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University of Hamburg in 3D: Lesson Learned

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Abstract: Virtual worlds are difficult to classify. On the one hand, they caused one of the biggest hypes in the last years and were seen as the solution to push social networking and collaboration to a new level. On the other hand, the run for virtual land and designing the most impressive installation slowed down quickly and people got unconfident about the benefits. Even though many companies withdraw from virtuality, the number of worlds grew and many (research) institutes started to populate one of the largest playgrounds. In this contribution, we are going to share our experiences, but also claim the need for a sophisticated methodology to support development projects, increase the security, protect the property, close the gap between the worlds, and create a common database of knowledge and experience for other to read about *lessons learned* in (successful and failed) projects.
All projects done on the *University of Hamburg* Island in Second Life would span beyond the page limitation. Thus, this contribution can be seen as a movie trailer: Receiving an overview of the student projects with references to publications with more details. In this spirit, grab the popcorn, lean back, and enjoy the reading.

Keywords: 3D Digital Ecosystems, Education, Student Projects, Virtual World

Introduction

In 2007, we were pushed into the virtuality more by accident than having great plans to take advantage of the technology or even change the way education could be. And according to many reports, blogs, or publications around that time, we were not the only one who got caught unexpected by the wave of Second Life and all other rising worlds. First, the fun part dominated and the discovery of new developments in and around virtual worlds (aka 3D Digital Ecosystems (3DDE)) lead to great, but mainly uncoordinated ideas with generally no (or at least not much) concept or methodology behind it. Numerous companies, organizations, universities, or private people created installations of either real world replicas or designs that could be done nowhere else; sometimes without realizing that the bubble about 3DDE could burst, as it happened with Web 2.0 [3]. In particular, if sustainability was not considered as part of the overall concept. The growth during the first years was immense but left behind the required *customers* to fill the many locations; to make it a lively place. Paired with common scandals, the hype caused a delusion [14] and it got quieter about SL. Involvement and investment became a risky mission and many turned their back towards the former, and still, successful technologies like Web 2.0, Social Networks, or Mobile Computing [3].

Did 3DDE fail and have to be considered dead? The answer is probably yes and no. Without diving to deep into this discussion, we believe that the time of the hype was an important lesson to learn; i.e. about what is working and what is not. And taking a look back, we shall notice that the (Internet) community was not ready yet to add *depth* as another dimension to the Web. First, we locked many users out as the hardware requirements (i.e., bandwidth and computational power) overstrained their *window to the virtuality* []; second we overestimated the navigation and interaction in 3DDE, and third, forgot about added values that would attract and keep the general users in-world. No doubt, there are great scenarios [1, 12, 32, 33]. But same with web-sites: if there is no progress, why should I bother to come back; even if it looks perfect.

What is the paper about? The title spoils the content as the paper is basically about the work done on the *University of Hamburg Island*: A brief revue of projects and lived experiences. Nevertheless, the second part covers the findings or lesson learned and promotes research projects we engaged to increase the value of 3DDE and support future development. Especially the latter one is addressing the community and their contribution to create a source for future projects and providing sustainability for 3DDE. Section 1 covers the background on the *University of Hamburg Island* and how 3DDE provide opportunities to involve students; i.e. performing (international) research projects and collaborations (Section 2). Section 3 presents current approaches on methodologies for 3DDE for target-oriented development, and discusses, in our opinion, the most crucial needs for successful 3DDE development. The paper is concluded with an outlook and our expectations in Section 4.

1. Projects on the University of Hamburg Island

29th April 2008 marks the officially opening day of the island in Second Life, but the first steps in virtuality were done almost a year before that on the *Campus Hamburg Island*: A group of students, researchers, and most amazing, private people started their first project: visualization of a container terminal and its processes.[9] Over the period of the next two years, the idea of virtuality was integrated in the classroom, but extended beyond Second Life, which had too many limits regarding the inclusion of the real world. Other investigated worlds included Project Wonderland (called Open Wonderland [22] after Sun was bought by Oracle, who stopped further support for the Open Source project) and Open Simulator [23]. In addition, the projects resulted in spin-offs on the iPhone. The main projects are given in Table 1. And with all respect for other projects worldwide, even a small coverage would "blast" the page limitation, so that we have to restrict ourselves in that matter.

Project Name	Realization by	Lit.	Short Description
Container Terminal	T.Reiners, S.Wriedt F.Burmester	[2] [35]	First project demonstrating the processes on a container terminal with focus on the waterside.
Queue Simulation	M.Ebeling	[35]	Simulation of a pharmacy queue, where the user can set various parameters like kind of queue, customer arrival, or number of pharmacists.
Supply Chain Simulation	S.Wriedt	[35]	Interactive teaching scenario for the bull-whip-effect using the container terminal as supplier and the pharmacy as customer.
3DDE-Lecture	T.Reiners	[6] [13]	Lecture with international guest speakers and demonstration of production and logistics locations in Second Life. The course combined classroom and distance education as both reality and virtuality was projected in both worlds.
Bottle Factory	A. Erlenkötter H.Miu, F.Sommer C.-M.Kühnlenz	[9]	Student project about a production unit for a soda drink to demonstrate processes in lectures and to learn about requirements for designing production equipment.
Interactive Classroom	T.Reiners C.Dreher N.Dreher H.Dreher S.Gregory, B.Tynan	[6] [30] [13]	The joint project with the Curtin University was about transferring software development into Second Life, where the students learn the whole software development cycle. The results are shown on the *Australis 4 Learning* Island.
Business Departement	T.Reiners, S.Wriedt	-	Providing a space for institutes in the department
ePUSH	A.Hebbel-Segger C.Kuhlenkampff	[8]	The virtual world part of the project was about creating a seminar room, whereas the main technological development consisted of a holodeck implementation, where scenarios (e.g., arrangement of chairs/desks, objects) can be switched

[9] Note that the installation had to be abandoned due to space limitations.

			through a panel.
Graffiti (OpenWonderland)	S.Büttner M.Naumann L.Visser	[26]	Interactive pin-board in Project Wonderland which is accessible and synchronized from other media devices (iPhone), web-sites, and worlds (Second Life).
3D WII-Remote Input*	S.Leder	[26]	Extending the Wii-Remote input by J.C. Lee [19] to the third dimension and transferring the input to multiple worlds at the same time.
Avatar Tracking/Reporting*	Johannes Siep	-	Reports about movements, position, and actions of avatars on a web-site.
Interactive 3D Catalog*	C.Kuhlenkampff M.Wolter B.Altmann A.Wolter, R.Lindow	-	Designing and building an interactive catalog for 3D objects including a web-based repository. Later applications are, e.g., shopping support for stores like IKEA or a portable repository of all objects someone owns.
Harassment Simulator	J.Sponholz E.Born	[28]	Role play inhabits a viral role for virtual worlds. This project demonstrated how a simulator for harassment at the workplace could be realized.
Virtual Navigation	C.Miu	-	Using the IPhone to navigate through building; i.e. projecting information about locations on the camera and/or virtual representation of the building.
Automated Assessment Lab*	C.Dreher H.Dreher T.Reiners	[27]	For the interactive classroom and to demonstrate an automated essay grading software, we set up a lab including an advanced classroom, interactive posters, and a drop box for assignments.
Object Security Framework	T.Reiners S.Wriedt A.Rea	[25]	Introduce a feasible concept of object security. The proposed framework protects property and presents a methodology for exchanging objects across multiple 3DDE.

Table 1: List of projects done on the *University of Hamburg Island* in Second Life. The references show already published papers, others (marked with *) are currently prepared and close to be submitted to conferences and journals.

2. (Student) Projects to Cross Worlds: Summary and Lesson Learned

The initial motive, after deciding to have projects in 3DDE in the first place, was about creating a place for educational projects for students done by students. Therefore, projects were only started when either students took the lead (not necessarily providing the initial idea) or the project was in favor for teaching; i.e. designing classrooms and creating drop boxes to submit assignments. With respect to the paper length, we depict features to highlight the core aspects of projects rather than describing one or two projects in full details; see also references in Table 1.

Student Dreams Come True: All projects have one thing in common: No limits. We suggested subjects, but wanted students to decide on *what* to implement *how* in *which* environment. The *no guidance approach* for the first stage was challenging; i.e. considering their little knowledge in this area. The projects were open for students with major in, i.e., Business Administration, Information Systems, Engineering, Computer Science, Law, and Psychology; implying a broad variety of knowledge but not necessarily in programming, construction, or design. Nevertheless, we received a positive feedback from all students; i.e. addressing 1) the (motivating) game-like environment; 2) the inspiring freedom; 3) the publicity which encouraged the students to perfect their outcome as everyone is able to see and judge, and; 4) the opportunities of using innovative technology. In comparison to a classroom lecture (presenting and discussing slides), we experienced that students are far more interested in looking deeper into a subject to cover practical and theoretical concerns (kind of comparable to science fairs) and spend in average more hours than we expected and asked for. Note that the extra hours were used to improve the outcome (and not dealing with problems or class requirements).

Most students started with an introductionary course about 1) what are 3DDE; 2) what can be done in 3DDE, and; 3) what did other do in 3DDE. Especially invited speaker from around the world encouraged students to accept the new technology and apply it to some of their ideas. While we suggested SL, some verified suitability of different 3DDE first and chose the one matching best their requirements; a step strongly encourage by us to lower given barriers. We were surprised that students accepted the challenge as there was basically no experiences how it would turn out with respect to grades (which is a major issue for students) and workload. Obviously, not all went smooth, but compared to other software projects we had in the past (Java, C++, proprietary software), the number of complaints about, e.g., usability, learning curve, problems, or invested time was far below our expectations.

The project *Bottle Factory* is a good example to demonstrate the motivational aspect of 3DDE. Here, the students (major in Information Systems) had to design a production line for a *real* product; considering restrictions like space for the machines, access for maintenance, and coverage of all production steps. For the product, real-world companies were contacted by students; they analyzed different designs for machine settings; learned programming; and reviewed literature; and all with more commitment than anticipated from a group of four students. The outcome reflects all technical aspects of the production and is even now a point of interest for other students. The project *Harassment Simulator* [28] was inspired by the fact that students had to perform real-life role play but could not identify truly with their played roles. Therefore, the experiments were transferred to SL using the avatar in a mock-up office with different stations to walk through. Notable is that the experimental results are compared to existing case studies; accessible online together with a theoretical report on the subject. Compared to the other project, the user of the installation takes an active role and is in the focus of the experiment. It allows student to experience certain scenarios by themselves to learn about it, whereas further consolidation still requires communication with experts.

In summary, the given freedom on the subject in an unknown but rich (3D) environment turned out to be the key factor for above average results. Instead of following straight paths to the results according to their assignment, they could experiment with ideas and create something, which would be later (and during the development) accessible to the public (and not archived as most student projects). The visibility also supported collaboration and team work as meetings happened online. Furthermore, projects in SL turned out to be more equitably than offline projects as implementations (creator of objects) as well as online time can be logged for each student.

Crossing Worlds: Unfortunately, SL also reveals additional barriers. Students experienced a lock-in feeling as a result of restricted media integration and reduced connectivity to the outside world. Furthermore, the claimed immersion is difficult to achieve if keyboard and mouse has to be used for inputs. In some projects, we took a look around the corner to find answers to some pertinent questions, such as: (1) what are the alternatives to SL providing similar or additional features; (2) how can we increase students' connectivity and reduce the gap between the real and virtual world; (3) how can we increase the immersive feeling? The 3D-Wii-Remote project [26] provided an immersive control to interact with the 3DDE, whereas the Graffiti-Wall synchronized interaction across different worlds and devices [26]. Graffiti is about different media objects (e.g., images and notes) being placed on a virtual wall; including further operations like annotation or moving. All environments are synchronized; every change is immediately visible on all outlets. As all devices have different means of input (avatars in 3DDE, touch screen on mobile devices, mouse on Web-sites), the student learned about user interfaces and how to display and handle data objects; and Technology Acceptance Models.

Over the last three years, we learned that students require a large variety of (unique) projects. In addition, we observed the interest of students in emerging technologies, e.g., mobile computing and Web 3D. Therefore, we had to broaden our interest and in addition to 3DDE, consider related fields. According to feedback from students about their interest, it got more important that there are no dependencies to a specific 3DDE, not having to be online to work on the project, or having to use (proprietary and large) development environments; in short, having even more flexibility and freedom than any 3DDE can provide. This change was in our interest, as we could define integrated projects; e.g. a 3D catalog, where a mobile device is used as a portable object repository, a server to store and exchange all objects and a 3DDE to use the objects; e.g. classroom or game.

The world became an Open Point: The islands *University of Hamburg* and *Australis 4 Learning* are neighbors. It takes just one click to move the avatar from one to the other island. And 3DDE supports (international) collaboration by providing tools to work in the same space at the same time; e.g. an immersive audio system and synchronized visualization of media. We initiated various collaborations, some over a short period of time like guest speakers, others to realize larger project as we have done with *Australis 4 Learning* – shared island of *Curtin University, Perth*, *University of New England, Armidale*, and *Australian Catholic University, Sydney* [5, 6, 13, 27, 30] – and individuals like Alan Rea (*Haworth College of Business, Western Michigan University, United States*) about object security [25]. 3DDE is going beyond the often cited *flat world*, but eliminates distance completely; allowing students and researchers to be alike and meet without barriers. While social networks are great for asynchronous communication, 3DDE are about getting together to communicate and collaborate in real time.

3. Methodology, Security, Freedom

3D Digital Ecosystems represent important (and still emerging) markets with great expectations for the future; i.e. according to studies by Gartner [10, 14]. The hype had an exponential effect on attracting stakeholders to participate; even without concepts, ideas, or capabilities to realize a product with unique features. Nevertheless, our experiences in the projects as well as various interviews with expert indicate that given 3DDE (providing the required freedom for creating unique scenarios) are still in development or create limiting barriers. While we did not perform a thorough analysis of all existing 3DDE but limited ourselves to the most common in education and research, we were still able to identify three major concerns: Methodology, Security, and Freedom. Here we are able to outline the subject, but have to refer to other outlets for further reading.

Support for Developers and Stakeholders: 3DDE and the Web are not so far apart: if it is not done right, it will not attract interest; unless users are required to use it. Outstanding installations (e.g., [34, 12]) are accompanied by numerous other projects which do not receive the same perception. Even though projects might fulfill their intention, they probably could receive a higher impact by following a specific methodology for 3DDE and including domain experts and knowledge about 3DDE. Note that this is especially the case where 3DDE distracts from the content instead of adding value to it. In the aftermath of the SL hype, it is possible to identify projects that started experimental but later embedded a strategy to increase the outcome. Several methodologies for, e.g., development, evaluation, or learning have been suggested [7, 11, 15, 21, 31] but so far no (holistic) solution achieved an impact being comparable to, e.g., classic software development models like Waterfall or Agile Developing. Our experiences over all projects exposed the similarity to software development, but with further requirements to cover the social rather than technological aspects [18, 24], reflect on the application domain, and take provisions for 3DDE sustainability. It is crucial to cover important dimensions (e.g., stakeholder, application domain, system development method, required 3DDE features, or 3DDE knowledge) and processes for the 3DDE development lifecycle.

Thus, we initiated projects to 1) consolidate the accumulated Know-How of 3DDE projects in a database, 2) build a platform for accessing and intersecting the database (*structural model*), and 3) derive a *process model* for the whole project; from the first sketch to the retirement and reuse of the implementation; called Methodology for Avatar-based Development of Systems (MEADS) [5]. In a nutshell, the so far identified key to success lies in a project team with experts in their fields (compared to having a stage of getting known to, e.g., the 3DDE or programming language), clear aims/goals to achieve within the project (defined *before* choosing the 3D environment), coordination of specifications (i.e., technical and design), selection of the *best* 3D environment (via pair-wise comparison of weighted features), implementation (using classical systems development models), deployment (e.g., the final product or step-by-step as done with Web 2.0 (beta status) products), sustainability (i.e., *keeping the beat* to prevent ghost installations), and retirement and reuse. For all stages, references from a knowledge database are used to support stakeholders in receiving suggestions and finding decisions. The database is used to keep information about finished projects; e.g., application domain, stakeholders, their involvement and 3DDE knowledge, tasks, durations, required resources (workload, money, hardware, software), and 3DDE features.

Security, Encryption, and Inter-Worlds Transfer: Without doubt, the user has a special relationship with his avatar. But even though the gain in value through experiences (i.e., in World of Warcraft) [4], it is also highly influenced by the owned objects (i.e., property); the true building block of virtual worlds [16]. Users have large investments (this can be time as well as virtual and real money) to create, buy, or upgrade objects. Unfortunately, these objects are limited to the originating world and can seldom transferred to either (external) repositories or other worlds; i.e., if the world is operated by companies with the need to make revenue. In this context, security can be seen from two perspectives: Loss of objects and (unauthorized) access by others. If objects are restricted to just one world on external servers (and interoperability or inter-world exchange is not provided), it becomes necessary to assume scenarios where the world is not online (e.g., no user can login to use objects or create financial transfers), closed for good (with all objects being lost), or most potential customers migrate to another 3DDE (such that investments might not produce revenue). Securing objects against unauthorized access is a vulnerable facet and particularly important if 3DDE have open access. In Second Life, object privileges cover modify, copy, resell [20], but even visibility (an important characteristic for research projects and prototype development) can only be controlled by modifying access to the island but not the object; which other 3DDE provide by default.

Research centering on object security in multi 3DDE is still quite undeveloped. Securing objects in single environments is mainly done through restricting access by authentication and access control lists, while the transfer of objects is mainly centered on discussion about standards [17]. Industry to date is interested more in protecting music and movies, instead of 3D objects in 3DDE. The technology to protect objects is discussed in numerous publications (e.g., watermarking, encryption, and signatures) but not yet adopted to 3DDE. In-world, most 3DDE take precautions, but in case of allowed exports, we have to guarantee, for example, uniqueness, maximum count, or unsophistication. In [25], we describe our current research on the architecture GOMS (Global Object Management System) which incorporates well-known and approved standards to create a secure and trusted environment stretching over multiple 3DDE.

Escape the Prison: The next important step, already part of research and alliances (Open Grid), is to connect worlds and allow (almost) unrestricted exchange of objects and accessibility to all worlds using just one avatar. We covered this subject in [25], but also extend the freedom in other projects, where mobile devices (iPhone) or multiple worlds [26] are used. Here, the major limitation was not the object itself (being mainly a collection of nodes, edges, and surfaces), but included functionality in given programming languages. While constructive details of the object can be automatically transferred in any other format, this is not possible for functionality. Besides keeping multiple implementations of each function within the object [25], we analyze the option to call server-based modules returning the computational results. This would allow for one implementation for all worlds rather than one for each world. Instead of feeling trapped, we do see the next step in the smooth integration into the Web (2.0/3D) to eliminate media breaks and increase acceptance.

4. Conclusion

Is our story worth sharing? Did we achieve more than others? Are these important questions to be answered? Even if the answer to all questions is *no*, we want to go ahead and put our knowledge, our experiences, and our work on the table. Not necessarily to be judged, but to provide input for the claimed knowledge repository we intent to build. We hope that the lesson we learned from out projects will support future projects to be successful and do not fail just because there were known issues not being considered; leading to the abovementioned knowledge repository containing aggregated information from projects in all (virtual) worlds, covering all domains, and all users [5].

Based on discussions with stakeholders (domain experts, technical developers) around the world and our own experiences, we identified important fields for research and development to improve the status of 3DDE in the society. In short: object security, inter-world transfer (objects and avatars), interoperability (with other worlds, software, and web-sites), merging 3DDE with reality (augmented reality), and sharing experiences are crucial to push 3DDE out of the shadow back on the stage. And to conclude the paper: All initiated projects entered unknown terrain, but turned out to be a success; either in the classroom or self-studies of student. We conducted international courses, had student run simulation and could simplify blended learning and presentation of processes. However, and this might be the current drawback of 3DDE, the success was only given if actively promoted, supported, and maintained. And our motivation for MEADS.

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