and developing almost weekly into new directions and spits out new generations of interactive virtual items regularly. All kinds of professional or just self-made virtual items like shoes, tools, textures,[28] animals, houses, vehicles, clothing and outfits, and completely set up avatars already flip a lot of money on a daily basis. Almost all of this money goes to the "content-creating" users and is spent by other users. Sometimes the spent Linden Dollars are also gratuities with a small but real impact. It is quite common to find a "tip jar"[29] near the stage or next to the turntables when a live music event is happening.

These tips are split between the owner of the location and the actual musician, and are normally not really big money, but can actually reach a "low-income" level.

Virtual shoes are another good way to earn money inside the Second Life economy. Like in physical life a pair of shoes now is more a status symbol than

[26] Several different "OpenSim" servers connected to a "3D Network".

[27] The convergence and mixture of all virtual worlds, virtual reality, and the Internet itself.

[28] Pictures optimized for 3D content creation.

[29] Second Life object visitors can tip other residents.

a foot protection, its original purpose. For the same reason they are also top selling products in Second Life. The prices range from free gifts to over 30 US$ per single copy of virtual shoes. The same can be seen with virtual cars and vehicles.

Even though in Second Life an avatar may just fly around and not wear shoes or drive vehicles, it is still a magnificent part of the in-world market. A lot of cash is spent not only for the quality, look, or "feel" but also for "virtual value" like brand and status of the real or virtual item (Fig. 13.11).

Fig. 13.11 A typical set of virtual goods which can be bought in Second Life

The best virtual item ever is money itself. Currently the former "gold coin" is made of less valuable metal or normally represented by a printed paper which has no actual value. The best way to earn money still is dealing and working with money. Like in the stock or bank and financing market, the action to calculate and bet on the behavior of values is the first virtual game and probably the first virtual world. Therefore, back in the days when there were no specific rules in Second Life (except the "Big Six," the Second Life Community Standards) (Linden Research, Inc. 2006), gambling and virtual banks were brought into Second Life by pioneer business persons / avatars.

After Second Life became "free to play" in 2007, millions of new residents flooded the system with money. The legend states: The FBI logged into Second Life to investigate several virtual casinos. Gambling quickly was forbidden in Second Life in July 2007 (Reuters 2007). In January 2008, the exponential growing "virtual banking" also got banned from Second Life to better protect the Second

Life residents from scam and fraud. Since then also the virtual stock exchange and other third party money services are more restricted and better monitored.

It took Linden Lab almost two years to recover from the loss of revenue. One of the top selling products currently is a next generation of gaming reminding one of gambling. Several legal and popular casual games can now be found in Second Life.

Another generation of Tamagotchi-style items is heating up the virtual market. The so-called Breedables were another one of the top-selling products in Second Life in 2010. Not only the developer and producer (typically a Second Life network of designer(s) and coder(s) who found a “real-life” company for this) of these Tamagotchi-like animals earned big cash, but also the average users can earn serious money with this system. These animals or plants are more a sort of living 3D software that follows rules so they can be bred and farmed similar to real animals and plants. This is the newest form of gambling like social games in Second Life. These interactive products are much more sophisticated, but less popular than the famous “Farmville” Facebook game. It is more comparable with playing online Poker professionally—although the chances for players are much better. First of all, you have to understand the very complex game and its rules, then you have to invest money in order to breed and grow virtual items. If you invest in food, shelter, and probably even in special equipment and get the right animal and combine it with the right partner, you might get lucky and create a very valuable offspring. These offsprings can be sold on online auctions, special market Sims or bidboards. Prices can range from 100 L$ (about 0.30 US$) to over 200.000 L$ (about 550 US$) for one virtual animal.

Apparently the first inventor who got famous in Second Life with this sort of 3D social game was a young German student (I did not succeed in retrieving his real name and address), who developed breedable chickens (Sion chickens) and earned a lot of money in 2009. When some people succeeded in copying the chickens, he took his money and left Second Life completely. Inspired by his success, an American company expanded this idea and developed breedable bunnies, which overflowed Second Life quickly. The company itself and several users who invested from the beginning also had a lot of revenue. The revenue stream collapsed later on, probably because of lack of professional customer service. Another group of users then founded a new company and developed breedable horses, taking the market with the same speed and similar success. For example, they sold special horses for the American Cancer Day in order to donate the money. Within 72 h the amount of 74,000 US$ was collected (Breedables 2010a). The production company of the “bunny-makers” accused the “horse-makers” of having breached their copyright, and now an American judge has to create a precedent in the following lawsuits in early 2011 (Breedables 2010b).

This is a typical business story about virtual goods and its potential and its dangers. The YOUin3D.com GmbH does not work in this field directly, as we cooperate with reasonable specialized companies and freelancers to participate in this sector.

I always smile when I punch in my pin number at a cash machine because I have to think about the surprised comments of someone first seeing Second Life over my shoulder: “You are crazy, this all is not real! These are just numbers and virtual friends! There is no real money!”

13.14.11 Value Creation in Virtual Worlds

It is difficult to establish oneself in a market which is based on a technology that is, despite ongoing major proceedings, still in its beginning. To develop a business plan which can be flexible enough and can be adapted to the constant changes of virtual worlds is quite a task. Although we, as the YOUin3D.com GmbH, offered a wide range of services from the beginning, we still need to change and improve our services on a regular basis.

13.14.12 Server Hosting and Providng Knowledge

Many clients,companies in various industries, academic institutions, or private persons, rent or buy virtual land in Second Life or OpenSim. The YOUin3D.com GmbH operates also as server, hosting agency and so a lot of virtual land is used as a venue for conferences and meetings, e-learning platforms for promotional purposes, or just private projects.

The Second Life servers themselves are located at Linden Lab, Inc., in San Francisco, but the YOUin3D.com GmbH is offering a provider service for easy handling of Second Life Sims and estate administration. OpenSim servers instead can be located directly at the customer's company or also can be hosted externally. Besides setup, configuration, administration, and hosting, the YOUin3d.com GmbH offers knowledge transfer and advice. Since only a few customers have already gained experience in the field, most companies order a "complete full-service packet" including concept, scripting, building, implementation, and server hosting. The size of the hosted space depends on the usage and wishes of the customers. A lot of these services are not linked with the virtual city BERLINin3D.com, and so the revenue of these projects are additional to the main show piece.

13.15 3D Design, 3D Printing and Prototyping

A blank sim is like a blank canvas in three dimensions. You can either draw a map, and construct on the basis of this, or start visualizing freeform multidimensional objects and landscapes. Companies have various demands for virtual worlds, so the usage ranges from business-to-business applications to the visualization and three-dimensional views of data sets. For example, the YOUin3D.com GmbH has done an internal study for visualization of data sheets on the basis of an insurance company. So we made it possible to literally "quickly fly" over the insured clientele to check on the status and the amount of insurance. Special events like birthdays, or an insurance contract just running out, are visualized in a personalized symbolic way. A virtual red car flashing or a floating birthday candle can be recognized and instantly understood much better than a list of events by text or pictures on a 2D matrix. To understand and handle the exponential flood of data breaking onto our daily private and work life we will need better visualization tools. At the end our brains are 3D trained much better than anything else due to 3D being our primary cognitive environment.

The Fraunhofer Institute has even created a manufacturing process line in Second Life, which can be controlled by phone calls from outside the system by any visitor. The interactive production process is thus illustrated and the changes can be experienced in real time (Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e.V. 2009).

Probably the most revenue of the YOUin3D.com GmbH is created by 3D design. This includes the creation of buildings as well as designing all sorts of virtual content and interactive objects. This actual content is customized per the requests of private individuals and from companies (Fig. 13.12).

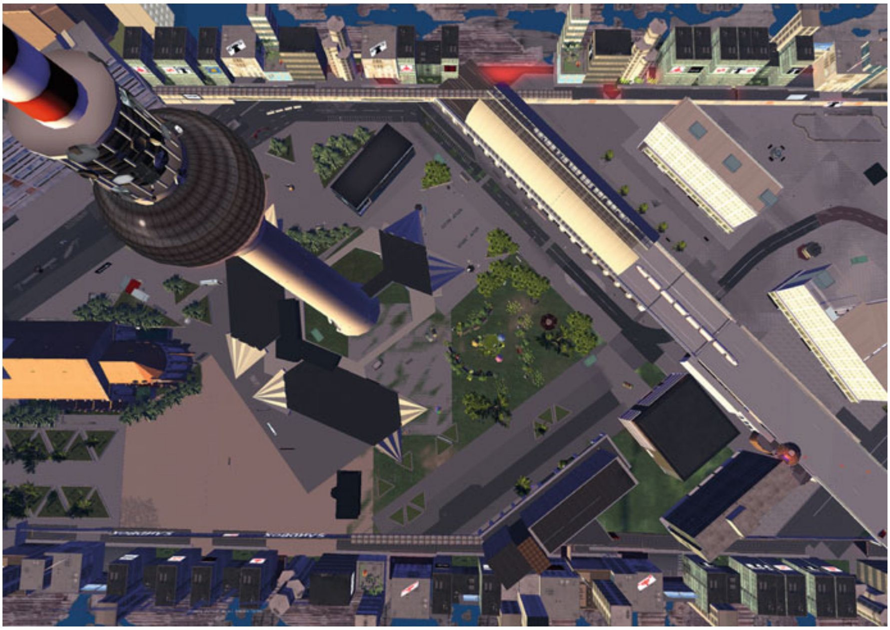

Fig. 13.12 Screenshot of a BERLINin3D.com. Always under construction

Objects and Structures can be recreated in true-to-detail and can imitate real actions. In addition, they may be edited collectively. This makes them ideal for prototyping and development of any "real" products. In combination with 3D printers (digital fabricators) these virtual 3D objects can be made into real physical sculptures. The YOUin3D.com GmbH owns a 3D printer and now can offer a complete prototype development, including the first virtual models and the production of a real physical prototype or even small series productions.

13.16 Meetings, Conferences and Live Streaming

Virtual environments are easy to set up, intuitive to work in, and fast interactive online meeting rooms. Worldwide easy access, several collaborative 3D objects, spatial voice, chat, group, instant messaging (IM), and additional planning and visualization tools enrich the avatar-based meeting situation. Also, interactive web sites can be used as interactive projection screens. Compared to classic video conferences, the avatar helps to handle the lack of real presence on the one hand; on the other hand, the avatar protects the recipient and helps to take stress out of the conference situation. The encounter in 3D environments is almost always referred to as the best way to meet virtually.

Also the social component cannot be underestimated. There are social effects similar to a real conference, including the casual meetings in the lobby or the after-dinner casual business meeting. It is easy to create an instantly relaxing or productive surrounding, just by a simple teleport. On the other hand, the voice and just the outfit of the avatar sometimes tells more about the person behind it than a "real-life outfit."

The simultaneous use of voice, chat, IM, and group notices in the meeting helps to maintain a "main information level" which is usually held in voice. This leaves room for other opinions and discussions in a silent and nonaggressive way. The anonymity and the lack of emotion of an avatar can even help to give a meeting a structure of relevance, and in some cases it even helps to discover special capabilities. For example, unlike in a real meeting, normally shy people have the possibility to add their opinion or bring up new and surprising suggestions without causing an aggressive disturbance.

A normal virtual conference has a moderator observing the text chat and forwarding important comments and questions to the actual speaker. In trained audiences, this is a great effective way to run professionally through a multilayer Q&A session.

The break-even point can be achieved quickly with virtual meetings. Savings in transportation and maintenance costs, rents, and attributable costs of food justify the initial costs in each case. In particular, larger events bring a return on investment to the company after the first stage.

Via live streaming, the YOUin3D.com GmbH has transferred real-life lectures on the virtual canvas. Conversely, we have also streamed virtual lectures live on real canvas. A great example is the "FaVE 2009 International Conference on Facets of Virtual Environments" in Berlin. The YOUin3D.com GmbH was the cooperation partner for broadcasting, implementation, and promotion of the FaVE Conference in Second Life (YOUin3D.com GmbH 2009).

The added value of virtual worlds for enterprise lies in the visual communication of information and additional channels of communications and the possible savings in travel costs (Fig.13.13).

Fig. 13.13 Second Life screenshot of the International Conference on Facets of Virtual Environments (www.fave-conference.org)

13.17 E-Learning, Simulations and Serious Games

The YOUin3D.com GmbH uses virtual environments to enhance the learning process.

The virtual worlds platform already exist, and so we do not have to develop a new technology each time to set up a complete learning environment. Also it is relatively easy to implement additional 2D web services as well as software that the company uses already.

For the development of e-learning and serious games applications we rely on our expertise in 3D design, programming, web-consistent communication, and knowledge transfer. We also offer the evaluation of learning outcomes.

YOUin3d.com GmbH forecasts an increasing demand for learning and training opportunities in three-dimensional worlds in business. Currently simulations are found across industries moving into the business processes.

13.18 Future

13.18.1 Universal Tool

Unlike any other virtual world, game, or even web 2.0 / web 3D platforms, Second Life has no specific use or goal. It is just a universal tool, used or abused in many different ways and therefore constantly developing into new directions. Its strongest skill is the universal combination and freedom to create, share, sell, and invent objects, scripts, and services. Even complete businesses are based on this platform. Therefore, it is very hard to bundle this into a profitable commercial product or offer. This quite unpredictable business situation leaves many more possibilities and provides more potential than actual use cases. Most companies are still insecure or unprepared, and not brave enough to make use of this technology.

13.18.2 3D Online Profile

The 3D avatar just seems like the natural next step or version of the "online profile." In some cases the use of such an avatar that is used as a "3D email address" may even help to combine and pull together the fast-increasing lines of communication that an average "modern" person has to deal with. Working with real-time data in general, and especially in the collaborative 3D data field, will flow into our workspaces. Still, there are several problems to be solved in the future with this medium, and two of them are considered as the most surging ones: direct Second Life access via the web browser and handling "traditional 3D data" formats like COLLADA. The long awaited "web-browser-based Second-Life-viewer" is available in public beta (Linden Research, Inc. 2011a). Also the improved Second Life viewer with the possibility to upload traditional 3D data can be previewed in the "beta grid" (Linden Research, Inc. 2010). Also, in the open-source sector, the first solutions are available.

13.18.3 OpenSim

Especially the Open Source technology known as "OpenSim" has much potential. Institutions and companies like NASA and Intel are already using it. A lot of virtual world science and education projects are tending more and more to OpenSim. The fact that it is a highly customizable free Open source software brings a lot of advantages. Besides some usability problems, OpenSim can deliver a similar technical solution for companies like Second Life. Besides mixed reality conferencing rooms, there are several e-learning and additional 3D tools available to deliver a totally new effective and probably fun work situation, all "behind the firewall." OpenSim servers can be set up in any secure situation and are indeed a sort of "3D web" or "3D Intranet" server system.

13.18.4 Hyper grid

A common vision of the future 3D Internet is the idea of the growing hypergrid, a decentralized network of "OpenSim" servers connected with the "hypergrid Protocol",[30] similar to how the World Wide Web is set up. The "hypergrid protocol" connects different private or company OpenSim servers, so the 3D visitor (avatar) can freely "browse" (teleport) through these connected 3D web sites / OpenSim servers. Although it is only the technically correct description, the "hypergrid protocol" sounds almost like "Hypertext Transfer Protocol," which is mostly known as HTTP and the basis of the modern Internet. Some experts are saying things like "everyone who has a web site now will have their own grid later."

13.19 Conclusion: Web 3D

Most specialists agree on one statement: "3D Internet is coming, the only question is when."

Time is the "killer app" and mankind already has a common sense of the future. A lot of technical features are becoming reality every day, features which were formerly just science fiction.

Major parts still missing in this puzzle are 3D projection and visualization tools like holograms or 3D screens. In the near future, the 3D TV might become one of the top selling consumer electronics. Additional solutions are being addressed. The next generation of these devices will hopefully bring a reasonable, glassless, and compatible 3D experience.

The question is, what operating system will run on these devices?

As a matter of a fact, Second Life consists of complex software almost as detailed as an "operating system" like Windows. I personally prefer to work with Second Life rather than any other software or platforms, and in some cases I have already started implementing basic operating functionalities connecting web sites and tools, all inside my virtual 3D workspace.

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Biography

Jan Northoff (aka January Lightfood)

Having founded the virtual city BERLINin3D.com, Jan Northoff is now CEO and Scrum Master of his 3D Internet solutions company YOU in3D.com GmbH. He is specialized in 3D avatar and real-time environments for business, educational, and artistic uses. His company is Second Life Gold Solution Provider and OpenSim developer and offers services for e-learning, web conferencing, machinima, serious games, and social media. Note: The real picture of Jan Northoff is shot by Frank Wittig.

Part VI
Development Issues and Implementation Benefits

Chapter 14
Supporting Diverse Needs of Learning Groups: Towards Highly Flexible Learning Settings in Collaborative 3D Virtual Environments

Christian Gütl, Vanessa Chang, and Stefan Freudenthaler

14.1 Introduction

In today's digital world, educators are faced with tremendous challenges in keeping up with new and emerging technologies to support learning. The pervasive use of networked technologies and the uptake of the younger generations in using this medium are compelling reasons for educators to keep pace with the ever-changing technological and social situations. Today's generation no longer relies on physical attendance at lectures nor are they confined or restricted to collaborate in shared physical rooms. Students can be geographically dispersed or in situ and rely on appropriate tools and learning settings to support their learning. In addition, learning communities are also becoming increasingly dynamic in terms of their specific learning requirements and learning group formation (Gütl and Chang 2008). In contrary to these stated needs, technological solutions are often not flexible enough to cater for these requirements and, therefore, students were left to follow compulsory learning processes (Hornik et al. 2007). This situation calls for technologies to be flexible regarding the support of a variety of learning situations and settings. Learning and teaching processes are complex and they are influenced by a number of characteristics, and thus the requirements for learning environments are strongly dependent on those characteristics (Gütl and Chang 2008; Gütl et al. 2010). As a consequence of the modern learning settings, contextualization, socialization, and

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collaboration aspects of student learning have become prominent research topics over the last few years (Gütl and Chang 2008; Albion 2009; Chang and Gütl 2010).

In a collaborative learning setting, students are expected to actively participate in learning processes as well as practising soft skills to stimulate social and interpersonal skills (Konstantinidis et al. 2009; Smith and MacGregor 1992; Stahl et al. 2006; Stacey 1999). The challenge for educators to ensure effective collaborative learning also takes place in a nontraditional setting (e.g., virtual environment). Cognitive science and pedagogical research not only developed modern educational approaches but inspired also technology-enhanced learning. There exist a great number of reported failures in e-education which have further inspired research in this area (Bernard et al. 2000). In particular in distance education, different studies such as Bernard et al. (2000) show issues of high dropout rates, low level of quality learning, feeling of isolation, lack of appropriate communication channels, and difficulties to be self-organized. Thus, over the last decades, learning technology applications have included tools for organizing and delivering learning content for individual learning activities which support communication and collaboration. Although collaborative support has been developed to overcome some of these problems, there are still a number of existing approaches and technologies with deficiencies related to the interpersonal communication perspective. 3D virtual worlds such as Second Life, OpenSim, and Open Wonderland for virtual collaborative environments can offer features to mitigate these issues (Gütl 2011).

3D virtual worlds have become popular over the last few years for various application scenarios such as entertainment, communication, and collaboration as well as for learning and training activities (Fox et al. 2010). From a collaborative learning viewpoint, the advantages of such environments include the support of multiple communication channels as well as providing the feeling of presence and awareness. 3D virtual worlds can reduce barriers between group members, support the feeling of belonging to a community, and may facilitate interaction between users and/or objects and thus collaboration between group members (Gütl 2011).

A number of learning environments for various learning and training activities have also been developed. These environments support activities such as skill training, prework training, experimentation, virtual lecturing and seminars, role play, and group assignments (De Freitas 2008; Fox et al. 2010). Almost all of these environments have been designed for a specific purpose and the development work in this area is resource intensive and time consuming (Henckel and Lopes 2010). Regardless of these challenges, there is a strong demand for flexible and easy-to-adjust learning environments according to the specific needs of learning groups in a particular context (Hornik et al. 2007; Gütl and Chang 2008). In the context of virtual 3D learning environments, research groups call for tools and frameworks which support the easy creation, simple reuse, and adaptation of such environments (Albion 2009; Farley 2009; Gerbaud et al. 2009; Fox et al. 2010).

The situation outlined so far has motivated us to initiate research towards a flexible system, which supports adaptation and configuration of virtual collaborative learning environment according to the specific learning communities' needs. A first proof of concept and preliminary findings was discussed in Gütl et al. (2010).

In this chapter, we focus on our research about an improved approach of the virtual world Second Life application. Furthermore, we provide an outline of our findings and recommendations. The structure of the remainder of this chapter is organized as follows: Sect. 14.2 presents the background and motivation for collaborative learning environments and supporting technologies. Related work on the proposed idea is given in Sect. 14.3. Section 14.4 summarizes the research aim and the identified requirements of a flexible learning environment. The prototype development and use cases are outlined in Sect. 14.5, and finally, the findings are discussed in Sect. 14.6.

14.2 Background

14.2.1 Collaborative Learning Activities

From a historical view on the notion of learning, educational researchers have treated the learning process merely as a psychological phenomenon. During the twentieth century, philosophers as well as education and cognitive science researchers introduced new views on learning and knowledge, with contextualization, social aspects, and interpersonal interactions being important aspects. As one of the emerging theories, collaborative learning has gained increasing interest over the past two decades (Alavi and Dufner 2005; Stahl et al. 2006).

Collaborative learning is seen as a joined intellectual effort by the learning community, whereas the collaborative learning activities include, among others, skill development, knowledge acquisition and sharing, categorization as well as promoting and negotiating differences to achieve a mutual solution (Smith and MacGregor 1992; Dillenbourg et al. 1996; Alavi and Dufner 2005; So and Brush 2006; Gütl 2011). The learning community is generally composed by students and teachers but may include also domain experts and professional workers. By this, the learning group mutually searches for understanding and meaning, explores different solution paths, or creates a product as an outcome. Note that the key to collaborative learning lies into the mutual and coordinated engagement of all members. That is, activities may also be divided into subtasks according to the competences of the group members. Furthermore, the process may also include (relatively) independent cognitive systems which exchange messages or can even be seen as single cognitive systems by itself having its own properties. From this, different theories emerged, for example, the *socio-constructivist approach*, the *sociocultural approach*, and the *shared cognition approach* (Smith and MacGregor 1992; Dillenbourg et al. 1996; So and Brush 2006; Gütl 2011).

A minimal implementation of collaborative learning into practical applications should include (a) sharing of learning tasks, (b) mutually applying expertise knowledge and skills to improve the quality of the learning process, and (c) building or consolidating a learning group. With collaborative learning, not only the role of students change but also the role of teachers moves towards a coaching role (Smith and MacGregor 1992; Bernard et al. 2000). Research focused on different aspects i.e., (pre-)conditions, interactions, and effects in collaborative learning settings in different disciplines and application domains. In comparison with individual learning scenarios, findings show that collaborative activities are more effective in terms of attitude, motivation, and achievements by the students. In addition, meta-skills like communication, coordination, or conflict management are trained and improved. Studies reported on challenges and issues about collaborative learning. This includes extra efforts for designing and implementing collaborative learning activities. Other issues include the relationship between teachers and students, which may be confusing and disorientating, in particular with group members from different cultural backgrounds learn and work together. Research has shown that low achievers can progressively become passive when they work together with high achievers in learning groups. Moreover, collaboration may not benefit students who are below a certain development level. This chapter endeavors recommendations to curb these challenges and issues and to promote collaborative learning in modern learning settings.

14.2.2 Technology Support in Collaborative Learning

Interestingly, e-education research, tool development, and implementation in real learning settings has been around for several decades but with few reported success stories. Distance education is mainly a vehicle for delivering learning content in individualistic learning settings and did not sufficiently consider learners' needs. Research findings support this by identifying problems such as (a) feeling of isolation, (b) procrastination, (c) lack of multiple communication channels, and (d) difficulties related to self-regulation (Bernard et al. 2000). Effective use of appropriate technology to support collaborative learning activities is a promising way to overcome those problems.

Some important theoretical perspectives on collaborative learning tools illustrate the users' needs. From a learner-centered perspective, principles like developmental and social influences are essential. Collaborative technologies should enable social interaction, interpersonal relations, and communication to support the different developments within and across intellectual and social domains. From a constructivist viewpoint collaborative tools can be used for both the cognitive and social constructivist approach. For the first approach, the focus is on increasing the relevance of learning and posing contradictions. For the second approach, the focus is on providing alternative perspectives and negotiations. From the sociocultural perspective, tools for collaboration need to support principles like mediation, assisted learning, intersubjectivity, and distributed intelligence in learning communities (Bonk and Cunningham 1998). From the viewpoint of the social presence theory, two important factors of intimacy and immediacy need to be considered. A person's perception of social presence in a (learning) environment is strongly influenced by the peers' intimacy behavior, such as eye contact and physical proximity. Such behavior can in turn create the feeling of intimacy and enhance the level of social presence. Finally, the transactional distance theory does not define a physical distance but a "transactional distance" as a pedagogical phenomenon. This transactional distance can be viewed as the learner's perception of physical and communicational gaps caused by geographically dispersed learning environments. Its perception is a relative construct which is determined by the structure and number of dialogs (So and Brush 2006).

Influenced by the abovementioned theories and increasing interest in collaborative learning we have consequently developed a great variety of information- and communication-based tools over the last decades. In the context of computer-supported collaborative learning (CSCL), some early related developments have started in the beginning of 1980s, and more significant activities and community building started in the late 1980s. Interesting projects in those days included the ENFI Project from Gallaudet University (computer-aided composition or "CSCWriting"), CSILE Project (Computer Supported Intentional Learning Environment) from University of Toronto (knowledge-building communities and collaborative writing), and the Fifth Dimension (5thD) Project to enhance students' skills for reading and problem solving (Koschmann 2001; Stahl et al. 2006). Since those early days, a great number of diverse tools have been implemented, which can be classified as synchronous collaboration tools, such as chatting and shared applications, and asynchronous collaboration tools, such as discussion forum and collaborative writing. In an orthogonal view, Alavi and Dufner (2005) define three classes of collaboration support in learning settings: (1) Group Support Systems (GSS) provide functionality to support communication, coordination, and interaction among group members; (2) Collaboratories are virtual workplaces which provide tools to control and coordinate but also facilitate group learning and integrate external resources; (3) Integrated Learning Environments combine several GSS and make them usable by an integrated environment. Functionalities and services of such learning environments include multimedia learning content management and access, e-assessment as well as synchronous and asynchronous tools for communicating and working together. As there is conceivably a variety of influential factors on collaborative learning and technology support given by the high complexity of such learning settings, studies and research findings in practical settings show quite a blurred picture ranging from great failure to successful examples (Alavi and Dufner 2005; Stahl et al. 2006; Gütl 2011).

Although technologies and tools to support collaborative learning settings have been around for a while, issues such as interpersonal communication still exist. While application of video conferencing and other audio and/or video presence in distance learning attempt to reduce some of the problems, but an absence feeling of co-location and limited opportunity to work on activities is still present. In this context, virtual 3D virtual worlds can be a useful and powerful alternative (Redfern and Naughton 2002; Gütl 2011).

14.2.3 3D Virtual Environments and Collaborative Learning

The research community has a broad view on virtual worlds, and consequently a variety of definitions can be found. For a better understanding within this work, the definition by Bartle (2010) will be used. Bartle is the first person who has worked on a text-based definition for virtual environments. In this regard, a virtual world is "an automated, shared, and persistent environment" where more than one user can be at the same time. A set of rules define the surrounding physics in terms of how the system behaves and how the environment continues to exist regardless of users' individual presence or absence. Such an environment enables users to "interact in real time by means of a virtual self." Users are represented as unique entities, mostly as avatars, performing actions according to a set of rules, whereas the world adapts and changes accordingly without delay.

From a historic viewpoint, virtual worlds have been available for decades. One of the early text-based systems was Multi-User Dungeon (MUD) in 1978. Nine years later, the basic idea of AberMUD became available under UNIX. AberMUD inspired further works and between the very late 1980s and early 1990s, TinyMUD, LPMUD, and DikuMUD emerged. Notably, on the technical side there is the availability of a fully functioning scripting language for object creation, and on the application side there is the early educational usage of such world for role plays and social interaction. Graphical virtual worlds can also be traced back for decades. Interestingly, one of the earliest graphical systems, having almost all concepts of the above definition, has been available within the PLATO e-learning research program at the end of the 1970s. The community of graphical virtual worlds has become more active since the 1990s, and in particular virtual worlds have become widely popular through systems such as Second Life and World of Warcraft (Bartle 2010).

A variety of tools and virtual worlds have been developed for different purposes and in various application domains (Bartle 2010; Taylor et al. 2010; Gütl 2011), more specifically a number of virtual environments have been developed for learning and training purposes (De Freitas 2008). 3D virtual world-based environments include settings of (a) formal education in a controlled environment, (b) guided or unguided informal education, (c) various forms of distance learning, (d) vocational skill training and knowledge transfer, and (e) learning and training for people with special needs (Chittaro and Ranon 2007). Among some other application, Second Life, OpenSim, and OpenWonderland are interesting alternatives of 3D virtual worlds to be used for collaborative learning activities. Advantages of such environments in the context of learning and training include (a) usage of multiple communication channels for both verbal and nonverbal, (b) the feeling of presence, (c) the awareness of objects and populated avatars and their behavior, (d) the facilitation of collaboration on object and integrated tools "in-world," and (e) guidance support by peers, tutors, or intelligent tools (Konstantinidis et al. 2009; Gütl 2011).

14.2.4 The Need for More Flexibility in Collaborative Virtual Learning Environments

Learning and teaching processes are very complex and they are influenced by a number of characteristics, and thus the requirements for learning environments are strongly dependent on those characteristics (Gütl and Chang 2008; Gütl et al. 2010). Consequently requirements for virtual learning environments are strongly influenced by the learning or training context, the pedagogical expectations, and the size and characteristics of the learning group (Gerbaud et al. 2009). In this specific context it is notable that learning communities are becoming increasingly dynamic in terms of learning group formation and their specific learning requirements (Gütl and Chang 2008). In contrary to these stated needs, often technological solutions are not flexible enough and therefore lead to compulsory learning processes where the learners must follow (Hornik et al. 2007). This situation calls for methods and technologies to be flexible to support a variety of learning situations and settings.

As discussed, there is a variety of virtual world applications for learning and training activities (De Freitas 2008; Fox et al. 2010), but almost all of them are designed to support specific learning and pedagogic objectives in defined application domains (Gütl et al. 2010). In this context, Gerbaud et al. (2009) identified that there are opportunities in 3D virtual world technology to include adaptability of learning settings and to incorporate dynamic changes during a specific learning activity. Farley (2009) calls for a mechanism to conform to a "reuse" standard in order to protect investment in learning environment development. This will enable adaptation, interoperability, and reuse in different virtual world platforms. Fox et al. (2010) identify the inability of educational (research) community to make use of modern technology to collaboratively work on tools and build systems, while Albion (2009) states that one of the reasons not to adopt new technologies in educational settings is the lack of development resources to tailor applications.

Coffman and Klinger (2008) argue that the situation stated above requires "rich environments" which "offer many different types of learning activities to appeal to different learning approaches." Consequently, this reveals the importance of virtual learning environments which are not only highly customizable, provide sets of tools, but also facilitate the integration and easy adaptation of preexisting tools and content. Also, the learning communities should be able to easily define the specific virtual learning environment and/or reuse predefined settings (Gütl et al. 2010).

14.3 Related Work

There are third-party tools such as *Google SketchUp*, *Blender*, and *3D Max* to create learning content using 3D virtual worlds. Prominent virtual word platforms, such as Second Life and OpenSim, have their own built-in authoring tools. For the purpose of reuse of (learning) content, there exist repositories such as Google 3D Warehouse, Blender Model Repository, and the Second Life market place. Creating 3D objects and compiling of reused objects in a learning setting require skills and experience for the authors of learning environments. The more complex the learning settings, the more efforts and skills are required. Different roles and access rights will be involved to create interactive objects which require scripting (Gütl et al. 2010).

Following the discussion on supporting tools on creating learning environments in 2003, Pape et al. (2003) reported on the *Ygdrasil* framework for composing of shared virtual worlds. This framework builds on elements of existing systems for virtual reality programming and supports the rapid and easy development of 3D environments by using a scripting language and a shared scene graph. Similar frameworks and environments are Alice, Avocado, and Bamboo. Another interesting proof of concept is based on the open standard X3D, which is seen as powerful and extensible, but it does not provide a simple environment which might also be the reason for slow adoption by the broader community. In a 3D virtual world application scenario, X3D offers a good support of creating and manipulating 3D scenes but it does not sufficiently support other features such as the interaction between users accessing the same scene or data persistency. To overcome those drawbacks, the DWeb3D toolkit was built which deals with synchronization and persistence as well as multi-user management and interactivity (Quintella et al. 2010). Although there exists useful support of creating environments on the technological side, the appropriate support for the learning community to easily create and reuse content and tools is still missing.

On the viewpoint of an application level, Dafli et al. (2009) cover reuse and exchange of an OpenSim-based learning environment for different medical learning scenarios. Their solution was mainly on the organizational side of reusing an existing server installation as well as adjusting and adapting avatar appearance and inventory, but there is a lack of tools to support the adaptations. Similarly, Farley (2009) reviewed ways of reusable learning design and environments based on Second Life but did not specifically cover detailed aspects on design and development of any tools. Albion (2009) discusses the idea of a low-threshold application for learning settings which aims to empower content experts to incrementally adapt and implement learning experiences in virtual environments, and the application will also be embedded easily in Web pages. A project which aims at Web3D development tools and resources suitable for end users and guidelines for implementation was introduced. These projects, however, are still at an early stage specifically targeting the learning application domain and are still in an early prototype stage. Gerbaud et al. (2009) reported on the Generic Virtual Training (GVT) project, an authoring platform to create virtual environments for procedural training. GVT relies on external tools for the creation of 3D objects or the use of object banks. The tool itself enables a pedagogical strategy to be defined as well as the procedural flow and the interaction patterns. GVT also enables users to reuse existing setups and adapt them for similar application scenarios.

Useful support provides OpenSim's module concept (*Region Module*) which allows new or preexisting functionality to be added or edited. For example, OpenWonderland provides a Web-based tool to manage tools and an integrated user interface “in-world” to enable user to use this tools (Gütl et al. 2010). Henckel and Lopes (2010) focus in their work on the support of integrating and linking simulation models with 3D objects in order to define the “in-world” behavior in the application domain astronomy. For this reason they have developed StellarSim which is a plug-in architecture for scientific visualizations, which currently supports OpenSim. The main idea is to integrate a simulation module in OpenSim which interprets object’s properties (such as shape and texture) and behavior (model) described in the description files. This approach already reduces the effort for creating scenarios; however, it is still not end-user friendly. Gütl et al. (2011) report about an approach to integrate physics simulations in OpenWonderland. By using OpenWonderland’s module, existing simulations from MIT’s TEALsim projects have been integrated and can be easily used by end users for learning scenarios. This is done by selecting them from the 3D world’s tools menu. This approach appears to be end-user friendly; however, each of the simulation needs to be integrated in the 3D world by skilled developers.

Similar to the previous idea, the Toolkits Project provides “in-world” inventory to create specific learning settings for Second Life learning environments. The inventory includes a chat box, an action board, a feedback survey tool, a chat logger, and a notecard dropbox (HEA 2010). Simulation Linked Object Oriented Dynamic Learning Environment (SLOODLE) is another toolset to link Second Life and learning management system Moodle. It manages authorization of users between the systems and information exchange between systems. In-world support for creating individual learning applications include chat tool, quiz tool, assignment dropbox, tool for object access, and collaborative website browsing as well as an award system to enhance student engagement (Kemp et al. 2009). A similar project also exists to integrate Moodle into OpenSim (CTN 2009).

Although service-oriented architecture (SOA) is a powerful approach for building flexible learning environments, this has yet to be fully exploited in virtual world research and development (Gütl et al. 2010). Booth and Clark (2009) introduce the idea of a pluggable services-oriented learning environment which makes use of Project Wonderland’s shared application’s feature to make learning tools accessible “in-world.” Cai et al. (2008) report about a framework to build flexible learning environment in different virtual 3D worlds which is based on the idea of an open, flexible service ecosystem that includes virtual learning services.

Finally, the project *Medula* is introduced which aims to offer new ways to create, search, display, remix, and share digital assets for educational virtual worlds. The vision of the project, initiated by the Federation of American Scientists (FAS), is to build on and combine existing technologies to coordinate and support the use of digital assets, such as media, documents, and software, in 3D virtual environments. The Medula framework aims to bring together easy-to-use tools and services for the management of assets and related activities as well as intellectual property management and learning management. As this project has only just begun, it is already pointing towards an innovative phase in virtual world design and development.

14.4 Motivation and Requirements

Our previous work on immersive collaborative learning environments, as discussed in Gütl (2011), has shown benefits in terms of the support for distance learning settings. The set of tools offered will enable student groups to work collaboratively on assignments. However, radical and flexible solutions will have to be brought in to cover the specific students' needs and preferences and learning activities. To be efficient in terms of the use of resources, energy, and space, effective learning environments must be designed. It is also sensible that flexible and dynamic learning environments be created. These analysis and arguments are in line with the literature as outlined in the previous sections and may also be justified by our own research on learning (digital) ecosystems (Gütl and Chang 2008).

In order to get better insights, an online survey was administered in the second half of 2009. Two hundred and ninety eight out of 333 responses were counted as complete and reliable. The study focused on learning behaviors and preferences of online tools (Freudenthaler 2011). The findings revealed that the subjects call for easy-to-use tools which support specific learning settings and personal preferences. In terms of an appropriate 3D virtual world, Second Life was indicated as a tool of choice for hardware affordances and familiarity of 3D worlds.

The situation analysis has motivated us to initiate a collaborative research project on a flexible solution for collaborative learning settings using 3D worlds between the School of Information Systems (SIS), Curtin University, Australia, and the Institute of Information Systems and Computer Media (IICM), Graz University of Technology, Austria. In the first stage a proof of concept was designed and developed based on Second Life (Linden Labs 2011). The main focus was to develop a tool which supports instructional designers, teachers, students, and learning groups to (a) easily configure, store, and reuse learning settings facilitating the actual needs of specific learning groups and (b) enable the simple instantiation of "in-world" learning spaces by learning communities. The management of the tools and learning settings has been organized by a browser-enabled Web application which controls the Second Life platform providing specific learning environments. Findings from the first stage of this research were reported in Gütl et al. (2010). The remainder of this chapter describes the prototype development and review of the second phase of the research project.

In the second stage of the research project, the concept of combining a Web-based "off- world" management tool controlling the "in-world" learning environment was further extended and improved. The requirements on an abstract level were organized into two parts: "off- world" and "in-world." The "off-world" requirements include (a) the management of 3D object compounds or items such as presentation and communication tools as well as aesthetic items and virtual furniture, (b) the management of individuals and group roles and their linkage to access rights "in-world," (c) the management of specific learning settings, i.e., creation and adaptation of learning environments by selecting and placing 3D items "in- world," (d) the managements of users and groups for instances of specified learning settings, (e) the time management of instances of specified learning settings including virtual space allocation and instantiation of the specified learning environment, and (f) the usability and extensibility aspects. The "in-world" requirements encompass (a) centralized communication between "off-world" and "in-world" application, (b) support for multiple learning environments and their dynamic instantiation, (c) easy mechanism to control 3D items, i.e., dynamically instantiate and positioning, and (d) the handling of access and control rights of virtual places and tools. The remainder of this chapter provides a snapshot of the design and implementation of the prototype and a detail description is reported in Freudenthaler (2011).

14.5 Prototype Development

14.5.1 Conceptual Architecture

Following the main ideas and the abstract requirements stated in Sect. 14.4, the application has been split into two main parts. The *"off-world" application* is designed as a Web application managing the flexible learning settings, user and group information as well as the scheduling of virtual learning environments. The graphical front-end interface enables the users to access and interact with the application by a Web browser. The persistence layer represents the front end of the Web application and handles the data management. The communication layer manages the *"in-world-off-world"* data exchange using http protocol. The *"in-world" application* is designed as a Second Life application which controls different virtual areas "in-world" by the learning environment which we called the *"Brain"*. Each of the Brain components is controlled by the "off-world" part and a dynamic instantiation and positioning of items managed in the Second Life Inventory. Consequently the Brain components are also handling the access rights of the specific areas and instantiated items. Items in the inventory may include simple 3D objects such as chairs or complex interactive compounds such as communication and collaboration tools.

14.5.2 "Off-World" Development

The design decision for this part of the prototype was driven by minimizing the effort, and therefore the development has been built on open accessible frameworks and software. Figure 14.1 shows the conceptual architecture of the software components. The Web application was built upon Google Web Toolkit (GWT) version 2.0.3 (Slender 2009) and running on Open Source JSP and Servlet container Apache Tomcat (Brittain and Darwin 2007). GWT is a development toolkit for building and optimizing complex browser-based applications following the AJAX concept; and the development of the applications is supported in JAVA. The client-side

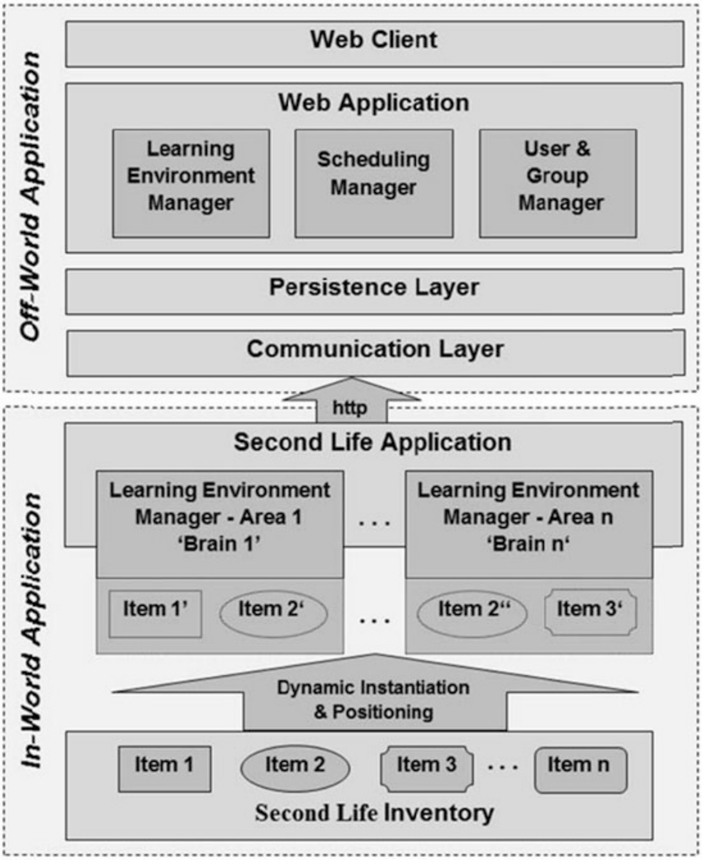

Fig. 14.1 Conceptual architecture of the flexible learning environment

application is automatically compiled into optimized JavaScript code which is browser client independent. In order to minimize the developing effort, GWT supports the basic widgets of the "drag-and-drop" features. The persistence layer has been realized by using the Open Source database MySQL (DuBois 2009). Finally the communication layer handles polling requests from the Second Life application (for details see Sect. 5.3) to control the learning environments "in-world" using http protocol.

Figure 14.2 illustrates the functionality and the related graphical user interface of the Learning Environment Manager in the "off-world" side. Multiple virtual areas "in-world" can be managed and selected to create or adapt to specific virtual learning environments for required learning settings (see top left side, label "1"). The selected virtual area is visualized in the window in the top center of Fig. 14.2. In order to create the specific setting, the component also manages information of different classes of Second Life items, such as presentation tools, decoration, or aesthetic items and others (see top right side, label "2A"). Two-dimensional representations of the items are shown in the right window. The items can be selected and positioned in the virtual area window by the “drag-and-drop” feature. Each of the designed setting can be stored and recalled for further usage (see control elements in the bottom center, label “2B”). The current learning environment setting visualized in the virtual area window can also be transferred into Second Life in order to create or update the “in-world” setting. In this version of the development, there is no graphical user interface support to add new items or define new virtual areas.

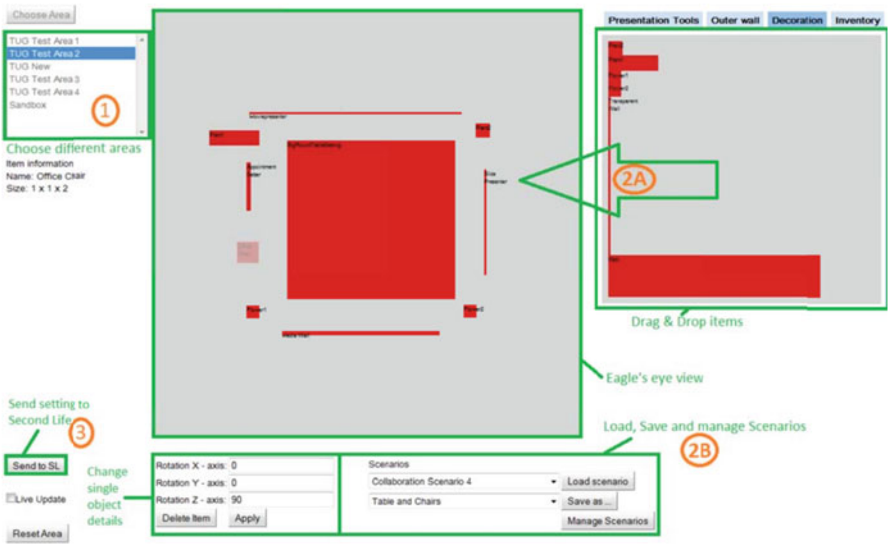

Fig. 14.2 Web-based graphical user interface (Freudenthaler 2011)

In order to use the virtual areas effectively, the application supports the booking and scheduling of the use of virtual areas for specific learning groups. The learning settings corresponding to the learning groups’ previous settings can be recalled to provide a preconfigured virtual learning environment. Figure 14.3 depicts the “booking” graphical user interface of the virtual learning environment and the rights management.

Consequently, all data related to the user and group manager are persistently stored in an instance of a MySQL database within the virtual room schedule manager and the learning environment manager. The database design related to the first two components is common and it includes tables about the Second Life virtual areas such as name, location “in-world,” and SUrl; the Second Life items such as name, size, rotation and single/multiple instances support; and learning environment setting such as selected virtual area, Second Life items, and their position or movements, and it flags whether updated data has been changed “in-world” environment (Freudenthaler 2011).

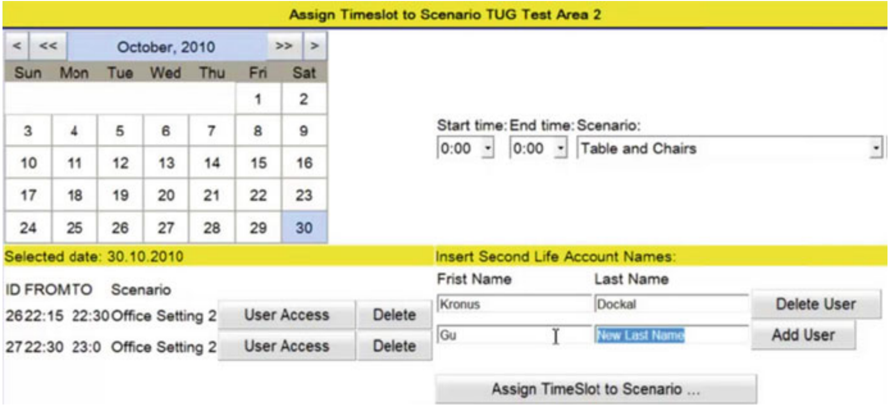

Fig. 14.3 Schedule and access rights management (Freudenthaler 2011)

14.5.3 "In-World" Development

Dense description and guidelines of how to use Second Life and to create complex, interactive objects "in-world" can be found in a numerous publications, such as Weber et al. (2007). Second Life is a commercial massively multiplayer online world (MMOW) where space or virtual land and some services (such as image or texture upload) can be used on commercial base. Simple usage and the client software are free to use. Users are represented "in-world" as avatars which are customizable. The client software has a built-in editing tool to create virtual 3D objects or items using different types of basic shapes and textures as well as rotation and transformation feature. Such items can be designed as interactive objects using the Linden Scripting Language. Second Life also enables designers to integrate Web pages as well as audio and video streams into the virtual environment. 3D object "in world" or more general application can also communicate "in- world" with each other and with external applications "off-world" by using email, XML-RPC, or HTTP requests (Freudenthaler 2011; Gütl 2011).

In order to frame an area or environment in Second Life, users can use the built-in object editing tool or import 3D objects and enrich some interactivity using the scripting language. Users can buy items from a market place; however, composition and positioning in the environment require manual effort and skills. There is no simple mechanism which supports the dynamic creation and positioning of items.

To overcome the problems as stated above, a central object for each of the virtual areas was designed to provide space for the dynamic creation of learning environments. This is controlled by the central object called the *"Brain"* (see also Fig. 14.1). The functionality of this centralized object is written in the Linden Scripting Language which is used to create and control other objects and items using a communication channel "in-world" and to communicate with the "off-world" application using the HTTP protocol.

The Brain objects can create instances of items from the inventory by addressing them by unique names. The process of creating these items is called *rezzing*, a Second Life terminology. In order to position the items in the learning environment, the items need to be moved and rotated by the Brain object. In order to control the instantiated items, each of the items needs to communicate with the Brain object on a unique communication channel and needs to have a script to control and perform the commands for moving, rotating, and deleting from the Brain object. A constraint of the proposed solution is the fact that the instantiated items can only be controlled up to 10 Linden meters. A special handling has been implemented for creating the basic structure of the virtual learning environments including wall, floor, and roof components. Again there is the constraint that a maximum size of an object cannot exceed the size of 10 Linden meters and thus must be split into smaller pieces. The item is then created by moving the Brain object close to the position.

In order to control (create, update, or delete) the virtual learning environments from the "off-world" application, the Linden script of the Brain objects runs in an infinite loop and polls the communication layer using HTTP requests frequently in intervals not exceeding the number of allowed requests from the Second Life world to external sources. As long as no control commands are in the queue, the script stays in a NOP (no operation) mode. For example, if a new virtual learning environment has to be built or an existing one needs to be updated, the "off-world" application queues the necessary operations to be transferred and executed "in-world" but also takes care of assigning unique identifiers for each of the items to be instantiated. The commands for creating and controlling items are *create, move, rotate*, and *delete*. For example, to create the basic structures for the "wall," the *create wall* command has been specified. The simple data structure for the commands is compiled from the following fields: (a) the unique identifier within the application, (b) the unique name of the items stored in the inventory, (c) the number representation of the virtual area, (d) the commands create|createwall|move|rotate|delete, (e) and the three-dimensional data for moving and rotating. Once a command has been executed, this command is flagged and removed from the queue.

This version of the prototype does not automatically add a new item in the "off-world" or "in-world" application. To add a new item, a control script has to be added, and the item has to be integrated in the inventory with a unique name. There are also constraints with the delegated rights of the item; in particular if the items are bought in the Second Life market-place, it must allow the scripts to be changed or added, and multiple instances must also be granted to be used effectively in the allocation. Also information of the newly added item (such as name and dimensions) must be added in the "off-world" application. At this stage of the project, the access rights are easily controlled by an almost translucent wall which either grants or denies access to the virtual learning environment according to the user and group rights defined in the Web application. Finally, to make use of the functionality described so far, the settings in Second Life have to be set to the following: (1) general access to the Second Life land and Linden scripts and (2) rezzing objects must be granted.

14.5.4 Cases

Our experiences of the practical usage of the different virtual learning environments are in the areas of design, configuration, and dynamically created learning settings. In order to illustrate the dynamic and flexible solution, two different environments were chosen to be presented in this section. The first environment captures a simple collaborative learning setting supporting a small group to meet, collaborate, and exchange ideas as well as to schedule and coordinate virtual meetings. Figure 14.4 (see top upper area) illustrates a drag-and-drop-based configuration of the learning environment using a Web-based graphical user interface, and the lower area of Fig. 14.4 shows the dynamically created learning environment "in-world." The second example shows a complex setting for vocational training which has also been designed and created by the application (see Fig. 14.5). Although this application supports and automatically creates a complex setting, we have also found that in some cases the grids are heavily populated with a lot of interactive objects, and some of the commands executed by the script were ignored. In such a case not the entire environment is built. As our project is still at a prototype stage, we have not checked whether an item has been created successfully. Also we have not developed a mechanism which can be implemented in the Second Life world to check the completeness of the creation. Quality assurance check and process will be considered in future projects.

14.6 Lesson Learned

The development can be divided into "off-world" and "in-world" parts. The Web-based application development was straightforward. On the positive side, it was easy to develop using the Google Web Toolkit (GWT). Accessible and good documentation are provided and forums for developers are also available. In particular, effective support was gained for the front-end development of the "drag-and-drop" feature. Excellent documentations were also available for MySQL and the Tomcat server. On the negative side, the browser-independent support for the dimensions of areas and the graphical visualization of widgets had caused some problems. On an organizational level, the development in a firewall-protected environment had also caused some problems as testing with the Second Life system, any "off-world" application must be accessible from the Internet.

From the viewpoint of the "in-world" development, a number of issues have been identified although the main objective of the dynamic creation of flexible designed learning environments is proven to be feasible. One of the issues uncovered at the item cannot be easily positioned by an application or other objects; thus, each item requires a script to provide control. In addition, the commands must also be integrated in the inventory of the controlling object. It is also required that the items must have the correct rights to create multiple instances. The right privilege for

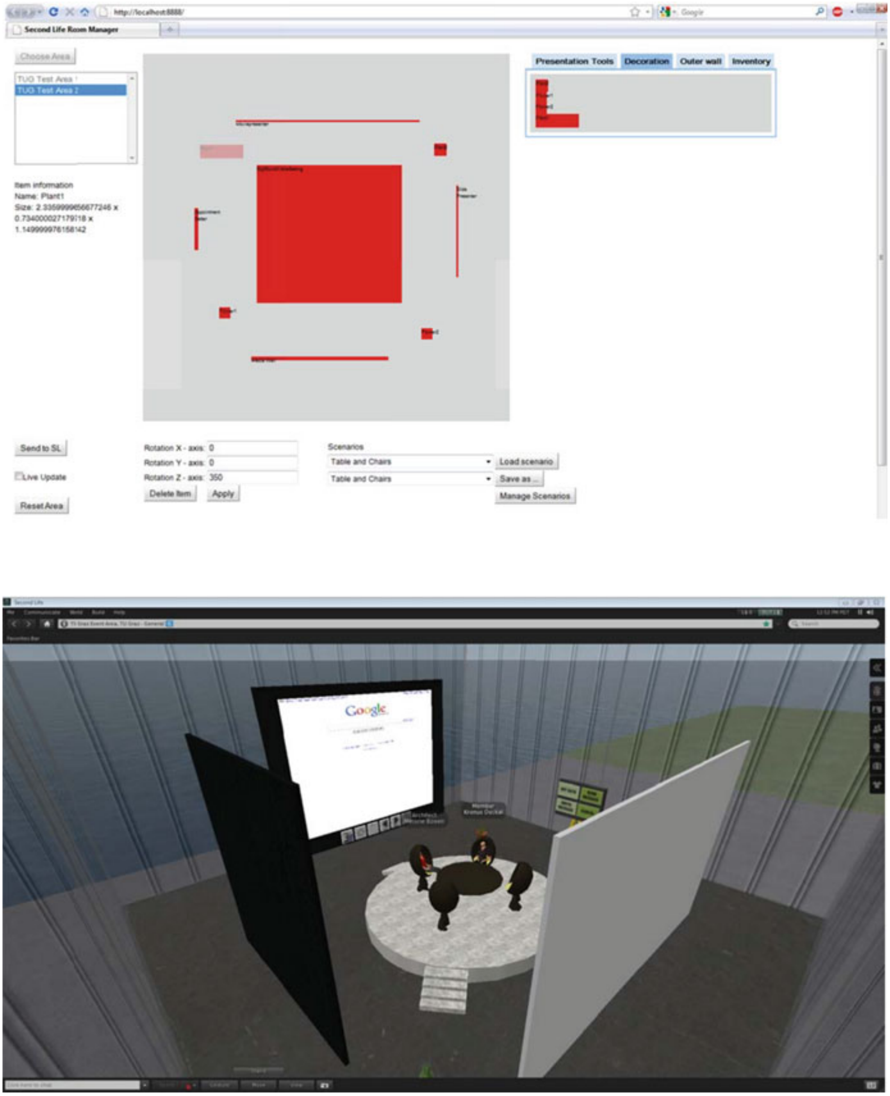

Fig. 14.4 Example of a collaborrative learning environment configured using the Web interface (*upper diagram*) and the dynamic instantiation "in-world" (*lower diagram*)

adding scripts and running multiple instances may provide a problem if a third-party item or tool was used without having the full control.

Other issues including objects in Second Life, such as the Brain object, can only create and control other objects in a limited distance of 10 Linden meters. Moreover, the function calls such as creating or rezzing objects may cause time delays. Scripting commands for certain objects may not be executed in populated areas within an island and this may result in settings that are not completely built as

Fig. 14.5 Example of a complex setting of a collaborative learning environment dynamically created

requested. In another development practical difficulty, the center of complex items (multipart prim) does not always indicate the actual center of the object and the center is entirely dependent on the order of the composite objects which is compiled or selected. Thus, the exact positioning by the tool can create problems. In order to create instances of items using a Linden language script, the names of items in the inventory need to be unique. To control (e.g., move, rotate, delete) the instantiated object requires also a unique communication channel. The current version of the application does not consider any security aspect. On a more general perspective, the usage of the commercial platform Second Life relies on the provided features and functionality because the systems are built on closed software and there is no API mechanism to integrate one's own module or to include other ways to add functionality.

From the usage point of view, the tool's review of expert level as well as a preliminary qualitative user study suggests the following findings; more detailed information can be found in Freudenthaler (2011). On the positive side, the Web-based graphical interface is easy to understand and virtual learning environments can easily be configured. It also reduces human effort to build new learning settings by editing preexisting ones. Also the user management and virtual space scheduling can support teachers and learning groups to access the virtual learning environment when they need it. In terms of efficiency, virtual spaces can be used for several learning activities. On the negative side, the current version does not support an easy way to integrate new items "in-world" and the corresponding data "out-world." Also, as the main aim of the prototype is to show the creation of learning settings, help feature was not implemented within the Web or the "in-world" application. Another drawback is that no status information is provided during the process of creating a virtual learning environment and during the scheduling of the "in-world" room management.

14.7 Summary and Future Work

The literature survey suggested that educators and other stakeholders in the educational arena are faced with tremendous challenges. New learning settings and learning environments are required to support dynamic forming learning groups. These groups can either be in situ or geographically dispersed and have their preferred tools and methods.

3D virtual worlds have become popular for collaborative learning settings. The advantages include the support of multiple communication channels as well as providing the feeling of presence and awareness. 3D virtual worlds can also reduce barriers between group members, support the feeling of belonging to a community, and may facilitate interaction between users and/or objects and thus collaboration between group members.

Such virtual collaborative environment can provide significant advantages in collaborative learning settings. Creating an effective learning environment will require educators or developers to have the design and implementation experiences and the specific requirements and preferences. However, teachers or learning groups should be able to easily define the specific virtual learning environment and/or reuse predefined settings. Consequently, this reveals the importance of the virtual learning environments project which is highly customizable. The application also provides a set of tools but also facilitate the integration and easy adaptation of preexisting tools and content.

There is some research to support an easy creation of virtual world settings which ranges from conceptual ideas and visions for the educational application domain to frameworks for building 3D world settings supporting mainly programmer or very skilled users. However, there is a lack of research and development activities on applications which directly supports the less-inclined programmers or end users such as teachers and students.

The situation analysis has motivated us to initiate a collaborative research project on a flexible solution for collaborative learning settings using 3D worlds. The current prototype implementation has been built on the 3D virtual world Second Life. In order to offer a simple way for the end users to create and adjust virtual learning environments, a Web-based "off-world" management tool controlling the "in-world" learning environment was provided. In the "off-world" part, different parts of the virtual learning environment (such as 3D objects, communication tools, and collaboration tools) can be selected and positioned. The "in-world" part of the virtual learning environments will be dynamically created according to the settings of the application outside the 3D world.

The initial findings of the prototype implementation are very promising. The feasibility of an application which enables end users to easily create and reuse the virtual learning environments has been proven. However, further research and improvements for the usability, security, and reliability of the prototype will need to be extended. In the next phase of our research project, we will explore opportunities and obstacles to build a similar application for the Open Source OpenSim platform. In addition, ways for integrating existing Web-based tools such as Web 2.0 services and knowledge repositories will also be explored. The access of such environments by various end devices is becoming increasingly important and needs to be carefully investigated.

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Christian Guetl holds a Ph.D. in Computer Science from Graz University of Technology (TUG) and has received the "venia legendi" for applied computer science in 2009. He is the chief scientist at the Institute of Information Systems and Computer Media at TUG in Graz, Austria, where he leads the Advanced Educational Media Technologies Group. He is adjunct research professor at the School of Information Systems at Curtin University in Perth, Western Australia, and he is the founder and head of Guetl IT Research and Consulting. Christian has authored and coauthored in more than 120 peer-reviewed book chapters, journals, and conference proceedings publications. He is involved in numerous organizational and editorial boards as well as program committees. He serves as a board member of the European chapter of the Immersive Education Initiative (E-iED), managing editor of J.UCS, coeditor of the International Journal of Knowledge and Learning (IJKL), advisory board member of the International Conference of Blended Learning (ICBL), initiator and chair of the CAF workshop series, and cochair of the ViWo and e-Education Ecosystem workshop series. His research interests include information search and retrieval, e-education, e-assessment, adaptive media technologies, and virtual worlds for learning and knowledge transfer. He has established successful collaborations on these topics with European and overseas institutions. Given his knowledge and research interest, he is frequently invited as a visiting professor, such as to MIT and UTS.

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Professor Vanessa Chang is the current Dean of Teaching and Learning at Curtin Business School, Curtin University. Her previous position was the Head of School of Information Systems at Curtin University. Professor Chang developed the Web-based Learning Environment Instrument (WEBLEI) in 2001 and this instrument has been adopted by researchers and institutions to assess the use of the online learning environments. Her recent research activities have focussed on e-learning in 3D Virtual Worlds, mobile learning and e-learning ecosystems. Professor Chang has collaborated with Professor Christian Guetl from University of Graz (TUG) since 2007 and together, they have worked on a number of experiments on 3D Virtual Worlds using Second Life and OpenSim. Professor Chang has also cooperated with colleagues from the Curtin School of Information Systems and colleagues from Molde University in Norway in teaching enterprise systems business process concepts in a globalised context using Second Life virtual worlds. The experiment has been reported in multiple publications. She has published in both journals and refereed conference proceedings on 3D Virtual Worlds and other Web 2.0 technologies.

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Chapter 15
Transforming Ideas to Innovations: A Methodology for 3D Systems Development

Carl Dreher, Torsten Reiners, and Heinz Dreher

15.1 Introduction

The pace of technological development is increasing exponentially: the industrial revolution marked the advent of increasingly rapid technological and social change (Nye 2008). With the dawn of the modern information age, Moore's Law has quantified this exponential trend in the context of information technology (Mollick 2006). Concomitant with technological advancement is sociological change: the modern knowledge economy is a revolution in the way we interact socially and commercially (Rooney et al. 2005). Information Communications Technology (ICT) is at the confluence of technological advancement and revolutionary social change. Revolution being a politicised term for what we currently couch as "innovation"—making things better.

15.1.1 Socio-Technological Evolution

As read-write networked communications technology (currently, Web 2.0) becomes more powerful and ubiquitous, the balance of power is shifting from major institutions (corporate entities and government institutions) towards the people. That is to say, the collective voice of citizens is empowered by the capacity to publish user-generated content (e.g., personal websites, blogs, wikis, and multimedia content such as on YouTube); and communicate globally with any entity that has a presence on the Internet (i.e., individuals, corporations, or governments). While the above-mentioned facts are well known, their implications for social change are just beginning to be explored.

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As ICT continues to advance, so will social change, thereby revolutionising our social institutions that regulate political governance, the economy, and social interaction (Buccoliero and Calciolari 2007; Pesce 2000). Political governance is being changed by ICT-use, and because networks enhance peer-to-peer communication, this gives citizens the capacity to unite and self-regulate independent of their governments. While still early days, this trend is already beginning. Large political movements have been organised in China and South Korea via technologies such as text messages, email, blogs, and bulletin boards (Chung 2008). Furthermore, Australian politicians have begun utilising social networking utilities such as Facebook yet endorse Internet censorship (Bambauer 2008). The advent of intelligent semantic analysis tools may soon enable meaningful, uncensored communication between millions of people via the aggregation of semantically similar messages from multiple users in blogs (potentially called massively multiple communication services, MMCSs). Such technology would greatly leverage the communication, self-awareness, and autonomy of previously disenfranchised populaces. A united citizenry could destabilise the balance of power that governments currently hold.

ICT is also changing commerce by enabling people the world over to access information, goods, and services that were previously unavailable to them (e.g., Google's suite of services, Amazon.com, and eBay), thus, increasing the competitive pressure on commercial organisations. The movement away from intellectual property rights and towards open-source software is further destabilising the status quo (Feller et al. 2005). This is compounded by the ease with which digital property can be obtained illegally in the software and entertainment industries (i.e., programs, music, movies, and games). These trends are forcing companies in the software and entertainment industries to change their business models (e.g., towards strategies dependent on the initial free provision of goods/services in order to establish a customer base that then generates revenue from advertising and/or charging for premium goods/services).

ICT is also revolutionising how we interact socially. Social utilities such as Facebook, MySpace, and 3D Virtual Worlds (e.g., World of Warcraft and Second Life) are an emerging phenomenon that are rapidly being adopted by large segments of society—commonly thought to be younger generations, dubbed digital natives (Boyd 2008). Such social utilities provide networked digital public spaces that are replacing the physical publics spaces (e.g., parks and town squares) in which we have traditionally gathered (Boyd 2008).

In short, the increasing rate and extent of socio-technological change is affecting our social, commercial, and political processes. These systems must adapt/innovate in order to remain effective. Research, development, and commercialisation can play an important role in this adaptation/innovation.

15.1.2 The Role of Research Commercialisation

The social, commercial, and political change outlined above is a reality that will likely continue to accelerate. It has the potential to change our social structures in ways we cannot fully predict, such as decentralising educational institutions towards distributed industry-integrated learning (Bentley 2000). Survival in a changing environment requires adaptation: for individuals, this currently manifests as the need for lifelong learning, and; for corporate entities (e.g., financial institutions, insurance brokers, ICT companies, and educational organisations alike), this requires constant innovation via research, development, and commercialisation (of information, goods, or services). That is to say, as the pace of change increases in our modern economy, the role of research, innovation, and commercialisation will have increasing importance for the adaptation and survival of institutions (commercial institutions certainly but also social and political institutions as outlined above). Indeed the Australian Government has recognised the importance of research commercialisation in the modern knowledge economy through its National Research Priorities (National Research Priorities Standing Committee 2007).

A number of government-commissioned reports acknowledge the importance of research commercialisation (Australian Centre for Innovation et al. 2002; Howard 2005; Phillips KPA. 2006). Knowledge transfer has been defined as the process of research commercialisation whereby knowledge, intellectual property, or inventions are transformed into economic and social benefits for individuals, corporations, and society in general (Australian Centre for Innovation et al. 2002). It is consequently an intrinsic aspect of the Australian Government's National Research Priorities (Phillips KPA. 2006). Knowledge transfer can include a variety of processes: knowledge access (free distribution of knowledge through such means as publications and conferences); knowledge production (selling knowledge products via spin-out ventures, licensing, patents, or selling publications, etc.); knowledge relationships (selling knowledge services through consulting or contractual relationships); and knowledge engagement (longer-term collaboration between academics and industry or community for mutual benefit) (Phillips KPA. 2006).

Knowledge transfer and research commercialisation may take place within the context of universities, government-sponsored research centres, and commercial entities (including sole-traders, small-to-medium enterprises, and multinational companies). In many respects, the presence of ubiquitous, powerful ICT in the networked economy can level the playing field such that a valued product can be leveraged with less capital expenditure than was previously required (e.g., Google) (Vise and Malseed 2005). This increased accessibility of ICT has led to widespread creation of networked communities, which are now being called digital ecosystems.

15.2 Digital Ecosystems

Digital ecosystems are a prime way in which ICT is changing how humans interact online (Fenn 2006; Sarner 2008). They comprise both 2D interfaces (through Web 2.0 applications such as Facebook, MySpace, Flickr, and Twitter), as well as 3D interfaces (through virtual worlds such as World of Warcraft and Second Life).

15.2.1 Introduction in 3D Digital Ecosystems

Certainly, 3D virtual worlds offer rich potential that is still being explored and developed (Prentice 2007). 3D virtual worlds have been described as ‘online environments that have game-like immersion and social media functionality without game-like goals or rules. At the heart is a sense of presence with others at the same time and in the same place’ (Constable 2007). These qualities of immersion and presence are facilitated via an avatar, a user’s in-world representation (usually a humanoid figure) that enables navigation and interaction in the 3D environment. The content of 3D virtual worlds ranges from developer-generated (e.g., World of Warcraft) to predominantly user-generated (e.g., Second Life). For instance, Second Life facilitates user-generated content via a menu-based 3D object creation tool and a programming language (the Linden Scripting Language, LSL). Similarly, the cost of use varies—some virtual worlds operate on a fee-for-use basis (e.g., the BarbieGirls.com virtual world or World of Warcraft), while others offer free entry (e.g., Second Life provide free avatar accounts and a freeware viewer client).

3D virtual worlds offer an unprecedented opportunity to engage in a Web-based digital environment that mimics the physical environment in which we have evolved. Humans have evolved as social beings in a 3D world governed by physical laws (e.g., time, space, and gravity). We are predisposed to interact in this environment (i.e., to pay attention to faces, to perceive body language, to desire social interaction) (Kail and Cavanaugh 2000). Humans have enthusiastically adopted 2D digital ecosystems (Boyd 2008), and this trend is continuing with 3D digital ecosystems (3D virtual worlds), which offer the capacity for more natural interaction by recreating our physical world in a virtual environment. Specifically, 3D virtual worlds are unique because they simulate both the visual appearance and functionality of the physical world; and comprise a real community of users who (in some virtual worlds) engage in a virtual economy (using in-world currency that is exchangeable for real-world currency). For instance, Second Life has a vibrant in-world economy, real-estate market (Abrams 2007), and a simulated stock market called SL Capital Exchange. This creates a complex, self-regulating ecosystem comprising autonomous agents (i.e., humans represented by avatars), and means that virtual worlds are more than just simulation technology, they literally are 3D digital ecosystems (3DDEs). Indeed, the virtual world interfaces extend users’ capacity to interact and increase their freedom of expression to explore the gamut of human endeavour, including artistic creation, recreation, social interaction, educational pursuits, collaborative developments (e.g., information systems), and entrepreneurial activities. Furthermore, virtual worlds are an emerging technology that is under continued development. As such, they offer appealing opportunities for social interaction, educational applications, commercial activities (including training, public relations, and marketing, in addition to e-commerce), as well as research and development.

15.2.2 Synopsis of Benefits and Limitations

For organisations engaged in ICT research, development, and commercialisation (e.g., universities and businesses) there are certain benefits and limitations to the use of 3DDEs. In this section, we discuss benefits and limitations of 3DDEs using the well-known 3DDE Second Life as an example.

Benefits of using 3D virtual worlds in research, development, and commercialisation include economic benefits, ICT-system advantages, enhanced collaboration, research productivity, and staying at the forefront of innovation. In Second Life, financial benefits for projects include low start-up costs and the use of micro-payments, with most in-world purchases being small (e.g., < L$10, with an exchange rate of approximately USD$1 to L$260) (Linden Research 2008). Additionally, 3DDEs such as Second Life can enable improved simulation and planning before enacting expensive real-world structures or systems. The flexible simulation capacities enable prototyping and incremental-iterative modelling of physical structures, ICT systems, and business models that would be prohibitively expensive to experiment with in the real world.

ICT-system advantages of Second Life are free Internet-based access with multiple online users being able to experience immersive, simultaneous communication in a user-friendly interface requiring minimal experience (e.g., approx. 10–20 h) for proficiency in navigation and building functions. The “game-like” 3D interface and avatar-interaction is more interesting and intrinsically motivating than 2D software. Furthermore, Second Life provides users with an integrated development tool and a constant stream of user-generated objects.

Collaboration is enhanced within (networked) 3DDEs as all users can simultaneously see system developments as they are implemented. 3DDEs such as Second Life allow immediate application/visualisation of one’s development in context, which expedites iterative system testing and refinement. Furthermore, Second Life facilitates synchronous and asynchronous communication between team members via text, voice, and body language (i.e., emotive facial expressions and body movements). Indeed, the simultaneous work and communication within Second Life promotes a sense of immersion and presence. In the context of project development, this can foster team spirit and aid effective collaboration.

Research productivity is also benefited. In the authors’ own experience and through observing research students, there is a culture of enthused engagement and innovation in the community of users that literally generates the content of the Second Life ecosystem. This creativity spills out of Second Life into Web 2.0 applications such as wikis and blogs, which provide comprehensive user support. By engaging in the development of an emerging technology such as this, work becomes play, and innovative productivity is easily transferred into research projects and publications. Indeed, project students working in Second Life have been invited as guest speakers at conferences and published papers. When the cultures of the Second Life user-community and the academic community combine in encouraging research/development and presentations/publications, then we have seen that this promotes researchers’ engagement and success in a research track.

Importantly, in Second Life, users own the intellectual property rights to their creations (Linden Research 2009a). In short, research productivity is enhanced by the engaging 3DDE and by immersion in a rich culture of ICT innovation amongst the Second Life user-community.

It is perhaps because 3DDEs are an emerging technology that their current limitations relate to both technical and social factors. Technical limitations currently relate to Internet bandwidth requirements and the need for powerful computers (Linden Research 2009b); and the relatively large Internet usage requirements in organisational contexts where usage is metered and charged for. However, in any organisation that is serious about supporting its research, these considerations are no limitation whatsoever. A social factor that limits the benefit gained by research organisations (especially universities) from 3DDEs is that this emerging technology is rapidly evolving, both technologically and socially (Prentice and Sarner 2008; Sarner 2008). For instance, a challenge that universities face is for academics to stay at the forefront of innovation in industry and society generally and for university policy makers to not only remove institutional barriers but to actively promote innovation by changing the structure of institutional ICT service provision. As such, it is pertinent to consider the possibilities that 3DDEs present for future research, development, and commercialisation in information systems.

15.2.3 A Research Commercialisation Case Study

3DDEs offer rich possibilities for research, development, and research commercialisation. This section describes the authors' implementation of a university information systems research, development, and commercialisation project in Second Life. This project has informed our understanding of problems and opportunities regarding 3DDE systems development as discussed below.

A research program regarding Automated Essay Grading (AEG) (Williams 2006; Williams and Dreher 2004) has yielded an AEG program dubbed MarkIT (www.essaygrading.com) that is being commercialised in a joint venture called Blue Wren Software, founded by Bob Williams and Heinz Dreher. In collaboration with Curtin Business School, the Online Automated Assessment Laboratory was established in Second Life on the Australis 4 Learning educational island. Its functions are (a) to promote the use of and benefit from AEG in educational institutions by enabling knowledge transfer and proof of concept (Fig. 15.1), see Dreher et al. (2008), and (b) to complete the AEG process fully online by interfacing a 3D assignment submission box in Second Life (Fig. 15.2) with an external database and AEG program (MarkIT), which presents results (grades and feedback) in Second Life (Fig. 15.3) (Dreher 2006).

An iterative-incremental method was used to develop the Online Automated Assessment Laboratory 3DDE system, which was both ad hoc (outcome oriented) and heuristic (practical and creative). 3DDEs such as Second Life rely on user-generated content to fill or enrich the world; thus, the vast majority of in-world content is ostensibly developed ad hoc. Through reflecting on our experiences developing this 3DDE system (and others before it), we outline below a number of problems with an ad hoc approach that represent opportunities for improvement; see also Reiners (2010) for an overview of additional projects done within the research group manifesting problems such as those described below.

We found that an ad hoc and heuristic approach to developing 3DDE is creative but unpredictable. We noticed that various unplanned developments/innovations added value but also changed the direction of the Online Automated Assessment Laboratory 3DDE system project. This had both advantages (i.e., facilitating the collaborative incorporation of information systems project students, whose innovations augmented the functionality of the system) and disadvantages (i.e., increasing development time and cost). In light of this, a more structured systems development method is required for projects where quality, specificity, and resources are critical (e.g., 3DDE stores or virtual embassies).

Fig. 15.1 Curtin business school automated assessment laboratory in Second Life

Other problems we have experienced while developing 3DDE systems include, not knowing the limits of the 3DDE (e.g., regarding data security with external database interfaces); how to overcome certain problems (e.g., assigning users' external identifiers to their Avatars); whether other 3DDE developers have found resolutions to similar problems; the best design approach (e.g., balancing interface functionality with ease-of-use); and how best to attract users (i.e., public dissemination) and retain users (i.e., forming sustainable relationships and communities). One solution to these problems is a knowledge repository (similar to user support wikis or decision support systems, but for 3DDE systems development). A knowledge repository such as this could enhance quality, timeliness, and budgeting.

While an ad hoc approach is probably the best strategy for users engaging in low-stakes activities (e.g., recreation or small-scale businesses), the more important the outcome of a system (e.g., business and education), the more important it is to have a useful "map" to guide its development. As 3DDEs become more popular platforms

Fig. 15.2 Automated assessment laboratory assignment submission in Second Life

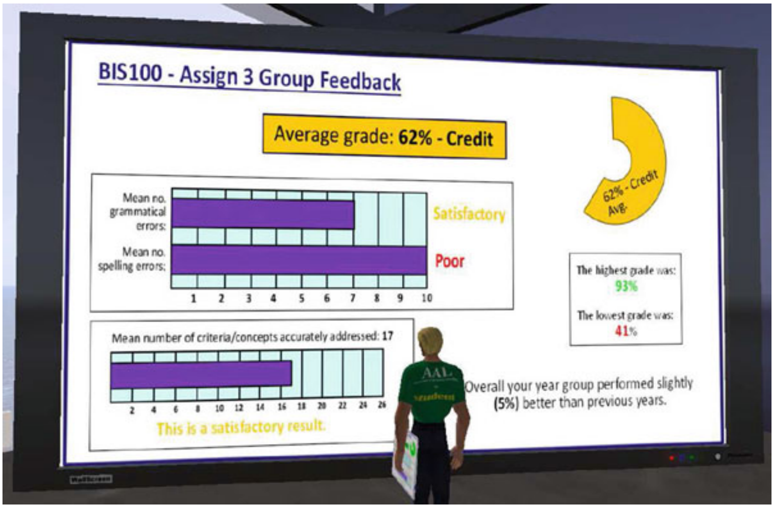


Fig. 15.3 MarkIT interactive feedback

for various human endeavours, 3DDE systems development methodologies will become increasingly important. Therefore, we propose an innovative methodology to support 3DDE systems development that is informed by our above-mentioned experiences and introduced below.

15.3 A Methodology to Support Users in 3D Digital Ecosystems System Development

Presented in this section is a methodology to support users in their development of 3DDE systems, entitled a MEthodology for Avatar-based Development of Systems (MEADS). MEADS is innovative in that it provides a comprehensive conceptual model of factors relevant to 3DDE systems development that comprises both a structural model and a process model. MEADS provides a multidimensional structural model (represented by the MEADS Cube; see Fig. 15.4) that combines a taxonomy of relevant dimensions (considerations) and a decision support system for choosing amongst various software development methods given the system/application's domain (e.g., education or business) and with consideration to roles of various stakeholders. MEADS also provides a process model, which suggests a methodology (i.e., an overall process or meta-method) for the 3DDE systems development life cycle (see Fig. 15.5). The need for and relevance of this conceptual model is outlined below.

Being an emerging technology, 3DDEs are growing in popularity, sophistication, and diversity, and consequently have an increasing emphasis on social aspects rather than technological novelty (Jäkälä and Pekkola 2007). In an increasingly complex "metaverse," it is important for 3DDE users to have a map to navigate the terrain. Having clear guidelines or models to follow can enhance the efficacy of user-generated systems for their intended purpose, whether they be for pleasure (e.g., users' recreational pursuits), for profit (e.g., businesses operating within 3DDEs), for education (i.e., problem-based learning via projects), or for other activities (e.g., governments with 3DDE embassies) (Tapley 2007).

The creation of methods for systems development in 3DDEs is still an emerging field. A number of design methods have been suggested (Dang et al. 2008; Eastgate 2001; Fencott 1999; Gabbard et al. 1999; Molina et al. 2006; Seidel 2010; Seidel et al. 2010; Seo et al. 2001). These designs represent important progress in the field by offering methods that present original elements relevant to 3DDEs (e.g., Molina et al. 2006; Seidel et al. 2010) and can be quite sophisticated, for example, by analysing preconditions and requirements (e.g., Sanchez-Segura et al. 2005). However, no design has emerged as a dominant model. It is our view that a dominant model will maximise practical relevance to users by balancing specificity, parsimony, and flexibility in mapping the emerging terrain of 3DDE systems development. Thus, there is fertile ground for continued innovation.

In light of this, the current approach (MEADS) adds value to this field by integrating a number of important elements into one package that maps the emerging terrain of 3DDE systems development by providing specificity (via the structural model), parsimony (via the process model), and flexibility (via the adaptability and updateability of the structural and process models). More specifically these innovative elements include:

- Providing a meta-method (i.e., a methodology) for choosing amongst system development methods to suit a particular project, given various dimensions such as its application domain (e.g., education, business, government), stakeholder roles, the choice of 3DDE, the 3DDE knowledge required, the 3DDE knowledge available, time required, tools/objects required, and a rating of the relevance of the options within each aforementioned dimension
- Providing a decision support system for rating (and hence ranking) the utility of the various options available for a given project that will include an updatable database of empirical data and user reports that can inform decisions
- Providing project management functionality by allowing estimation of the time required for work items
- Integrating the systems development methodology, decision support system, and project management functionality within an interactive 3D application (implemented across a variety of platforms)
- Providing an overall process (methodology) for the 3DDE systems development life cycle (one that includes unique factors such as the sustainability of an application)

Introduced herein below is the MEADS conceptual model that will guide subsequent systems development and empirical research to refine and implement the interactive 3DDE system.

15.3.1 Methodology for Avatar-Based Development of Systems

In essence, the MEADS *conceptual model* provides both *structure* and *process*. The structural model is a multidimensional taxonomy (represented by an interactive 3D cube, dubbed the MEADS Cube; see Fig. 15.4) that is used to survey the possible options for the structural dimensions. The *process model* is a comprehensive method for negotiating the entire life cycle of 3DDE systems development (i.e., for each stage and stakeholder; see Fig. 15.5). MEADS is oriented towards developing applications/systems within 3DDEs rather than developing the 3D environment itself. Thus, we use the term ‘system’ to refer in general to user-generated processes/structures within 3DDEs and between 3DDEs and the Internet. As such, we are using the term *system* in a broad sense to describe the outcomes of the following activities that are often undertaken in 3DDEs: developing 3D objects comprising functional systems of objects (e.g., a virtual lecture theatre); developing programs to govern the interactions of 3D objects within a 3DDE and their interaction with systems external to the 3DDE (e.g., databases and websites); and designing social systems (e.g., social communities or educational institutions) and economic systems (e.g., businesses) that are facilitated by the aforementioned 3D objects and scripts.

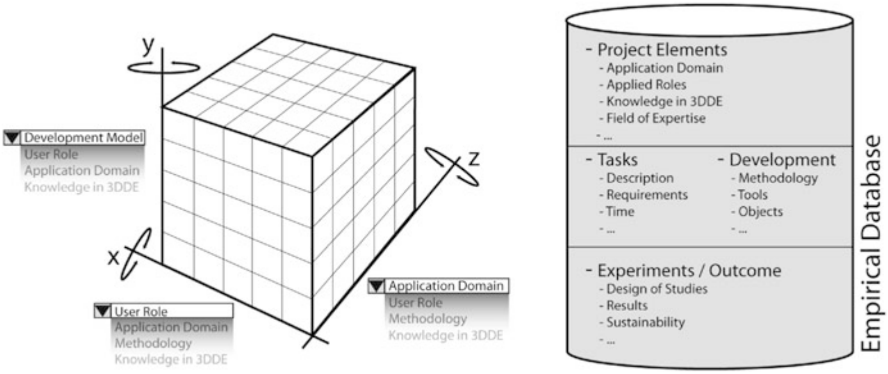


Fig. 15.4 The MEADS multidimensional structural model: the MEADS Cube, a 3D Interactive Interface. *Note. In this figure the MEADS Cube displays three structural dimensions (software development methodology, application domain, and stakeholder roles) that are relevant early in the process. However, the 3D interactive interface enables the comparison of different dimensions against each other in order to provide relevant decision support to stakeholders at each stage throughout the system development life cycle*

A functionally innovative aspect of MEADS is its graphical user interface that is based on the MEADS Cube (see Fig. 15.4). MEADS needs to be independent of any particular 3DDE; thus, we plan to implement it across various platforms, such as web browsers, 3DDEs, and multiple devices (including smart phones). In harmony with the native format of 3DDEs, a cubic structure was chosen to represent the multidimensional nature of MEADS (see Fig. 15.4). The MEADS Cube has three axes (x, y, z) that are used to represent multiple dimensions, which are either categorical (e.g., methods on the *Software Development* dimension) or continuous (e.g., duration estimates on the *Time Required* dimension). Note that intersections of values between dimensions might not be relevant, possible, or populated with values. Therefore, these statuses will be indicated in the MEADS Cube in order to simplify the multidimensional space into a comprehensible and functionally relevant system. We suggest that initially the x and z axes carry the *Stakeholder Roles* and *Application Domain* dimensions, respectively (though each axis can be customised to allow maximum flexibility as the project progresses and other dimensions take primacy). The variety of dimensions include *Systems Development Method*, *3DDE* (a list of known 3DDEs and relevant properties), *Relevance* (a 100-point ranking system to rate the various options in order to facilitate decision making), *3DDE Knowledge Required*, *3DDE Knowledge Repository* (a database of empirical data from studies and use cases), *Time Required* (to facilitate project management planning), and *Tools/Objects Required*.

The avatar-based methodology is designed such that each of the stakeholders involved in the project can engage with MEADS through avatars representing the various stakeholder roles (e.g., user, designer, and tester). Innovatively, this allows one to temporarily adopt a different role (and hence point of view). While the skills required for each domain are specific to a person's vocational history (e.g., programming), temporarily adopting another's point of view can have certain advantages. We anticipate that skilful use of this feature will enhance creative development (through seeing fresh perspectives) and improve team work (through facilitating communication and understanding by allowing stakeholders to virtually step into each others' shoes).

Outlined in the section below are the characteristics of MEADS at each of its six stages (see Fig. 15.5). This *process model* parsimoniously guides stakeholders through the complexity of the various considerations that are important when developing 3DDE systems. The methodology is flexible and includes choice of particular systems development methods to fit a project's characteristics. The methodology comprises Planning (Stage 1), Specification (Stage 2), Software Development (Stage 3), Deployment (Stage 4), Sustainability (Stage 5), and Retirement/Reuse (Stage 6).

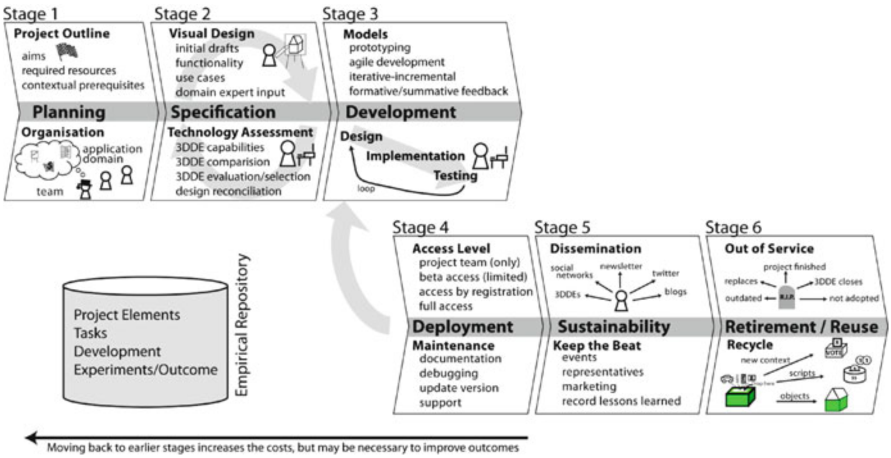


Fig. 15.5 The MEADS process model: a six-stage methodology

15.3.2 The Six Stages of MEADS: An Overview

The six stages of MEADS are outlined below by describing each stage, stating its outcomes or deliverables and providing an example. Additionally this section explicates how the *process model* integrates with the *structural model* (operationalised via the MEADS Cube). It is important to note that each stage comprises two elements, which are illustrated in the top and bottom panels of the graphics that headline each stage herein below.

15.3.2.1 Stage 1

Description: Stage 1, *Planning*, comprises conceptualisation of the project. The two elements of Stage 1 are the *Project Outline* and *Organisation of Application Domain and Team*.

The Project *Outline* element involves outlining the project's general aims and specific goals; required resources (e.g., funding, hardware, and software); and contextual prerequisites (i.e., what preconditions are required for the project development to start, such as obtaining consent from collaborating organisations). This element involves gaining an understanding of the stakeholders' requirements, whether the stakeholders' requirements are possible in general; and whether 3DDEs are the right platform to achieve the requirements.

The *Organisation of Application Domain and Team element* involves specifying what is required and who will do it, by considering the following components: application domain (i.e., the professional field in which the application is situated); knowledge/skills required (i.e., to achieve the project); stakeholder roles (i.e., mapping their relevance to the project); and team composition (i.e., matching project requirements with the required professional skill sets). To enact this stage, dimensions of the *structural model* are employed—the empirical database and the rule-based decision support system (as described in the example below).

Outcomes/Deliverables: Outcomes of this stage include agreement about what the project aims to do; what skills and knowledge are required; and who comprises the development team.

Example: Figure 15.6 illustrates how the *structural model* is used to map different dimensions against each other to support decision making in the *Planning stage*. The top pane visualises the relevance of *Stakeholder Roles* for a given *Application Domain* (here education) rated on a 100-point scale on the *Relevance* dimension. To assist resource planning, the top pane compares the relevance of the design team's roles in terms of the resources required (e.g., time and cost) for an educational project (in this case indicating that in aggregate the programming role will require the most resources, such as time and money). The bottom pane maps the *3DDE Knowledge Required* against the *Stakeholder Role* for the *Application Domain* (i.e., describing the 3DDE knowledge required of the various stakeholders/team members, e.g., in order to assist selection of the best domain expert and designer available for an educational project). The interactivity of the MEADS Cube facilitates (a) navigation (e.g., combination of dimensions); (b) interaction with cells to obtain more information from the MEADS database; and (c) alteration of the data within the MEADS database.

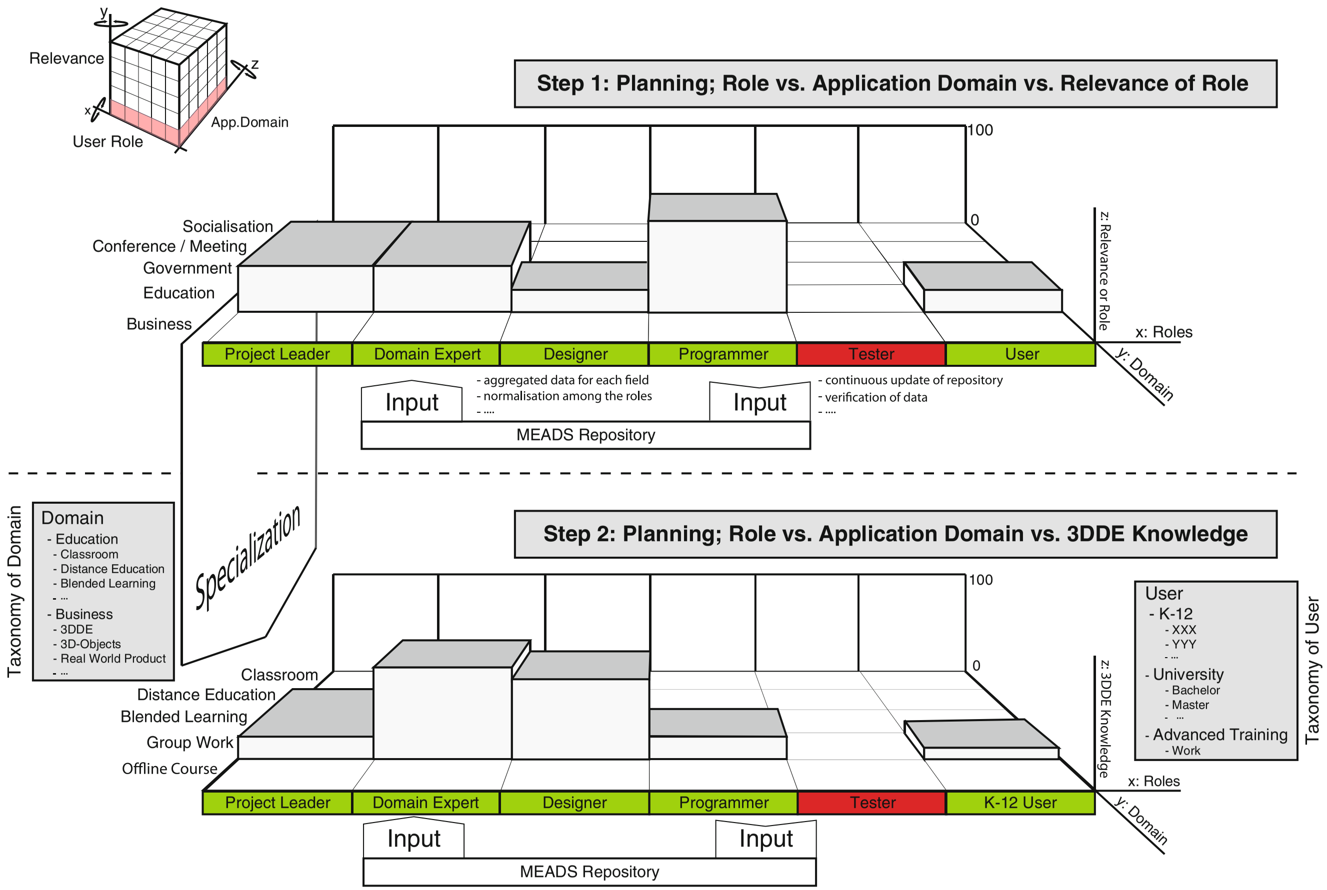
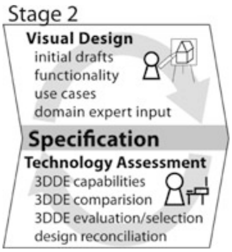


Fig. 15.6 Using the MEADS Cube to map relevance of role (*top pane*) and 3DDE knowledge required (*bottom pane*) against stakeholder role and application domain

15.3.2.2 Stage 2



Description: In Stage 2, *Specification*, project stakeholders and system development experts collaborate to specify the details of the system. This collaborative approach is informed by the Technology Acceptance Model (TAM) (Davis et al. 1989) with respect to factors such as *perceived usefulness* and *perceived ease of use*. It involves selecting the right 3DDE, where the desired design can be realised by the available technology so that users will be able to (a) access the content, (b) achieve their anticipated outcomes, and (c) experience added value compared with traditional (2D) software solutions. The two elements of Stage 2 are *Visual Design* and *Technology Assessment*.

The *Visual Design* element graphically depicts the system. Doing so involves the following components: developing initial drafts of visual appearance (independent of any particular 3DDE to maintain the integrity of the desired design); specifying functionality (from the perspective of developers and users); and gaining domain expert input (i.e., ensuring the visual design and functionality incorporate the domain's particularities in order to check that the desired features are possible with the extant technology in general).

The *Technology Assessment* element determines which is the best 3DDE for the project and is informed by both the MEADS *3DDE Knowledge Repository* and the 3DDE technology expert's knowledge of extant 3DDEs. This element involves the following components: 3DDE capabilities (examining/determining the capabilities of various candidate 3DDEs); 3DDE comparison (a systematic pair-wise comparison of candidate 3DDEs to highlight their characteristics); 3DDE evaluation/selection (having highlighted their characteristics, evaluating the global relevance of each candidate 3DDE using the MEADS *structural model*, and selecting the 3DDE that best matches the project); and design reconciliation (a reciprocal interplay between desired design and technological capabilities where the design is adapted to accommodate the weaknesses and maximise the strengths of the chosen 3DDE).

This last component, design reconciliation, acknowledges that (a) there may be no 3DDE available that provides everything the design requires (i.e., the 3DDE's *weaknesses*) and (b) the chosen 3DDE may present opportunities that were not included in the design (i.e., the 3DDE's *strengths*). Design reconciliation is operationalised via an iterative-incremental process between the design team (e.g., designer and domain expert) and programming team (e.g., programmer and 3DDE technology expert). In Seidel et al. (2010) method, considerations of design and technology are separate processes (Stages 3 and 4, respectively). In our view this is valid in software development but not in 3DDE systems development. Software development (2D design) follows standards based on a relatively limited number of operating systems. In contrast, the numerous extant 3DDEs often do not share common features or functionalities. Hence, in the MEADS *conceptual model*, we take a practical and flexible approach that acknowledges the reciprocal interplay between the desired design and the technological capabilities of extant 3DDEs.

Outcomes/Deliverables: The deliverable produced in this *Specification* stage is a document that specifies all system features and how they will be developed. Whereas Stage 1 (*Planning*) outlined the project (i.e., its aims, goals, required resources, and contextual prerequisites), Stage 2 specifies (and where needed, refines and adapts) the project's components in sufficient detail that even another team would be able to realise the project. This specificity can help improve communication and collaboration between stakeholders.

Example: We illustrate Stage 2 in Fig. 15.7 by using a case study example (i.e., designing an assignment drop box for use in the Online Automated Assessment Laboratory 3DDE system; see Sect. 15.2.3). Figure 15.7 demonstrates the importance of collaboration between stakeholders (here the designer, programmer, and domain expert). The proposed incremental-iterative process involves the designer presenting models, which are evaluated by the other stakeholders according to their expertise. That is, the domain expert verifies the applicability of the model regarding both functionality (e.g., required processes or best-practices) and visual appearance (e.g., domain-specific notation/symbols). Based on the feedback, the model is modified until a solution is achieved by discussion and consensus. To facilitate a solution-focused approach in this process we recommend (a) the use of immediate and constructive feedback between experts and (b) making only a single adjustment for each iteration.

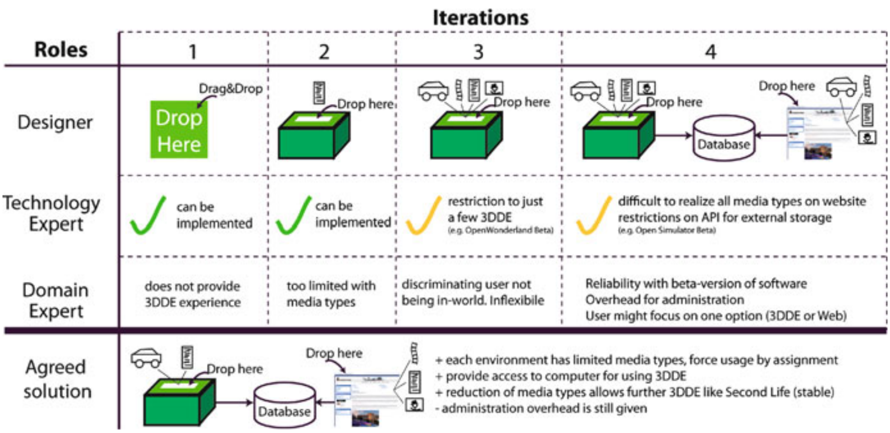
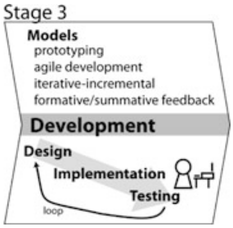


Fig. 15.7 An example demonstrating the iterative process of defining specifications for implementation in a 3DDE. *Note. This figure uses an example (i.e., designing an assignment drop box) from the case study in Sect. 15.2.3 (i.e., the Online Automated Assessment Laboratory 3DDE system). Here, we limit ourselves to a short scenario to describe the interdependences between stakeholders*

15.3.2.3 Stage 3



Description: In Stage 3, *Development*, the planned specifications are actualised in a working system. Whereas Stage 2 specified the 'what,' Stage 3 relates to determining 'how' to develop the system, and then 'doing' so. 3DDEs system development imposes additional considerations than does 2D system development (i.e., relating to the third spatial dimension and the merging of multiple emerging technologies). However, many 3DDE system development activities can be related to traditional (2D) system development approaches (e.g., management of internationally distributed teams that span unique and diverse cultures, professional backgrounds, personalities, and languages). The two elements comprising this stage are *Models* and *Design, Implementation, and Evaluation*.

The first component, *Models*, involves selecting the most useful software development model (or combination of models) to be employed. Each model has its pros and cons, and the best-suited model (or combination) should be chosen for a given 3DDE systems development project. The MEADS Cube (*structural model*) assists this choice by providing information on a range of approaches that are most relevant to developing 3DDEs. These include the waterfall approach (i.e., a structured and formalised progression through stages); prototyping (i.e., quickly developing elements of the system for testing and evaluation); agile software development (i.e., using storyboards to depict sections/stories of the development process that are progressively implemented with immediate feedback); and iterative-incremental development (i.e., facilitating rapid development of versions that are incrementally improved via quick iterations of the design-implementation-evaluation sequence). Across the range of software development models that are available, the use of formative and summative feedback is useful in the implementation process of this stage. Formative feedback focuses the development team and stakeholders on a qualitative evaluation of the system appearance and functionality, whereas summative feedback can be used to quantitatively evaluate the extent to which the current implementation meets the project aims and the system specifications.

The *Design*, *Implementation*, *and Evaluation* element of the *Development* stage involves an iterative loop between these three activities, which are incorporated into the particular system development method(s) chosen. *Design* regards the programmer determining how, in technical specificity, to implement the visual design and functionality. *Implementation* is the process of system building/coding. *Evaluation* involves appraising the appearance and testing the functionality in comparison with the specifications produced in Stage 2.

Outcomes/Deliverables: The deliverable of this stage is a finished product that can be deployed. As in Web 2.0, this might be a beta version that will go through further cycles of improvement.

Example: By way of illustration, Fig. 15.8 shows an excerpt of the MEADS Cube with two tasks mapped against the dimensions of *Stakeholder Roles* and possible *Software Development Models* (with the first choice highlighted in red). The colour of the boxes represents the importance for the role in implementing the task (where green is superior to yellow, which is in turn superior to orange). Selecting a field shows further information regarding specific aspects of the model (as depicted in the magnified panes to the right and left).

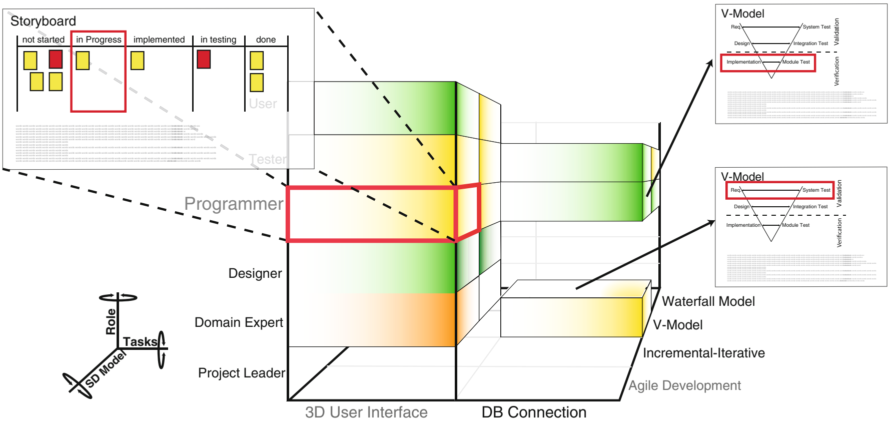
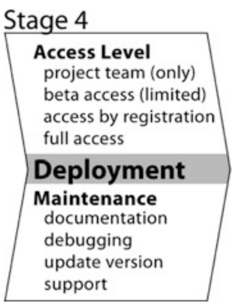


Fig. 15.8 The use of the MEADS Cube in the software development stage

15.3.2.4 Stage 4



Description: Stage 4, *Deployment*, covers the final distribution, use, and maintenance of the software. The deployment strategy can vary with the product and markets/users targeted. The two elements of this stage are *Access Level* and *Maintenance*.

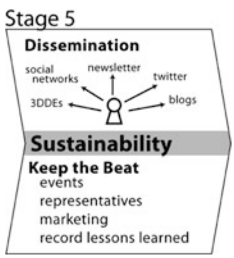
The *Access Level* regards the specification of who is given access to the deployed deliverable. This is an important element to consider in high-stakes projects involving Intellectual Property (IP) rights. Levels of access include the project being: restricted to the project team and/or key stakeholders, accessible to limited sections of the public (e.g., bloggers) in beta versions; and open to the public via registration, or actively promoted to the public in full-release versions (either for free or with fees).

The second element involves *Maintenance* of the system in a functional state. This involves providing access to documentation; debugging; updated versions; and support. 3DDEs are usually deployed online and less frequently shipped as a product; therefore, the use of early deployment and continuous extension works well for a number of reasons. Firstly, 3DDE implementations are very similar to Web 2.0 applications (i.e., regarding understanding, access, and social aspects). Secondly, 3DDEs are hosted on a server, which allows simple and short update cycles. Nevertheless, in contrast to other 3DDE development methodologies (i.e., those cited above in Sect. 15.3.1), we do not believe that deployment alone determines the success of 3DDE projects. We believe that success requires a sound strategy for sustainability (see Stage 5).

Outcomes/Deliverables: The deliverable of this stage is a well-functioning system. Alternatively, a deliverable within this stage can be a well-functioning iteration (e.g., a beta version) that may undergo further refinement via repeating Stage 3. Note that moving from Stage 4 back to Stage 1 or 2 (e.g., to revise a system post-deployment) can be costly in time and money but may be necessary or beneficial (e.g., in cases where the system fails due to technical or acceptance issues).

Example: Integrating users at an early stage helps to build social networks and promotes immersive project affiliation amongst users. Even a beta version with limited functionality can attract interest and expectations, which causes word-of-mouth advertising as well as repeat visits to see upcoming developments. Google's products/services provide a good example of this because they often release a new product/service with limited functionality before extending it later.

15.3.2.5 Stage 5



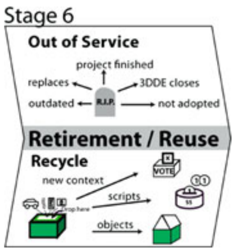
Description: Stage 5, the *Sustainability* of 3DDE systems, goes hand in hand with deployment but extends beyond the concept of system maintenance. Once a 3DDE system is deployed, it needs more than just to be kept functional; it needs to be kept alive socially because social interaction is an integral part of 3DDEs. However many 3DDEs are referred to as *ghost worlds* (Burmester et al. 2008) because other avatars are seldom seen. Ironically, an empty 3D installation can be more boring than a 2D social networking site with no users logged on (e.g., Facebook without friends in the chat room). The two elements of this stage are *Dissemination* and *Keeping the Beat*.

Dissemination involves a sustained level of promotion that is appropriate to the application domain and stakeholders. This may include advertising or promoting discussion on media such as 3DDEs, social networks (Web 2.0 platforms), newsletters, twitter, and blogs. *Keeping the Beat* is another important component for sustainability. Providing social stimulation for users can be achieved in various ways, including hosting events; providing representatives; marketing; integration in everyday (work) life by connecting the 3DDE to their real life (including accessing their desktop applications and documents); and enhancing users' membership with and loyalty to the 3DDE implementation.

Outcomes/Deliverables: The key deliverable of this stage is a plan specifying strategies for how to maintain an active social network of users. The primary outcome is enacting this plan for sustained dissemination and keeping the beat. Collateral outcomes of the process of sustaining a 3DDE system are feedback and refinement. Here, incorporating feedback from users is paramount. Learning from past experiences will help optimise future projects by improving deliverables and avoiding inefficient investments of time, money, and other resources such as reputation. The MEADS *3DDE Knowledge Repository* can function as a catalyst to facilitate the sharing of experiences and resources amongst those comprising the development team and stakeholders. While this process of feedback and refinement relates most closely to the activities comprising this stage, it can extend to all stages in the MEADS *process model*.

Example: Having users frequenting an installation is essential. Facilitating this requires investment of resources by stakeholders (i.e., time and/or money) in order to create and maintain points of attraction. These points of attraction can be regular events, dynamic tasks to be solved in exchange for rewards, giveaways, educational content, representatives, recreational activities (e.g., music or movies), or tools to assist/improve socialising.

15.3.2.6 Stage 6



Description: Finally, Stage 6 regards the *Retirement and/or Reuse* of a 3DDE. A maximally useful model of the 3DDE systems life cycle includes demarcation of the retirement of 3DDE systems out of service and planning for the reuse of both knowledge and resources in future projects. The two elements of this stage are placing a 3DDE *Out of Service* and *Recycling* its components into other systems.

In principle the project manager should define when the project runs *Out of Service* and what happens afterwards. In practice, this is rarely done and 3DDEs are frequently abandoned, which just augments the Ghost World phenomenon described above. Reasons to put a product out of service can include technical, organisational, or user-related factors. Furthermore, software also can outlive its expected lifespan and require upgrading or replacement in order to be compatible with newer software developments or changing social/market factors.

Recycling is an important element of the systems development life cycle. This can relate to the reuse of both scripts and objects and includes consideration of context (e.g., using them in the same or new contexts) and adaptation (e.g., copying the script/object or adapting their specifications to form new components). This could range from periodic reuse of predominantly unaltered systems (e.g., annual conferences) through to reuse via adapting various components. Reusing components can reduce costs or promote creativity (e.g., through novel combination of objects or adaptation of them to form new versions).

Outcomes/Deliverables: Deliverables of this stage are plans for how to retire a system out of service and how to benefit from reusing its elements. Key outcomes of this stage are the acts of retiring a system out of service and reusing its elements.

Example: In our own projects we have found that retirement and/or reuse of project outcomes can happen quite regularly, such as when new versions are released or the system's purpose is no longer required. Regarding our case study of the Online Automated Assessment Laboratory 3DDE system (see Sect. 15.2.3), we found that reuse started even during the development stage, where certain components were shared with other projects (e.g., the drop box and a presentation desk). In another use case that regarded a university course in supply chain management (Burmester et al. 2008), we had to disassemble a container terminal simulation in Second Life. All parts with potential reuse were sorted, classified, and archived by focusing on the kind of part (i.e., script, model, or texture) and their generic affordances in other contexts. This has provided us with a collection of artefacts that are available to decrease the development time of other projects (e.g., by being able to reuse dependable items). Indeed we have since reused a number of these container terminal artefacts, including reusing container objects at different locations as buildings; recycling scripts for controlling cranes into forklifts; and reusing slide presentation technology in other lecture halls. Having outlined the six stages of the MEADS *process model*, we turn now to the discussion of the proposed applications and benefits of MEADS.

15.3.3 Proposed Applications and Benefits of MEADS

This section discusses the ways we envisage that people can use and benefit from MEADS in a practical fashion and with realistic expectations. In the development of MEADS, we synthesised theoretical knowledge (of information systems and systems development) with practical experience (from various 3DDE projects). We focussed on developing a model that is universal, domain-general, and applicable. Herein below we make practical recommendations for how people might best benefit from MEADS because skilful use of any tool involves knowing when to use it and to what extent, for example, by making no use, partial use, or extensive use of MEADS.

Firstly (regarding no use), it is our view that no particular systems development model is needed in small-scale and/or low-risk projects (e.g., recreational users developing systems for entertainment or aspiring entrepreneurs experimenting with small-scale sandbox developments). Our opinion is in line with research suggesting that even some professional developers do not follow systems development models and prefer a heuristic approach or find more benefit from adapting systems development methods for each project (Mathiassen and Purao 2002; Päivärinta et al. 2010).

Secondly (regarding partial use), the MEADS *process model* is parsimonious and when used as a methodology alone it can support project experts in adapting systems development methods for each project. However, when used alone it is not specific enough to successfully guide all stakeholders from different domains towards a common outcome within requirements for scope, time, and cost (i.e., when collaboration is required). Indeed, even expert 3DDE developers can find that it is difficult to provide accurate estimates of time, cost, and functionality because (a) of the wide range of 3DDEs and (b) 3DDEs are a highly dynamic emerging technology (i.e., with new developments comprising both platforms and content).

Thirdly (regarding extensive use), the combined use of the MEADS *process* and *structural models* provides an optimal blend of parsimony, specificity, and flexibility/adaptability. This is most useful when projects have high importance, cost, and/or complexity (especially those involving collaborative teams). In order to help make application of the *process model* be maximally adaptable to specific projects, we plan to populate the *structural model* with empirical data from completed projects (referred to as the *3DDE Knowledge Repository*). The pooled data of many projects will help to refine estimates for subsequent projects. To help make this data accessible, the MEADS Cube (*structural model*) distinguishes multiple dimensions (i.e., categories of data that inform important distinctions for 3DDEs).

In order to make these data maximally accessible, it is important that the data are aligned with the project metadata, which are part of the structural model's ontologies that map dimensions relevant to 3DDEs. These include the application domain (e.g., education, business, and recreation) and the stakeholders involved (i.e., their roles, knowledge, skills, and experience). For each project contributing to the MEADS database (*3DDE Knowledge Repository*), the collected data will summarise factors such as who was involved; what was required; what was accomplished; what process model was used; what tools, objects, and scripts were used; what it cost; how long it took; what the quality of the outcome was; and how long it was sustained for.

Users will be able to mine these data, by navigating the MEADS Cube (*structural model*) according to the given parameters (e.g., application domain and stakeholders involved). This will support the decision-making process and can help to estimate the success of the overall project. For example, the project leader (and/or other team members) could specify relevant parameters (e.g., the application domain of education and the desired outcome as being an interactive lecture theatre). These queried data could then be used to estimate the development time and cost based on information from similar previous projects in the database. Additionally, reusable components like objects or scripts will be provided to help reduce the project's duration and increase the quality of the outcome.

Project management is an important aspect of ensuring that systems are developed to specification, within budget, and within time. Projects fail or encounter resource problems when goals exceed capabilities. Further challenges arise when trying to predict unknown factors that are inherent in working with emerging technologies such as 3DDEs (e.g., technical aspects of development and social aspects of user acceptance). Defining a minimum set of requirements for each stage of development lowers the risk of failure, but without prior knowledge/experience from use cases every estimate incurs a high degree of uncertainty. Here, MEADS can provide a valuable empirical database (i.e., the *3DDE Knowledge Repository*) to help stakeholders make accurate estimates of resources required (e.g., regarding duration, knowledge, money, hardware, and software). Thus, while the MEADS *process model* provides a useful temporal structure, the MEADS Cube (*structural model*) will provide a valuable data structure when populated with data from diverse use cases. However, the real value of this will depend on the quality of the data gathered.

From a socio-technological perspective, the quality of projects can be greatly enhanced by the powerful leverage that is provided by an open-source, collaborative, community-based approach to projects (e.g., Wikipedia). Thus, in order to develop the MEADS database, we aim to stimulate a community project that provides open access in order to share experiences amongst all users. For commercial projects, data security can be facilitated by either (a) publishing aggregated data rather than complete datasets or (b) using local databases for internal projects with in-house teams. Note that this flexibility regarding data security acknowledges the importance of research commercialisation for innovation.

15.4 The Future for Innovative 3DDE Research, Development, and Commercialisation

The continued growth of high connectivity computing in society and business will likely force ICT research-oriented institutions to keep pace with socio-technological advances lest they become increasingly irrelevant to community life and industry (Kozma 2003). This is particularly relevant to universities, which need to stay at the forefront of research to gain funding from the government and competitive grants and attract students in order to viably function as a commercial entity. If staying at the forefront of innovative ICT development is a priority, then it is certainly important to study current trends and to prepare for a range of possibilities (e.g., by upgrading hardware and "up-skilling" staff in industry-relevant skills). Consequently, the final section of this chapter regards emerging, possible, and desirable advances in ICT and information systems research and development. Current innovations in 3DDEs that are only beginning to be implemented include pedagogical applications such as smart lecture theatres and classrooms that function as educational support systems by linking the real and Virtual Worlds to facilitate blended learning and distance learning and new technology to improve the immersive experience (e.g., 3D mice, Nintendo Wii balance board and Wii remote, stereoscopic 3D glasses, and smart phones).

The use of such devices could promote more interaction between real and virtual environments and benefit interaction in classrooms in pedagogical contexts; systems development teams in research and development contexts; and employees and trainers in vocational training applications. For example, the use of wireless/mobile technology could allow educators and students to be mobile around the classroom while connected to 3DDEs by using various output devices (e.g., projector/lecture screens and "virtual-reality-goggles") and various innovative (3D) input devices. The advent of mobile phones that sense hand-held motion (via accelerometers) and geographic location (via global positioning satellites) presents intriguing possibilities for facilitating in-world navigation through movements in the real world, especially when combined with virtual reality headsets with stereoscopic (3D) vision. Such developments are the future of human space computing. In this vein, a rich field for development is education and training through simulations and games.

Educational games are a rich and largely untapped market. Their applications are as relevant to businesses for vocational training as they are to educational institutions. The video game industry is a booming and profitable market (Wolf 2008). Game users frequently report that computer games are highly motivating (Papastergiou 2009; Vorderer et al. 2003), which is an element often missing in modern educational contexts. Games also offer unique opportunities to learn skills. The development of educational simulations and games can be used to provide structured reinforcement to develop useful skills (e.g., critical/creative thinking). Second Life is a useful candidate for such developments due to its accessibility and flexibility. These game-like applications in Second Life could perform a number of functions, including teaching content (as per standard educational settings); developing skills (i.e., through constructivist learning principals, as in project units); and assessing performance for academic assessment (formatively or summatively).

Educational outcomes of these game-like applications could include (a) teaching in-world 3DDE skills such as navigation, programming, social interaction (acculturation), building objects ("primitives" and "sculpties"), and programming languages; (b) teaching creative and analytical thinking; (c) developing cognitive executive functions (i.e., attentional control, sustained attention, attention switching); (d) teaching goal setting and emotional intelligence skills, such as conflict resolution skills and delayed gratification because emotional intelligence skills predict real-world success (Goleman et al. 2002); (e) teaching pro-social online cultural norms and ethical values (using avatars to personalise the usually depersonalised online contexts); (f) teaching and developing project management skills; and (g) teaching and developing entrepreneurial skills through establishing actual businesses in Second Life interfacing the real-world via the World Wide Web. In short, the development of educational games offers rich pedagogical and financial benefits for educational institutions and commercial organisations alike.

Such domain-specific projects require skilled development and careful project management to optimise quality, time, and cost. Technology is a tool that must be developed and applied skilfully to yield the desired benefits. Deficits in these factors may cause suboptimal or detrimental outcomes (for developers and stakeholders alike). Importantly, experts in one field (e.g., systems development) may not have the requisite expertise in other project-critical fields (e.g., education or marketing). Thus, systems development teams are required, and following a methodology to promote effective teamwork is important in order to share experts' knowledge and integrate their practical skills. The methodology that we propose, MEADS, covers the critical factors specific to 3DDE systems development by innovatively integrating both *structure* (a taxonomy of knowledge in dimensions relevant to 3DDEs) and *process* (a methodology to guide the complete 3DDE systems development life cycle).

In summary, there is great potential inherent in the use of 3DDEs for information systems technology research, development, and commercialisation. Such developments will keep pace with the digital-native culture of younger generations and have the potential to innovatively revolutionise our social systems that relate to governance, education, commerce, and social interaction. Digital ecosystems, 3DDEs in particular, are set to lead the charge in our modern culture of accelerating innovation.

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Biographies

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Carl Dreher holds a PhD in Psychology, a Masters in Clinical Psychology, and a Graduate Certificate in Research Commercialisation. Inter alia, Dr. Dreher enjoys conducting research regarding mindfulness-based interventions in health care and emerging technologies in Information Systems. He is a 'digital native' who finds emerging socio-technological developments to be an excitingly innovative confluence between people and technology. Based on his own empirical observations, he has been known to claim that "smart phones are about just as much fun as you can have while being alone."

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Torsten Reiners is Senior Lecturer in Logistics at Curtin University in Perth, Australia. His research and teaching experiences are in the areas of operations research (meta-heuristics/simulations models for container terminals), fleet logistics, information systems, and several topics in eLearning and software development. His PhD-thesis Simulation and OR with SmartFrame demonstrated concepts for didactical models. Besides scientific publications, he conducts research in semantic networks to improve cross-border communication, (e)learning, and machine translation. Dr Reiner's interests also include virtual worlds and their interconnectivity/exchange without barriers. This research includes the development of adaptive systems, automatic processing, analysis, and evaluation of documents, innovative platforms in combination with emerging technologies like mobile devices. Torsten Reiners is co-founder of the Second Life Island University of Hamburg and Students@work, an initiative to promote education in Web 3D as well as the value of students' work.

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