Virtual Worlds

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1 History and definition

Recently virtual worlds have been intensely discussed both in public and in the scientific world. The mass media have reported in detail about the evolution and happenings in Second Life, a virtual world run by Linden Lab Inc. Interestingly, Second Life is not only used by private customers but also by well-known companies and even government institutions. Other companies such as Sony with “Sony Home” and MTV with its “Virtual Laguna Beach” have launched their own virtual worlds. The main goal of such company initiatives is to explore the potential for creating new products and services and building communities around established brands. It is the evolving 3-dimensional virtual space with its specific interactivity that makes the difference to similar Web 2.0 strategies of customer involvement within the mostly text-based World Wide Web (Bächle 2008, p. 129 ff).

The origin of virtual worlds lies in the first implementations of text-based role playing games. In 1979 the first multi-user dungeon (MUD) was programmed (Bartle 2003, p. 4 ff) and with the spread of the Internet, these computer games became available beyond the frontiers of the university networks. There were four key factors for further investments and the development of new virtual worlds: the enormous growth of Internet connections, decreasing prices for these connections, the immense progress of computer technology and graphical user interfaces, and the development of business models which assured stable revenue streams. Well known examples for successful virtual worlds with hundreds of thousands of users include “Ultima Online” launched by Origin System Inc. in 1997, and “Everquest”, launched by Verant Interactive and Sony Online Entertainment in 1999 (Castronova 2005, p. 53).

The content of virtual game worlds is often inspired by literature – especially the science fiction and medieval fantasy genres are of great importance. Virtual worlds in this tradition are games in the sense that the user takes over a character, strives to achieve certain game objectives, and collects valuable items and experience points on the way. This base structure of game world design can still be found in the latest representatives of this category, for example “World of Warcraft” with its 10 million users.

In 1989, the worlds “TinyMUD” and “Zone” were launched. These worlds mark an important offspring in the game world development since they were the first social virtual worlds (Bartle 2003, p. 9). In this tradition, the above mentioned Second Life and other contemporary social worlds such as “Habbo Hotel” and “There” can be seen. As opposed to game worlds, there are no game objectives in these worlds; the communication aspect comes to the fore and the content is designed to a significant part by the users.

Because of the multitude of different worlds already in use, it is quite difficult to give a common definition that fits all of them. Castronova (2005, p. 11) provides a very general definition when he says that

a virtual world is “an expansive, world-like, large-group environment made by humans, for humans, and which is maintained, recorded, and rendered by a computer.” Within these environments people interact mediated by their artificial representatives, so-called avatars, with each other and with the world’s objects. The mental experience of being within the world is called immersion and usually leads to the player having a strong identification to his or her avatar.

2 Design of virtual worlds

2.1 Architecture

Basically the architecture of a virtual world consists of a more or less function-rich client and a server grid which is usually maintained by a service provider company.¹ The responsibilities of the client are to provide a user interface for a specific device (e. g. PC, mobile phone, gaming console), to send certain user interactions to the server; to receive the current state of the relevant world sector, and to graphically or textually render it. The delay between events in the virtual world and their presentation on the screen is the most critical aspect in the communication between client and server because it directly affects the user’s experience. This implies certain requirements to the specific communication protocol (e. g. caching algorithms, anticipation of events) and to the network service quality (e. g. band width, latency, jitter, package loss).

As proposed by Bartle (2003, p. 43 ff), the server architecture can be separated into four layers. The so-called driver which implements the basic data structures and hardware abstraction is on the lowest level. Above this layer is the physics engine which is responsible for all of the physical behavior of the virtual world such as time, gravity, distance, movement,

¹ Besides the provider scenario, there are some approaches for decentralized peer-to-peer architectures, for example the Open Croquet Project (<http://www.opencroquet.org>) and the Metaverse Project (<http://metaverse.sourceforge.net>). In these scenarios the world itself is distributed among the user’s computers.

Fig. 1 Architectural layers of virtual worlds according to Bartle (2003, p. 43 ff)

and material properties. The world model defines all the world specific object classes (e. g. characters, artifacts, levels) and how they interact, for example the possibility of exchanging money and goods between avatars. Related to the control of non-player characters, algorithms of artificial intelligence can also be found in this layer. The top level implements the simulation of the virtual world: that means calculating all the state transitions for each object instance within the virtual world.

Similar to other domains in software development, standard interfaces and frameworks for certain functional blocks of virtual worlds and computer games have evolved in order to increase the reusability of software components. For example, Second Life uses the Havoc software component as its physics engine. There are efforts to provide integrated development environments (e. g. Microsoft XNA Game Studio) to further increase the productivity of virtual world development.

Besides the levels and building blocks of the architecture, there are other important design decisions that need to be made. One of them is the question of changing and extending the content during the lifetime of the virtual world. That means determining who should be able to change the world to which extent. The more the world is supposed to be variable, the more descriptive and dynamic programming techniques (e. g. scripting languages) have to be used. A further consequence of a dynamic appearance of the world is the use of fine-grained persistence objects in order to properly recreate the state after a server reset. There is always a trade-off

between flexibility of the world and its performance, and thus its enjoyment.

A growing world needs to have an architecture which can be extended, for example by connecting new servers to its grid. However, there are other concepts conceivable; most of the virtual worlds organize their server capacity along geography because this approach minimizes the coordination effort between servers. There are two variants for assigning virtual areas to servers. In the first one, this assignment is static. This has the advantage that the operations concerning a specific part of the world can be processed locally; however, this variant typically leads to certain restrictions of user interaction, e. g. a limited number of avatars located in a specific area. Beyond this, such implementations have not been able to make the area frontiers fully undetectable to the users. The second variant is a dynamic assignment of virtual areas to servers which leads to a seamless world experience, but is much more demanding from an algorithmic perspective. The advantage of the dynamic approach is that higher workload for some servers (caused by higher activity in a certain area of the world) can be compensated by less engaged servers (Bartle 2003, p. 96 ff).

Since virtual worlds are about users who communicate with each other, the design of the communication infrastructure plays a central role. Appropriate features (e. g. chat, maps and group functionality, search engines, recommender systems) which help the users to navigate and coordinate actions have to be designed and integrated within the overall architecture.

2.2 Content Design

The extent and character of what is called “the content” of a virtual world is defined by Bartle (2003, p. 54): “Essentially, content is that which the world provides to hold player’s interest. If players are consumers, content is what they consume.” In a broader sense, the rules designed for the use of the world can be also subsumed under content.

In a game world, we typically have a storyboard which is the basis for the content production and the design of gameplay. The background story comes either from other media, e. g. a license from a novel, or is created specifically for the world. Based on this story, there is a multistage iterative process to create characters, textures, artifacts, audio and video sequences, animations, and other types of content. Technically this process is supported by diverse content creation tools, e. g. motion capture tools, graphic and video applications, and a content pipeline to integrate these elements within the virtual environment. The level design puts it all together by defining the room architecture, the landscape of the virtual environment, the illumination and sound, and it determines the path finding for AI-controlled characters.

Beyond this, the frame story defines a more or less detailed social context which gives the creatures, artifacts and places their meanings and opens up further interaction possibilities, e. g. forms of cooperation or armed conflicts. Based on this, the user is offered world specific configuration mechanisms in order to set up a character and to choose a role. There are often specific development paths and behavioral expectations of other players and non-player characters linked to a role. In some of the worlds, the social structure is differentiated on the level of class, race, or even whole societies.

Because the main goal of content design is to be entertaining, it has to be assured that the complexity of the world experience doesn’t overwhelm new participants on the one hand, but on the other hand there always has to be some challenging new situations for the experienced user. The world designers address this problem in different ways. Many worlds predetermine a learning and experience process for each role that is reinforced by certain incentives, e. g. success experience, experience points and levels, social reputation.

During the process, the player is challenged by tasks with an increasing degree of difficulty. For this purpose certain parts of the content are often provided in separated sub-areas with limited entry. Complementary to this content reuse strategy, the virtual world can be extended, e. g. by new areas, new features of character types; however, some world extensions inherently run the risk of changing the overall balance of game forces which can have a bad effect on the user's experience.

As opposed to game worlds, generally there are no frame stories and no prescribed goals in social virtual worlds. The range of user involvement within the process of content production reaches from rather static avatar-based chat forums around certain topics, to Second Life's radical platform strategy where an empty world is given to the users for whatever they want to do there (Book 2004). For the content production in Second Life, an in-world graphical development environment is provided. This includes a scripting language, interfaces to import textures, and the integration of web services. The users build the content, trade goods and services with each other, implement in-world games, produce works of art, and build communities around manifold interests (Malaby 2006). Of course, the openness and the intended minimum of control in this approach are not without problems: there are many security and legal issues (e. g. copyright issues, theft of virtual items, fraud, cybersex with minors involved), the uncontrolled design process leads to large deserted areas of low excitement, and most of the first time users never come back because they cannot make sense of the virtual world.

The formal rules of a virtual world refer to the rights and responsibilities of the user and the provider. These rules are usually defined in the End User License Agreement (EULA). Typically, it specifies how access to the world is provided, which intellectual properties are claimed, which kind of behavior within the virtual world is prohibited, what kind of sanctions are imposed for violating these prohibitions, and which kind of claims for damage are excluded. The fact that the providers determine the design as the "coding authority" and claim far-reaching rights often puts them into a strong position compared to the user. This imbalance is criticized by some researchers; they argue that as virtual worlds are being used by more and

Fig. 2 Value chain of virtual worlds (according to Wirtz 2006, p. 530 ff)

more people, they are taking on the characteristics of public places. Of course, the power of the providers is limited since the overall customer satisfaction will have an effect on the economic position of the virtual world. Thus, the providers will have to decide in which ways the users can be involved in the rule making processes (Castronova 2005, p. 205 ff).

3 Business aspects of virtual worlds

The value chain of the virtual world business can be divided into the roles of hardware developer, software developer, publisher, distributor and operator (**Fig. 2**). Especially in worlds with a high degree of user involvement in the design and extension processes, it makes sense to add the users and their communities to the value chain. Within the virtual worlds and in secondary markets, e. g. eBay, a lot of virtual goods and fully equipped avatars are traded. Some game world providers try to restrict this kind of trading because it is feared that it will damage the game characteristics (Castronova 2005, p. 149 ff).

In other worlds, especially social worlds such as "Second Life" and "There", the economic activities of the users and the emergence of in-world value chains (virtual commerce) are explicitly fostered by open economic systems with transferable in-world currencies and built-in infrastructures for transactions (Bray and Konsynski 2007, p. 3 ff). The design of a virtual economy is a very complex task and has to address similar issues to real economies (e. g. inflation, deflation, specifics of virtual goods, money supply). So far, these related problems have not been resolved in a fully satisfying way and mark a field for further research (Bartle 2003, p. 297 ff).

The manifold aspects in the development of virtual worlds make it a highly

complex task. Often an interdisciplinary team consisting of designers, content developers, artists, programmers, sound engineers, and other specialists is deployed to tackle the related challenges. The management-related tasks of virtual worlds (producer) mainly include the coordination of the development process and the definition of the overall marketing strategy. Important decisions in this context relate to the choice of technologies and development tools, the licensing of content (e. g. franchise licenses), the definition of target groups for the world, the business model, and market entry.

Concerning the business model, the revenue model needs special attention (Wirtz 2006, p. 67 ff). For currently established worlds, different kinds of revenues can be observed: transaction-independent revenues, both direct (e. g. a monthly fee independent of use) and indirect (e. g. in-world advertising, sponsoring), as well as transaction-dependent revenues (e. g. fees for certain actions within the world as for example renting virtual real estate).

Difficulty of market entry comes from the fact that users have problems engaging in more than two worlds at the same time because of restrictions of time and money. Beyond this, engaging in a virtual world creates lock-in effects based on established social networks, reputation, learning curve, and virtual items collected. These assets are effective in preventing users from switching into another world (Shapiro and Varian 1999, p. 135). As a consequence of this, the successful market entry requires a combination of perceivable technological innovation, a well-designed business model, unique content, and a strong competency in community management; the latter means addressing target customers and triggering a self-reinforced communication dynamics.

If entering the market succeeds, the virtual world enters the production and

maintenance phase with its specific challenges. To begin with, there is the management of the hardware infrastructure which is required for a system with millions of users. This includes demanding requirements for the availability and reliability of the system, especially related to user-generated content, and for security management (e. g. detection of data manipulation and malware). A second area of difficulty is the user's expectation of new content without disturbing the running system for a long period of time and effective support that handles every user request in a timely manner. For this purpose, a maintenance team is usually deployed which observes the virtual world, recognizes dysfunctional tendencies, implements corrections which were reviewed by the design team, informs the users about relevant changes, and replies to their questions, complaints and change requests. Above all, the main goal of this team is to assure system stability and to keep the users within the world.

4 Importance for Business and Information Systems Engineering Research

Various studies (Bridges et al. 2007; Fetscherin and Lattemann 2007) and technology assessments (Zweck 2006) indicate that the development of virtual worlds is on a path of dynamic growth and innovation. It is likely that, similar to the WWW, this will be accompanied by far reaching changes in many societal contexts. To fully grasp these changes, virtual worlds have to be considered within the overall evolution of the Internet and the phenomena associated to the terms "Web 2.0" and "Social Web".

For Business and Information Systems Engineering (BISE) research, virtual worlds open up a new research area with a multitude of questions. Topics for further investigation include the questions for the organizational structures, development steps and necessary standardizations on the way to a Web 3D (Bridges et al. 2007), and the identification of layers to be integrated. Related to this, new opportunities for e-commerce solutions within such virtual environments need to be explored, reference models need to be developed, requirements for the infrastructure and technological support of transactions need to be specified, and the

institutional basic conditions for business activities within virtual worlds need to be defined.

With the technology in place so far, the vision of a complete reproduction of real-world structures and processes within information systems no longer seems to be mere fiction. The meaning of such a complete virtualization and its consequences for organizations, value networks, and working procedures is an open question. Along with the processes and functional areas of organizations, many areas for the application of virtual world technology can be imagined. Examples include new methods of market research, avatar-based marketing (Hemp 2006, p. 50 ff), the integration of customers and communities in the innovation process, applications in knowledge management using spatial representations of knowledge, support for virtual teams, new methods of recruitment and leadership training, and the provision of virtualized counseling services and help desk functions (Ondrejka 2007, p. 33 ff).

As a mass phenomenon, virtual worlds call for a societal discourse about desired and constructive usage scenarios, but also about the technology related risks. The range of risks includes reality escape, addiction, new forms of crime and terrorism, and questions about fundamental rights in democratic societies (Castronova 2005, p. 205 ff). Because of its interdisciplinary scope, BISE research can take over a coordination and integration function in the systematic investigation of the manifold aspects of virtual worlds.

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