User-centered Design and Evaluation of Virtual Worlds

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Abstract

Virtual worlds are objects of much research. Such research is needed for future wider application within education, science field or market domain. For instance, Hype cycle presents that virtual worlds are coming in productive phase in 5-10 years. Virtual world as we know today are not user friendly or effective as a seriously used communication tool. Of course, there is a lot of progress in this area. Let me consider Facebook plug-in for instance, which brings much easier login process compared to Second Life or Open Simulator installed client. Second thing could be release of SL Viewer 2.0. However, studies show that there are a lot of users demotivated or disappointed from the virtual world`s environment and after their first visit they never come back. That has to change.

Paper focuses at the problem from Information science point of view. Specifically, the author takes user-centered design as a core approach, which is needed to improve software usability. Usability as a broader term for experienced usability, apparent usability, user friendliness, quality of user interface, etc. must be measured and evaluated. The target of the paper is to present methodology of testing and evaluating virtual world environments. Paper summarizes core steps within user-center design, which is user task analysis, expert guidelines-based evaluation, formative user-centered evaluation, summative comparative evaluation. More closely, user task analysis contains pre-research, which is needed for understanding of users` needs, their work culture and their work goals, which they perform daily. There are work scenarios developed within expert guidelines-based evaluation and then users go through them within formative user-centered evaluation. After redesign of environment users go through two or more variations of developed user interfaces and analyze which one is better.

There is going to be a short overview of the virtual region VIAKISK within Open Simulator presented as well.

Key Words: You can add up to 10 key words. The first key word start with an uppercase letter, the rest will be in lower case, unless they are proper names. Use a comma to separate terms and a period after the last one.

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1. Introduction

Interaction among a human and a computer becomes object of much research, because quality of interaction affects the way software is used by its users. People generally choose software according to two criteria. These are time and effort

invested. People are more likely to use application, which enables finishing specific task as fast and with as little effort as possible.

There are a lot of thoughts and predictions about the future of web and technology. Web is becoming more visual in terms of well known "one picture stands for thousand words". Consider increasing number of infographics, interactive graphs, 3D visualizations or simulations shared on the web. Such model of presenting information to users is much more rewarding and efficient compared to large tables of data and long text documents. The visual trend with increasing quality of technology leads us to a new type of web which I call the *3D web* or *3D Internet*. *Virtual world*, which Bell defines as "a synchronous, persistent network of people, represented as avatars, facilitated by networked computers"[1], can be considered a forerunner for such a type of web. Virtual world can be also called a *Multi-user virtual environment* (MUVE)[2] or *(3D) virtual environment*. I use a term *virtual world* in this paper, because it seems to be most widely used within research and science papers. If situation requires broader term, I use 3D virtual environment.

Unfortunately, using virtual world (for instance Second Life or Open Simulator) is not an easy thing. The main issue is accessibility and usability. It is not an easy task to user to download and install software, create an avatar, sometimes even voice has to be used. If user overcomes the main barriers, he realises that communication is tricky, navigation and moving is almost impossible and I do not even mention changing colour of hear.

Despite the last paragraph, let us concede that 3D web is one of future possibilities. Gartner research says that virtual worlds are becoming a mainstream in five to ten years. This prediction is made with respect to the Hype cycle, which shows the actual position of virtual worlds in a phase of disillusion[3]. I could imagine that I visit online 3D store, where all goods are placed in regular shelves. Customer inspects every product as he does in a real store. Communication and interaction within the store is avatar-based. I mean, customer`s avatar can ask seller`s avatar for an advice using text or voice chat. Such type of store is developed by Dassault Systemes for instance.

The concept of online 3D store can be pushed forward. For instance, how about a 3D social network, web of The Times or The New York Times, 3D online auction or 3D official web of your town and local police department or 3D class?

If 3D web becomes mainstream, each company involved will need a kind of optimization for such virtual presence. I mean optimization in terms of designing the 3D virtual environment as usable as possible. The aim of the paper is to introduce methods of designing virtual world`s browser. I focus mainly on browser or client of virtual world (Second Life viewer, Imprudence etc.).

The paper describes a method of *User-centered design* and specific evaluation method suitable to virtual worlds. Next chapter is dedicated to a science background and basic terminology. Method of *User-centered design* is described in

chapter three. Chapter four introduces evaluation and testing of virtual world`s browser.

2. Background and basic terminology

The chapter is dedicated to background of given topic and also to clarifying related terminology. The methodology of designing and evaluation of virtual world`s browser from the perspective of Information science.

Human-computer interaction (HCI) is the theoretical approach which deals with interaction among computer and human and examines (1) technical factor – the software and its interface, (2) human factor – human, cultural and social background and (3) interaction – the process of information exchange. Anabelo Sarmento expresses an object of the HCI in his interview with other words.

> What are the main concerns of HCI? Some of the main concerns of HCI are (1) the development of human capabilities to use machines, (2) the designing and building of interfaces, (3) the optimization of the performance of tasks by humans and machines, (4) usability of the interface itself, (5) a better communication between human and machines.[4]

HCI research is based on interdisciplinary approach involving computer and behavioural sciences (cognitive science, psychology, sociology etc.), which provide the methodology and classification for our purpose.

As we stated above the quality of interaction and interface among virtual world`s browser and human is object to improve. *Interface* is a part of the browser which displays all information and provides functions needed for operating virtual world. The interface contains specific *user interaction components*. Gabbard defines "icons, text, graphics, audio, video, and devices through which a user communicates with an interactive system"[5] as user interaction components of virtual environment. These components are often "poorly designed and rarely evaluated with users"[6].

User interaction components together with visual quality and rendering efficiency influence user experience. *User experience* can be defined as complex of feelings from interaction with the browser. Garrett puts user experience into the context of the whole company.

> It is user experience that forms the customer's impression of company's offerings; it is user experience that differentiates a company from its competitors; and it is user experience that determines whether your customer will ever come back[7].

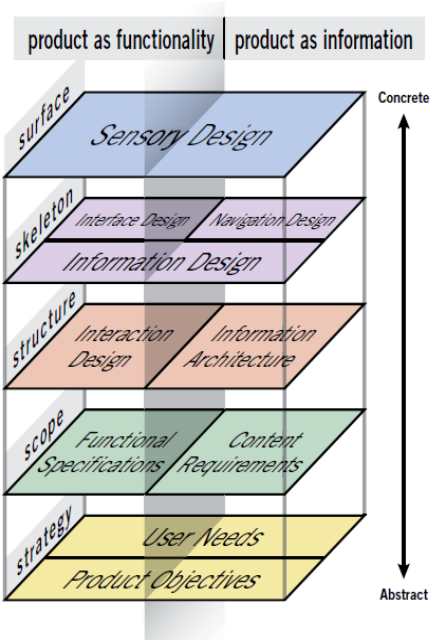
If the browser has an efficient and engaging user experience, then users are likely to use it for work and completing tasks.

We should point out the term *usability* as well. Usability generally means developing browser as easy to use as possible. Garrett says that the usability means different things to different people. "Some people use it to refer to the practice of testing designs with representative users. For others, it means adopting a very specific development methodology"[8]. Zaphiris and Ang specify three key factors of usability: effectiveness, efficiency and satisfaction. The effectiveness stands for a level to witch the intended goals of use of the overall system are achieved. The efficiency is amount of resources that have to be expended to achieve the intended goals. The satisfaction is the extent to which the user finds the overall system acceptable[9].

The chapter Background and basic terminology clarified HCI as background science for designing and evaluation of virtual world browser. We also defined terms interface, interaction components, user experience and usability which are often used in following chapters.

3. Applying User-centered design on virtual world browser

Software engineering is a process of software development which is traditional domain of software engineers - programmers and IT specialists. They focus on function and smooth working of software. They develop a programmer code and take care about overall system. Gabbart, Hix and Swan consider this approach *constructional*. They combine constructional domain with *behavioural* one, which represents view of the user and user interaction with the application. These domains – constructional and behavioural together are needed for designing reasonable system, which provides appropriate user experience[10]. We could consider these two domains as foundation of *User-centered design (UCD)*, which is presented in this chapter.



Picture no. 1. UCD design by Garret.

UCD is unique due to its focus on end-user. Every single process within development process considers user´s needs and tasks. Software is designed for users, not for itself. Companies should

fully apply UCD to make users satisfied with the product. Unfortunately it seems to be the opposite. Although UCD was already coined by Norman and Draper in 1986, the method is not planned and consistently applied. UCD is involved rather unconsciously or inadvertently and that causes lax and incomplete solutions.

UCD framework by Garret is made from five-level scheme (See picture no. 1.) which is called *User experience planes* and is assigned for a web. I am going to try to redesign it for virtual world browser, which is used as communication and collaboration tool within company. Every level (from bottom up) represents specific plane, which has to be accomplish during a design process. If all planes are developed, the browser should accommodate appropriate user experience. Each plane influences all higher levels.

All findings from each plane should be incorporated into one document, which I call the *project specification document*. The document serves as a main information source for software engineers and potentially new members of developer team or project partners.

3.1 Strategy plane

Strategy plane is important to explain **why we are developing** the browser. *User needs* and *Product objective*s are defined here.

User needs must be addressed because we need to know, what do users want from browser, what task they are dealing with or how do they work etc.

Products objectives are important for developers because they state developer´s expectations. Indicators that track whether the browser meets defined strategy should be set. All findings should be written down into the *project specification document*.

3.2 Scope plane

Scope plane is divided into *Functional specifications* and *Content requirements*. This plane is needed for defining **what exactly we want to design**.

Garret defines *Functional specification* as a document where all requirements are expressed. It contains requirements from user and from stakeholders (company members). For instance, we assign communication as higher priority function than tools for payment or editing avatar within our browser.

Content requirements determine way of delivering information to users in future. It is advantageous to know what content we are going to push to user in advance. Another question is what type of format we deliver. Is it pictures, video or just text? For instance, what language should browser accommodate? Do users of virtual world want to download content (presentations, documents, pictures atc.)? We should know how error messages are being displayed for instance. All findings should be incorporated into *project specification document*.

3.3 Structure plane

Structure plane is a third plane in a row and contains *Interaction design* and *Information architecture*, which together **explain how browser works**.

Interaction design defines responses on user behaviour or what each interaction component does when user interacts with it.

Two things are hidden behind the *Interaction design*. Users have an experience from using different systems in past. Such experience is transformed into so called *conventions* - mental concepts encoded within mind. Once browser meets users` conventions, it becomes easy to use. I give telephone convention as an example. Users need a list of friends, from which they can choose who to contact and how within a virtual world. If we take cell phone contact list with "last call" with friends` and profile pictures as a convention, users could understand and work with contact list easier and in the way they are used to.

Secondly, *Interaction design* deals with error messages, which should not accrue and if they do, they should offer undo option or other solution.

Information architecture stands for conveying information to users. Structuring of content is one of issues of *Information architecture*. Information and function of browser should be structured differently for different types of users. For instance, company manager and employee need different information. *Labels* as "manager" and "employee" might contain different information and features within the browser. Manager can find information about adding presentation and controlling presence of workers. Worker finds information about receiving a file, or how to navigate within presentation.

Every *Interaction design* and *Information architecture* findings should be incorporated into *project specification document*.

3.4 Skeleton plane

The *Skeleton plane* makes previously **defined *Structure plane* more concrete**. There is *Interface design*, *Navigation design* and *Information design* incorporated.

Interface design is about buttons, fields and other interface components, which have specific look and location. User should see the most important interface components for their task first and unimportant components afterwards. In case of our browser, function button for speak should be more visible than button for appearance editing. Another example: if we want to present options of communication (voice and text-based), should we use drop-down list, where user can choose from options or action buttons "voice" or "text chat"? Naturally different situations require different options.

Navigation design helps user to orient within the browser. Users should know where they are. For instance, if they need to change volume of their microphone, first they have to find it and then they need to know how to quit from the option menu.

Information design serves as a glue of two previously explained designs. For instance, *Information design* is responsible for getting right information for

beginners. It should offer information, what function is provided by button "Voice" or how to set up a microphone. In other words it is mainly *Information design*, which comes to play whenever system provides instructions. For instance if error message says that something is wrong, but does not say what is wrong, it is *Information design* problem.

All these three designs should be incorporated into project specification document in a form of wireframe, which integrates *Interface*, *Navigation* and *Information design* into one picture.

3.5 Surface plane

Surface plane is the last plane of *UCD framework*. Surface of a browser is everything what user sees on screen. *Surface plane* contains *Sensory design* which **combines content, function and aesthetics of the browser**. It is important, because it influences human senses while virtual world is working on users tasks. In other words, *Sensory design* determines the arrangement of information elements visually.

The first sense we could point out is visual. In our example, browser buttons (for instance "Voice" button or list of friends) should attract user`s eyes at first. *Contrast* is an important characteristic of a surface. On the other side, *uniformity* of surface ensures that colour, size and text font do not distract user´s attention. Surface could be optimized using sophisticated eye-tracking equipment.

Hearing is another sense that needs to be taken into consideration. Sounds, not only quality of voice chat, but also notifications, are important. Correct or wrong sound can make environment confusing for users.

It is a big question how to design effective touch-based browser. Windows has developed Kinect, which can be used for controlling virtual world of Second Life by body motions. Here are again a lot of opportunities for research on the influence of gestures and motions on the user experience.

Findings should be also written down to *project specification document* to make it complete.

4. Evaluation and testing of virtual world browser

The chapter describes evaluation of virtual world browser, which we developed in previous chapter. In this chapter we use structured iterative methodology for evaluation of interactive virtual environment coined by Gabbard, Hix and Swan[11]. I present two of the four methods*: User task analysis* and *Formative user-centered evaluation*.

4.1 User task analysis

User task analysis is unavoidable process in evaluation and testing of browser and for the UCD methodology itself. I mentioned *User task analysis* in a context of the *Strategy plane* of UCD in previous chapter.

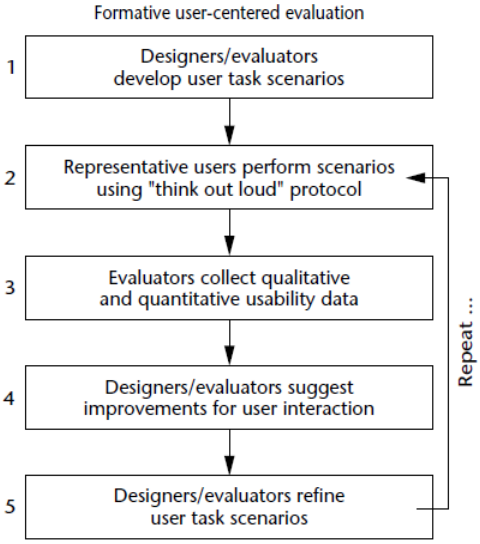
User task analysis is a process of "identifying a complete description of tasks, subtasks, and methods required to use a system, as well as other resources necessary for user(s) and the system to cooperatively perform tasks"[12]. Moreover, *User task analysis* identifies sequences and semantics, which determine relationships, hierarchy, ordering and importance of tasks. For instance, user has to find manager`s avatar at first (task 1) and then push button "voice" to start communication (task 2). Task 1 is a condition for task 2.

Detailed research on users and organizational goals and also social and organizational workflow is needed to identify relationships, hierarchy and ordering of users` tasks.

Data for *User task analysis* can be gathered from interview, questionnaires and observations or by using combinations of two or more presented methods.

4.2 Formative user-centered evaluation

Formative user-centered evaluation is defined as an empirical, observational evaluation method, which aims to iteratively and quantifiably assess and improve user interaction design. In this case, users participate on evaluation process. Picture no. 2 shows cycle of five step process. It starts with development of user task scenario based on *User task analysis*.



Picture no. 2. Formative user-centered evaluation by Gabbard, Hix and Swan.

Scenarios are then performed by users and evaluators collect qualitative and quantitative data using *Thing aloud protocol*, which records users` comments and feelings. If user can not finish the task, or there is another problem, it comes as critical accident. Every critical accident generates qualitative data. Quantitative data are represented by time needed to finish task or number of errors accrued during scenarios. Let`s consider our browser and scenario of finding manager`s avatar and establishing communication using "voice". User cannot find manager, because manager`s avatar is located in different place (critical event – qualitative data). Users spends ten minutes searching (quantitative data), finally he finds manager and push button "Voice".

System recalls connection error (critical event – qualitative). Connection is established at the third attempt (quantitative data – two errors appeared).

Gathered data serves as a background material for design changes suggestions. After all, scenarios can be refined and the process repeated.

5. Conclusion

The paper presented *UCD* and *Formative user-centered evaluation* as a suitable methodology for designing and testing virtual world browser. Both methodologies involve user into their process themselves, which makes final browser usable and suitable to users' needs.

Nowadays, there is a diversification among how users enter and operate virtual world using browser. There are web-based browsers or incorporated browser into Facebook and in my opinion there is going to be a lot of other innovations in future. But still, the technical part is not good enough. Companies have to run research on user behaviour, perception and cognition while using virtual world. Understanding users` comes first.

Notes

[1] Mark W. Bell, 'Toward a Definition of "Virtual Worlds", *Virtual Worlds Research: Past, Present & Future*, vol. 1, no. 1, 2008, <http://journals.tdl.org/jvwr/article/view/283/237>, p. 2.

[2] Chris Dede, and Brian Nelson, and Diane J. Ketelhut, and Jody Clarke, and Cassie Bowman, 'Design-based research strategies for studying situated learning in a multi-user virtual environment', *Proceedings of the 6th international conference on Learning sciences*, Santa Monica, California, International Society of the Learning Sciences, 2004, p. 1.

[3] Christy Perrey, 'Gartner's 2010 Hype Cycle Special Report Evaluates Maturity of 1,800 Technologies', Gartner Newsroom, Oct. 2010, Fab. 2011, <http://www.gartner.com/it/page.jsp?id=1447613>.

[4] 'Issues of Human Computer Interaction' (An Interview with Anabelo Sarmento). *Information Technology Newsletter*, vol. 15, no. 2, 2004, p. 15.

[5] Joseph L. Gabbard, and Deborah Hix, and J. Edward Swan II, 'User-centered design and evaluation of virtual environments', *IEEE Computer Graphics and Applications*, vol. 19, no. 6, 1999, p. 2.

[6] Gabbard, and Hix, and Swan II, 'User-centered design and evaluation of virtual environments', p. 2.

[7] Jesse James Garrett, *The elements of user experience : user-centered design for the Web and beyond, 2nd ed, Voices that matter* (Berkeley, CA: New Riders, 2011), p. 12.
[8] Garrett, *The elements of user experience : user-centered design for the Web and beyond, 2nd ed, Voices that matter*, p. 48.
[9] Panayiotis Zaphiris, and Chee Siang Ang , 'Section I. Fundamental Concepts and Theories', in *Human computer interaction : concepts, methodologies, tools, and applications*, ed. Panayiotis Zaphiris, and Chee Siang Ang, ed (Hershey, PA London: Information Science Reference, c2009), p. xxxv.
[10] Gabbard, and Hix, and Swan II, 'User-centered design and evaluation of virtual environments', p. 2.
[11] Gabbard, and Hix, and Swan II, 'User-centered design and evaluation of virtual environments', p. 2 – 7.
[12] Gabbard, and Hix, and Swan II, 'User-centered design and evaluation of virtual environments', p. 4.

Bibliography

Bell, Mark W. 'Toward a Definition of "Virtual Worlds"'. Virtual *Worlds Research: Past, Present & Future*, vol. 1, no. 1, 2008. p. 1-5, <http://journals.tdl.org/jvwr/article/view/283/237>.

Dede, Chris, and Nelson, Brian, and Ketelhut, Diane J., and Clarke, Jody, and Bowman, Cassie. 'Design-based research strategies for studying situated learning in a multi-user virtual environment'. *Proceedings of the 6th international conference on Learning sciences*, International Society of the Learning Sciences, Santa Monica, California, 2004, p. 158-165.

Gabbard, J. L., D. Hix, and J. E. Swan Ii. 'User-centered design and evaluation of virtual environments'. *IEEE Computer Graphics and Applications*, vol. 19, no. 6, 1999. p. 51-59.

Garrett, Jesse James. *The elements of user experience : user-centered design for the Web and beyond. 2nd ed.* Berkeley, CA: New Riders. 2011.

'Issues of Human Computer Interaction'. (An Interview with Anabelo Sarmento*). Information Technology Newsletter, vol.* 15, no. 2, 2004. p. 15,23.

Perrey, Christy. 'Gartner's 2010 Hype Cycle Special Report Evaluates Maturity of 1,800 Technologies', Gartner Newsroom, Oct. 2010.

<http://www.gartner.com/it/page.jsp?id=1447613>.

Zaphiris, Panayiotis and Ang , Chee Siang. 'Section I. Fundamental Concepts and Theories'. In *Human computer interaction: concepts, methodologies, tools, and applications*, edited by Panayiotis Zaphiris, and Chee Siang Ang, xxxv - lvi. London: Hershey, PA, Information Science Reference, 2009.