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Application Scenarios of Interactive Science Fiction Prototyping in Virtual Worlds for Education

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Abstract

This article discusses the potentials of 3D virtual worlds as tool for science fiction prototyping in education. Science fiction prototyping has become an important resource for creating, discussing, and assessing the impact of future scenarios. Introducing this creative process into education and training can help students understand societal and contextual implications of future technologies, scenarios, and environments. We discuss traditional SFP processes, such as story-writing, movies, or computer games that require different talents from their creators. Based on our findings we will introduce 'Interactive Science Fiction Prototyping (ISFP)' as a simplified creation approach in virtual world environments. ISFP enables students to create to reflect on science fiction scenarios in an interactive and collaborative way. As an example of ISFP a science fiction prototype of a future city was created and discussed in the virtual world framework Open Wonderland.

Keywords: Science Fiction Prototyping, Virtual Worlds, Open Wonderland, Interactive Science Fiction Prototyping, E-Education, Creativity.

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1. Introduction

Science Fiction Prototyping (SFP) was introduced by futurist Brian David Johnson as the *"use of science fiction as a means to explore, inform, and influence future scientific research and development"* (Johnson, 2010). Forecasting future environments, technologies, and scenarios can be an important methodology for identifying potential implications and issues. SFP involves not only creative design and development aspects, but also exploration and reflection on scenarios and elements. SFP is a way to support innovative research ideas, exploit their applicability, and relate to potential implications in the real world. This methodology is a valuable asset for different disciplines, such as urban research, climate studies, technological innovations, economic implications, or social studies.

In recent years, the potential of SFP for educational purposes has been discovered by different authors, such as Kohno & Johnson (2011) and Shedroff & Noessel (2012). SFP can help students not only to imagine future technologies and scenarios, but also to understand societal and contextual complexities, issues, and ramifications. The creative process transforms the learning into an engaging experience. Reflections help students learn how to think in a broader context, and how to foresee risks and issues.

Traditional SFP uses creative media formats such as storytelling, movies, or digital games to communicate or even visualize future ideas. The visualization of own ideas, however, can be challenging and requires technical and artistic know-how.

Several immersive 3D Virtual World (VW) toolkits, such as Open Wonderland (*http://openwonderland.org*), OpenSim (*http://opensimulator.org*), or realXtend (*http://realxtend.org*), allow users to create and adapt scenarios and environments without advanced technical knowledge and artistic talent. Another advantage is the support of different communication (such as voice chat, text chat, or gestures) and collaboration (such as whiteboards, image sharing, or document sharing) tools. These characteristics of VWs support reflection and discussion and make these learning environments popular tools to facilitate training and learning scenarios (Wilson, 1996).

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The main objective of this article is the exploration of perspectives of science fiction prototyping in 3D virtual world environments with focus on simplified creative content creation and collaborative reflection options in the context of education. This article is an extended version of the work published in Pirker et al. (2013) and in Pirker et al. (2014). We extend the previous work by introducing a model to enable an advanced form of SFP in immersive environments and apply this to the virtual world toolkit Open Wonderland to create a first showcase. We introduce '*Interactive Science Fiction Prototyping (ISFP)*' as an immersive, collaborative, and interactive process to create SF prototypes. ISFP should enable users to design, create, adapt, discuss, reflect, and experience scenarios in an immersive environment. The remainder of the article is organized as follows: in the next section we will discuss the background of science fiction prototyping and its application in education. Then, we will discuss the single steps of the interactive science fiction prototyping approach. Finally, we will discuss one potential application scenario using the virtual world framework Open Wonderland to describe this scenario in more detail.

2. Background

Creativity is an important factor in the current world that is reflected well in the economy. Creative industries and related activities have shown a constant growth during the last years (UNESCO, 2013). One big source for creativity has always been science fiction (SF) media. It generates, presents, and discusses new ideas, even if the technology is not ready yet. These ideas can influence the research and development of new technologies, products, and services. New technological breakthroughs in return influence science fiction stories as well (Johnson, 2011).

Interface design, for instance, draws many ideas from science fiction. One famous example of a resource for different innovative technologies and futuristic devices, which was influencing several future developments, is the television show Star Trek. In 1966 the show introduced a communicator as a communication tool. Thirty years later, Motorola released the first handheld cell phone, which was visually inspired this communicator. Another modern technology, which was also seen many years in advance in Star Trek, is the touch screen. Because of budget issues with 'Star Trek: The next Generation', it was not possible to create customized buttons for their computer panels. Hence it was decided to use a backlit panel for the ship's various instruments. A computer interface technology with motion control as seen in Minority Report fascinated many people and influenced the kinds of motion to use for specific actions, such as a wipe motion to trigger dismiss actions (Shedroff & Noessel, 2012).

Examples of the influence science fiction had on research go even further back in history. H.G Wells and Jules Verne created fictional worlds and stories already back in the 19th century. Wells was the first author who described ideas such as a time machine or invisibility, phenomena that still intrigue and challenge many scientists. In his novel 'Twenty Thousand Leagues Under The Sea', Verne created the idea of an electric boat that can swim under the sea. This was the first description of submarines (Roberts, 2006). In the 1920s another important contributor followed the trend of science fiction: Hugo Gernsback released both science articles and science fiction stories in the magazine 'Electrical Experimenter'. The stories at the time were more about the tale itself, not the technology displayed. This changed in the middle of the 20th century with Isaac Asimov, who added logic and scientific facts to his stories. More and more authors started to focus on the science part. These stories still inspire many new writers to describe their thoughts, technological innovations, or future environments and scenarios in a precise and scientifically underpinned way (Johnson, 2010).

2.1. Science Fiction Prototyping

When researching or developing a new technology the usual approach is to focus on gathering knowledge to first create a prototype, then to exploit and understand related aspects on the basis of this model. The underlying process is an iterative cycle that continues until the product is ready to be released. SFP approaches a different route. Instead of reflecting on how to create a technology or what it is all about, SFP asks how it will be used by its consumers and how it affects their environment. This approach discovers advantages and disadvantages of the technology itself or its impact on daily life. This can be a benefit in the development process. But more importantly, SFP can lead to new viewpoints, which give a better understanding on the social influence a new technology may have. This leads to the main goals of SFP: observing and studying new technologies, encouraging discussion, envisioning possible usage patterns, and uncovering problems.

Intel, for instance, uses SFP as part of future casting, where trends and new developments are analyzed and a future vision is built upon these findings. SF prototypes are used in this process to find out, how future technologies may look like in daily life (Johnson, 2010).

Similar to a normal prototype, the SF prototype is not an actual implementation of a final product, but a simple representation. This representation can be envisioned in different forms, such as written short stories, videos, or drawings (Johnson, 2010). As stated previously, evolving a story around a scientific fact is nothing new. SFP simply uses such stories in the context of a development process (Schwars & Liebl, 2013). Compared to traditional SF stories, which are most of the time developed to entertain or instruct a reader, a story built in a SFP process should be seen more as means to express new ideas (Graham, Greenhill & Callaghan, 2013).

On a general perspective every story starts with an idea that is also known as the outline in this context (Johnson, 2011). Stories revolving around an initial idea are called idea stories. Such stories begin with a question that is answered at the end. This kind of storytelling is also common in the mystery novel genre, where the identity of an unknown killer has to be uncovered (Card, 2001). In a similar way, the idea, which usually will be formed to a question, is the starting point of the SFP process. Johnson (2011) describes the remaining tasks of the SFP process as follows:

(i) *Pick Your Science and Build Your World*: The first and most important step is the selection of a scientific aspect, a technology, or an idea that should be explored. It is crucial to research and define the science fact in high detail. In the second step, a world and its inhabitants, like the main characters, have to be specified and described.

(ii) *Scientific Infliction Point*: In this task, the science, technology, or idea created previously is integrated into the described world. It is important to not focus on the technology itself, but more on its effects on the world and the people.

(iii) *Ramifications on Society*: With the new scientific elements or technologies added to the world, the people will react to its effects and change their behavior or their lives. This is in particular important for the next task.

(iv) *Human Infliction Point*: After the ramifications are clear, there should be something like a conflict between society and technology. There are many possibilities to resolve it: people can accept the technology, try to adapt to it, or they can reject it completely. But there are only two possible outcomes in the long run, either the technology changes, or the characters.

(v) *Lessons learned*: This is the point to reflect upon implications, problems, advantages, and risks of the experienced experiment and to explore the next steps, such as possibilities of improvement.

These five steps can be seen as a ‘three act structure’. The first act introduces the world and the main characters. Then the first plot point is introduced. A plot point can be described as an event that drives the story forward. The first plot point is equal to the scientific infliction point. The second act builds upon this event, where people have to react to the event. This leads to the second plot point, the climax, or in this case: the human infliction point. After this significant event, its resolution will be examined in the third act (Johnson, 2011; Kohno & Johnson, 2011).

In the process of creating a SF prototype, it is possible to focus either more on the technology or on the impact on society, what leads to the following distinctions: The first category is only concerned about the technology, the second kind looks more into the economic or cultural implication the science fact has (Graham et al., 2013).

2.2. Science Fiction Prototyping in Education

Creativity and independent thinking are becoming more important in the education sector (Oehlers, 2002). Teaching about the future, however, can be difficult. Teachers have no real knowledge about it, so they may have problems to convey it. Students in return may have difficulties when thinking about their future, so they get discouraged. Generally speaking, there are three different areas for future education. In the first area, future research and analyzing is done, examining visions of young people, preferable in schools. The second field teaches actual techniques and concepts of the future. The third is used for speculative research of education models containing future and foresight thinking (Gidley, Batemen, & Smith, 2004).

According to Gidley et al. (2004) there are five important points to create a creative future prognosis:

- Changes have to be found and observed.
- Effects of the changes have to be analyzed.
- Alternative future possibilities have to be identified.
- Preferred future possibilities have to be picked.
- Planning and execution have to be done in order to get towards the preferred future.

Kohno and Johnson (2011) used the SFP process within a computer security course at the University of Washington. The goal of this course was to expand the view of students on security aspects regarding context and society. The course was not fully based on SFP, but used it more for support. Zheng and Callaghan (2012) stated that SFP can be used as a learning tool for technical entrepreneurs. SFP can convey skills in the area of innovation that is important in this field of expertise.

According to Kohno and Johnson (2011) there are some advantages and disadvantages in using SFP in courses. First the spectrum of contextual thinking is broadened, including possible security risks of upcoming technology. Additionally the students generally have fun creating SF prototypes and experience the assignment as rewarding. This can give a boost to their learning engagement.

Furthermore, SFP uses a narrative form to convey ideas. Keeping information in the human brain is much easier, when it is linked to a narrative context. This might be a simple explanation why people can remember complicated parts of a story, but have troubles to remember a big sequence of numbers. Consequently, a story is easier to memorize (Schwarz & Liebl, 2013).

But there are also problems. First, students may reject this kind of course, because they do not expect such a high need for creativity in a course about computer security. Another drawback is that the outline only allows the observation of one to two contextual problems. Students may want to learn of more of them. The last problem is that students in a technical study may lack the experience in writing. So teaching them the basics should always be the priority, when using SFP in a course (Kohno & Johnson, 2011).

2.3. Science Fiction Prototyping in Virtual Worlds

The general consensus for SF prototypes understands them as short stories, in book form, as comics, or films (Johnson, 2011). But this should not exclude other forms of media, like video games or virtual worlds. Virtual worlds can be described as immersive, persistent virtual environments, such as Second Life or Open Wonderland, inhabited by multiple users. Represented by their avatars, users can socially interact with other people (Guetl, 2011).

It has been claimed that virtual worlds foster creativity and open new paths for creative expressions (Burri, 2011). One reason may be that virtual worlds provide an elaborate platform for collaboration. People can meet instantly, without a long travel time, to collaborate and share content in a three-dimensional setup (Guetl, 2011; Qui, Tay, & Wu, 2009). Additionally, virtual worlds are highly immersive. People experiencing a virtual world have a feeling of being present in this world (Guetl, 2011). Combining these attributed with the social aspects, in virtual worlds scenarios can be created, where not only individual people, but a whole community can be established and observed. Therefore, changes in the society can be monitored in a cost-effective and easy way. This is also possible on other online platforms, such as forums, but as stated previously, the avatar gives the user a sense of presence. Standing next to a group of avatars, for example, creates a better feeling of togetherness and influences the user’s behavior (De Lucia, Francese, Passero, & Tortora, 2008; Minocha, Tran, & Reeves, 2010).

Because of the nature of virtual worlds, the simulated environment does not have to follow constraints of today's technologies or laws of physics. This can lead to some creative objects, which could not exist in real life. Objects in virtual worlds can also be designed as interactive. This leads to an experience people could not have by just looking at them (Ward & Sonneborn, 2009). In comparison to the previously presented methods, virtual worlds may offer new advantages for SFP:

- *Immersion*: The user feels present in the world and is aware of the environment, other avatars, and objects (De Lucia, Francese, Passero, & Tortora, 2008; Guetl, 2011).
- *Social Observation*: Social developments and interactions can be observed when populating the virtual environment with enough people (Bainbridge, 2007; Minocha et al., 2010).
- *Content Creation*: Different media and art forms (like images, audio, 3D objects, web-documents, or videos) can be present in a virtual environment. By adding new interactivities to objects and the option to create different physical behavior, new forms of technologies are possible, (Guetl, 2011; Ward & Sonneborn, 2009).
- *Collaboration*: Meeting others is quickly possible, content sharing is easy, and discussions are intuitive (Guetl, 2011; Qui, Tay, & Wu, 2009).

Bannikov, Egerton, Callaghan, Johnson and Shaukat (2010) used a virtual world for developing a future product: free willed robots, which are quantum controlled. The basic question was how to implement a path finding system and how a robot using the system could be created in a virtual world environment. The simulation, which took place in this environment, used only items that had an effect on the path finding algorithm. The results of the simulation could be later used for further developments in real life.

3. Interactive Science Fiction Prototyping

Immersive environment toolkits such as flexible virtual worlds enable users to not only add new content, but also to adapt and interact with the environment and its inhabitants. The collaborative, immersive, and interactive nature of virtual worlds allows a new, innovative form of SFP. We introduce this interactive and more collaborative form of SFP, adapted to the nature of virtual world environments, as ‘*Interactive Science Fiction Prototyping (ISFP)*’. Based on Johnson’s definition of SFP, we specify ISFP as the use of science fiction prototyping in an interactive and collaborative immersive environment, to collaboratively design, create, assess, and reflect on future technologies.

Revising Johnsons (2010) five steps to develop a SF prototype, which is based on a more linear process, we define the following five phases to create interactive science fiction prototypes following an agile and iterative process:

(i) **Design and Planning**: The first phase is the collaborative design, where participants plan and design their vision of future technologies, environments, and scenarios.

(ii) **Creative Content Creation and Reuse**: In this phase users either create or reuse existing representations of the planned technologies, related elements, and other objects.

(iii) **Flexible Settings in Virtual Environments**: The future environment is formed and adapted with the created or reused items from the previous phase.

(iv) **Experience**: In this phase users experience the environment and the technology. The can explore it either in a social and collaborative way or experience the world on their own.

(v) **Reflection**: This is the phase where users reflect and discuss their ideas together, find issues or implications, and can revise previous phases to iteratively adapt the environment.

ISFP is an interactive and iterative process, which can be categorized in collaborative, creative, and reflective activities. Figure 1 gives an overview of the single phases in the context of the virtual worlds. In the next phase the single phases are explained in more detail with focus on the steps, requirements, and implications

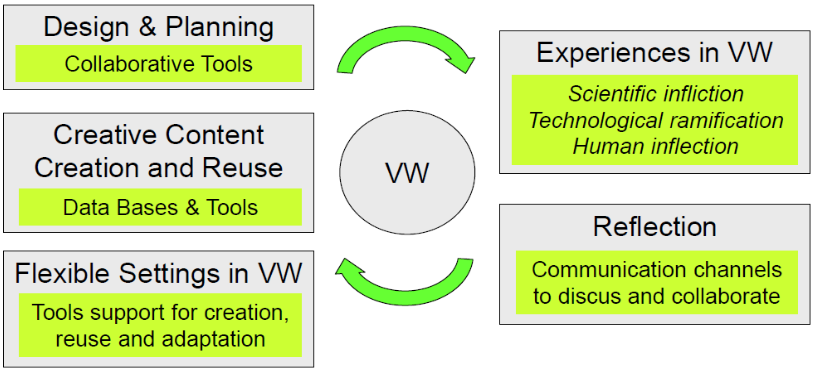

Figure 1. Model for Interactive Science Fiction Prototyping in Virtual Worlds

Design and Planning

Users start by designing and planning their prototypes in a group. The collaborative aspects should help them understand design issues and implications. Johnson (2011) refers to two steps (previously mentioned as "Build the world" and "Scientific infliction point"). First, a technology or a problem is defined. Second, the world and its inhabitants are fleshed out. All objects, elements, and technologies should be described in a high detail level to build an optimal basis for the next phase. Finally, these elements are put together to build a first scenario.

Based on these implications the following requirements of a virtual environment can be identified to support the design and planning phase:

- *Communication channels* (such as VoIP or text chat)
- *Collaboration and brainstorming tools* (such as whiteboards, writing tools, and shared documents)

Creative Content Creation and Reuse

The elements, objects, and environments, which were defined in the design and planning phase, are now collected. Content can either be created from scratch or retrieved from model databases and reused. 3D virtual worlds support the representation of two-dimensional, but also three-dimensional objects. Using 3D objects for the scenarios can enhance the feeling of immersion and create a better understanding of the scenery. When creating content from scratch the artistic talent levels of each user should be considered, so that also users without experience in 3D modeling can add content. Tools, such as Google SketchUp (*http://www.sketchup.com)*, simplify the 3D modeling process and enable a large user group to create content. Many objects and sceneries can also be found in online collections, such as the Google 3D Warehouse (*https://3dwarehouse.sketchup.com*), where users can search for elements, and download entire models to either use them straight away, or edit them with modeling tools.

To simulate interactive scenarios, some elements should also support reactive behavior. This can be provided by environment extension or enabled scripting capabilities. During the creation phase the user should be aware of potential experiences and ideas that can be triggered when creating and advancing scenarios, characters, or new ideas. The following requirements for a virtual environment can be summarized to support the creative content creation:

- *Create new objects and scenarios, or reuse and adapt existing scenarios and applications* (scripting, extending)
- *Import new objects easily* (3d, 2d, videos, audio)

Flexible Settings in Virtual Environments

To make the experience interactive and creative users should be able to adapt the setup of the environment and its content according to their ideas. Hence, it is necessary to promote adaptable environments that support flexible settings such as an easy form of moving, rotating, or scaling objects. Requirements for a virtual environment to support flexible settings:

- *Adaptability:* Elements depicting the chosen technology and environment should be moveable and editable.
- *Configurability:* It should be possible to change different parameters or switch among scenarios

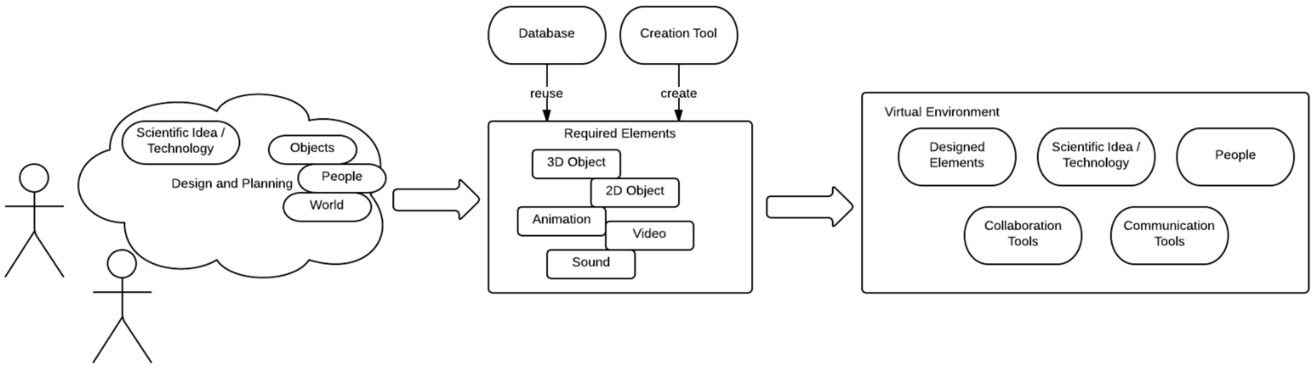

Figure 2. From the design and planning phase to the virtual environment prototype

Experience

In this phase behaviors, implications, advantages, problems regarding infliction points of the scientific elements with the environment, the people, or other elements are observed and experienced. This experience can be shared among the creators, but also among other users, who want to participate in this process. Group activities such as active discussions, role-playing, and games are possibilities to experience the prototype from different points of view.

Requirements for virtual environment to support optimal experience include:

- *Support of immersion*: The environment should have the capability to let users immerse in the created world.
- *Communication channels:* The environment should enable users to communicate and to support activities such as role-playing.
- *Interactivity:* To make the experience to a fully-fledged future adventure, possibilities to interact with the environment and its objects are necessary.

Reflection

To make the experience a learning experience the reflection process is probably one of the most important phases of the ISFP. The reflection phase should be a collaborative process to help users in understanding the future prototype from different perspectives. They should share their impressions, reflect on their ideas, and discuss potential implications, issues, and complexities.

Requirements for a virtual environment to support reflection processes include:

- *Brainstorming options:* Whiteboards, writing tools, and collaborative tools can help in this process.
- *Flexible settings:* Possibilities to immediately change objects, scenarios and environment in order to adapt to new ideas and explore changes.

Based on the single phases four main requirements of ISFP can be identified: (1) interactivity, (2) creativity, (3) collaboration, and (4) reflection.

4. Application Scenario

Based on the IFSP model one scenario was developed in Open Wonderland (OWL), an open-source toolkit for creating 3D virtual worlds. OWL already comes with a large body of communication and collaboration tools. It was chosen because of its focus on extensibility and interactivity (Kaplan and Yankelovich, 2011).

In this application scenario we introduce how to build a future city in Open Wonderland with the ISFP process. Creating a future city in virtual world environments can be an important experience for students to explore the future lifestyle, but also to find issues of urban, economic, and environmental nature. In this scenario students should think of their ideas of a future city. They should consider future transportation possibilities and the according traffic situation. Following the ISFP process, we describe the single steps in the remainder of this section.

Design and Planning

In the planning phase, students brainstorm about potential scientific ideas or technologies to explore. In the next step the students define the environment, actors, and elements they need to make the environment as authentic as possible. In Figure 3 three users are discussing their ideas by brainstorming on a whiteboard and uploading pictures illustrating their thoughts.

Figure 3. Brainstorming about implications of a future city

Creative Content Creation

Based on the results of the design and planning phase the required content needs to either get retrieved from databases, adapted, or created from scratch. A good resource to download three-dimensional objects, which are in their complexity level applicable for a virtual world, is Google Warehouse.

To create three-dimensional tools without advanced 3D-modelling skills Google SketchUp can be used (see Figure 4), which was designed to make 3D design also accessible to non-artists.

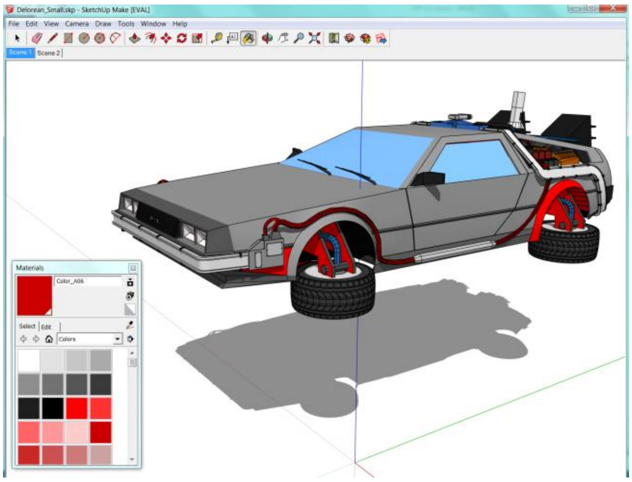

Figure 4. Creating or editing objects in Google SketchUp (Object from Google Warehouse)

Flexible Settings in Virtual Worlds

It is important that the created content can be easily added and edited in the virtual world environment. Open Wonderland supports the import of 3D objects by simply dragging and dropping it into the user client.

However, many users who are not used to work and model in 3D, experience problems to move and edit objects. This makes the implementation of a two-dimensional bird-eye view of the virtual world environment necessary, which can help users unfamiliar with arranging elements in a three-dimensional space (see Figure 5). The representation of the virtual world enables users to move objects by simply dragging them to a new position in a 2D view.

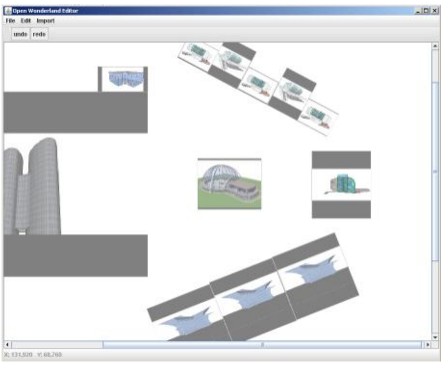

Figure 5. Two-dimensional world creator for easy and fast organization of in-world content

Experience

Collaborative settings tend to support an enhanced understanding of the situation and the content (Johnson et al., 1986). For the learning progress it is important that the experience happens in a group or together with a peer. In this scenario the students test how a city can handle different vehicles with different track layers and impellent (see Figure 6). They can intensify the experience by assuming different roles in role-playing games. In this scenario students can, for instance, be road users, the minister of transport, or children walking to school. They should see the prototype from many different perspectives in order to make the experience as valuable as possible.

Figure 6. Experiencing implications of different vehicle types

Reflection

In the reflection phase the following questions are raised to the students. What are the implications? What are potential issues? What can be improved? How would you improve the situation? Do you see dangers? The ISFP model is designed as an interactive process. At this point users can adapt the scenario and relive the previous phases.

5. Conclusions

This article has demonstrated that SFP in virtual world environments can help to express and explore own ideas about future scientific scenarios, environments, or elements in a three-dimensional setup. We have seen that using SFP in an immersive world supporting different form of interactions does provide new possibilities to create and explore prototypes. We introduced this kind of SFP as Interactive Science Fiction Prototyping (ISFP). To maximize the creativity and learning experience, most of the activities should be completed in groups. Based on Johnson's phases for SFP we defined the following five phase to build an interactive science fiction prototype: (1) Design and Planning, (2) Creative Content Creation and Reuse, (3) Flexible Settings in Virtual Environments, (4) Experience, and (5) reflection. To integrate ISFP into a virtual world environment the following requirements were identified: interactivity, creativity, collaboration, and reflection. We have shown one application example in the virtual world toolkit Open Wonderland, which complies with these requirements. However, to strengthen the factors interactivity and creativity it is important to integrate further tools such as world builder and object editors to enable users with different artistic and technological talents to extend the prototype based on their ideas. The next chapter will discuss necessary next steps in more detail.

6. Future Work

ISFP could become a powerful tool, not only in education, but also in other areas which build upon creativity and future possibilities. SFPs can bring certain benefits to teaching, which was shown by Kohno and Johnson (2011). Combining these benefits with the advantages of an immersive and collaborative virtual environment may add a new layer to the SFP learning effect and a better creative output because groups of people are involved. Unfortunately there is not much information about these possibilities at the moment, so further research is needed.

Besides educational settings, this interactive and collaborative process also supports other scenarios, such as testing future scenarios in a safe environment before implementing them in real life. This raises awareness of possible problems and issues new technologies may have. It can also be used for creative disciplines such as future art.

Because virtual worlds are often not intuitive to use when it comes to world building, tools for content and world creation are important. They should allow users with little expertise to easily construct their own worlds. Therefore future work will contain the development of an advanced editor prototype that supports users in the creation of 3D virtual environments. This prototype uses a 2D representation of the world, which is much easier to understand. It should also feature standard edit commands, like undo, or copy operations. Such operations are either very uncomfortable to use on virtual world platforms or they do not exist at all. The editor tool should also run while the user is present in the environment, so he can observe the changes he made in an instant. Such an editor may be useful, when creating a learning scenario. Building the environment may be time consuming with the constraints of the virtual world platform. Therefore the tool could be used to build the foundation of a scenario, like roughly designed rooms or buildings. After this outline is created with the help of the editor, users can add specifications to the objects directly in the virtual world. Because the tool will also show the position of every avatar in real time, educators could examine the behavior of their students. This could show them objects, which draw the most attention of the students, or where and how crowds evolve.

The next steps will also include an evaluation of the ISFP model with different user groups. This evaluation should examine the approach with focus on the four requirements interactivity, creativity, collaboration, and reflection.

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References

[1] Bainbridge, W. S. (2007) The Scientific Research Potential of Virtual Worlds. *Science* **317**: 472-476.

[2] Bannikov, A., Egerton, S., Callaghan, V., Johnson, B. D. and Shaukat M. (2010) Quantum Computing: Non-deterministic controllers for Artificial Intelligent Agents. In *Workshop Proceedings of the 6th International Conference on Intelligent Environments*, Kuala Lumpur, Malaysia, 2010 (Amsterdam, NL: IOS Press), 109-119.

[3] Burri, M. (2011) Misunderstanding Creativity: User Created Content in Virtual Worlds and its Constraints by Code and Law. *International Journal of Communications Law and Policy* **14**: 2-28.

[4] Card, O. S. (2001) *How to write Science Fiction & Fantasy* (Cincinnati, Ohio: F+W Publications).

[5] De Lucia, A., Francese, R., Passero, I. and Tortora, G. (2008) Development and evaluation of a virtual campus on Second Life: The case of SecondDMI. *Computer & Education* **52**(1): 220-233.

[6] GIDLEY, J. M., BATEMEN, D. and SMITH, C. (2004) *Futures in Education: Principles, Practice and Potential*, (Melbourne, Australia: Swinburne Press).

[7] GRAHAM, G., GREENHILL, A. and CALLAGHAN V. (2013) Exploring business visions using creative fictional prototypes. *Futures* **50**: 1-4.

[8] GUETL, C. (2011) The Support of Virtual 3D Worlds for Enhancing Collaboration in Learning Settings. In POZZI, F. and PERSICO, D. [ed.], *Techniques for Fostering Collaboration in Online Learning Communities Theoretical and Practical Perspectives* (Hershey, PA: Information Science Reference), ch. 16.

[9] JOHNSON, B. D. (2010) Science Fiction for Scientists!! An Introduction to SF Prototypes and Brain Machines. In *Proceedings of the 6th International Conference on Intelligent Environments*, Kuala Lumpur, Malaysia, 2010 (Amsterdam, NL: IOS Press), 195-203.

[10] JOHNSON, B. D. (2011) *Science Fiction Prototyping: Designing the Future with Science Fiction* (San Rafael, California: Morgan & Claypool).

[11] JOHNSON, R.T., JOHNSON, D. W. and STANNE, M. B. (1986) Comparison Of Computer-Assisted Cooperative, Competitive, And Individualistic Learning. *American Education Research Journal* **23**(3): 382-392.

[12] KAPLAN, J. and YANKELOVICH, N. (2011) Open Wonderland: an extensible virtual world architecture. *IEEE Internet Computing* **15**(5): 38-45.

[13] KOHNO, T. and JOHNSON, B. D. (2011) Science Fiction Prototyping and Security Education: Cultivating Contextual and Societal Thinking in Computer Security Education and Beyond. In *Proceedings of the 42nd ACM technical symposium on Computer science education*, Dallas, Texas, 2011 (New York, NY: ACM), 9-14.

[14] MINOCHA, S., TRAN, M. Q. and REEVES, A. J. (2010) Conducting Empirical Research in Virtual Worlds: Experiences from two projects in Second Life. *Journal of Virtual Worlds Research* **3**(1): 4-21.

[15] OEHLERS, A. L. (2002) Imagining the future: Youth in Singapore. In GIDLEY, J. and INAYATULLAH, S. [ed.], *Youth Futures: Comparative Research and Transformative Visions* (Westport, CT: Praeger Publishers), ch 9.

[16] QUI, L., TAY, W.W. and WU, J. (2009) The impact of virtual teamwork on real-world collaboration. In *Proceedings of the International Conference on Advances Computer Entertainment Technology*, Athens, Greece, 2009 (New York, NY: ACM), 44-51.

[17] PIRKER, J., WEGHOFER, P. and GUETL, C. (2013) Science Fiction Prototyping: Flexible Settings in Immersive Environments. In *Proceedings of the International Conference on Interactive Computer aided Blended Learning*, Florianópolis, Brazil, 2013 (Vienna, AUT: International Association of Online Engineering), 321-326.

[18] PIRKER, J., GUETL, C., WEGHOFER, P. and FEICHTNER, V. (2014) Interactive Science Fiction Prototyping in Virtual Worlds: Fundamentals and Applications. *International Journal on Recent Contributions from Engineering, Science & IT*.

[19] ROBERTS, A. C. (2006) *The history of science fiction*. (Basingstoke, Hampshire: Palgrave Macmillan).

[20] SCHWARZ, J. O. and LIEBL, F. (2013) Cultural products and their implications for business models: Why science fiction needs socio-cultural fiction. *Futures* **50**: 66-79.

[21] SHEDROFF, S. and NOESSEL, C. (2012) *Make It So. Interaction Design Lessons From Science Fiction* (Brooklyn, NY: Rosenfeld Media, LLC).

[22] UNESCO. (2013) *United Nations Creative Economy Report 2013 Special Edition*. (New York, NY: United Nations Development Program).

[23] WARD, T. B. and SONNEBORN, M. S. (2009). Creative Expression in Virtual Worlds: Imitation, Imagination and Individualized Collaboration. *Psychology of Aesthetics, Creativity, and the Arts* **3**(4): 211-221.

[24] WILSON, B. G. (Ed.). (1996). *Constructivist learning environments: Case studies in instructional design*. (Englewood Cliffs, New Jersey: Educational Technology Publications).

[25] ZHENG, P. and CALLAGHAN, V. (2012) Creative Science: a new way of learning innovation and entrepreneurship?. *Enterprising Matters eMagazin, Issue on Entrepreneurial Learning in Organisations*.