

Usability and Accessibility in Web 3D

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ABSTRACT

In this paper a model for usability/accessibility evaluation methods for application in Web 3D social software is being introduced and exemplified by looking at the currently popular phenomenon Second Life. The social aspect of specific Web 3D functions/applications will be in focus, as well as the issue of accessibility which poses an important aspect in Virtual Reality (VR) worlds. This plays a role especially for official institutions that wish to set up a presence in Web 3D, due to current legal developments that strengthen accessibility requirements.

Author Keywords

Second Life, Social Software, Usability, Accessibility, Web 3D

ACM Classification Keywords

H5.m. Information interfaces and presentation: HCI, Miscellaneous.

INTRODUCTION

Short Overview of Web 3D Background

Web 3D has been around for more than 10 years but it has not become very popular until 2006 when a big media awareness began to hype a phenomenon called Second Life, an online multi role-player game-like 3D world. It all began back in 1995 with VRML (Virtual Reality Modeling Language [17]), a standard for internet 3D graphics presentation. Much similar to HTML the source code of a 3D presentation is provided in plaintext and is interpreted by a special browser (also called “viewer” due to its visual application) or web-browser plugin. The same concept underlies VRML’s successor, X3D (short name for “Extensible 3D”), which was released as ISO standard in 2004, providing advanced functionality. Its most well-known viewer application is the “Octaga Viewer” [10], which plugs into most web-browsers and Adobe Acrobat.

Second Life and the Grand Challenges

Nowadays, however, most people who use Web 3D use Second Life (SL). Len Bullard, an experienced X3D Guru puts it this way: “[...] it appears that X3D is simply too difficult to use and the money is going to be made in SL or similar ‘user friendly environment’ that are focused on social spaces and shared worlds.” [9]

The reason is that content creation in SL is much more intuitive than in native X3D. In SL, the content is added and modified “in-world” instead of in an external editor. This obviously lowers the barrier for a user to start building things, as illustrated in *figure 1*. This concept is known from Web 2.0 applications like Youtube, Myspace or Flickr, where users themselves become authors without having to know anything about web design. This corresponds to the first “great challenge” put up by Lawrence A. Rowe and Ramesh Jain in their ACM Report on Future Directions in Multimedia Research [13]:

“To make authoring complex multimedia titles as easy as using a word processor or drawing program.”



Figure 1: Content creation in Second Life

Another reason for the relatively high acceptance¹ of SL is that it is designed for social interaction between users (or their avatars, that is). A search function, user group functionality, public and private chats and more gadgets facilitate this concept. Considering also the immersive VR factor of a 3D world, this addresses the second “grand challenge” in the paper quoted above:

“To make interactions with remote people and environments nearly the same as interactions with local people and environments.”

Altogether meeting the two challenges quoted above form the cornerstone for well-designed social software. However, our intention is to go a step further and extend requirements by the often-overlooked principle of accessibility. Apart from the fact that accessibility has a high priority on the EU-Commission’s Agenda [8] we also consider this specifically important in our Web 3D context, because in an avatar-based VR world like SL, where users identify themselves with their “virtual existence”, certain limitations that obstruct the life of disabled persons in “reality” are no longer compelling. Creating an immersive VR experience that heeds at least most of the requirements of the *W3C Web content Accessibility Guidelines* [19, 20] is a third challenge which supplements the two aforementioned ones and therefore we deliberately include it into our discussion.

Accessibility

Web accessibility aims to provide access to the web to any person, including those with disabilities. A web page or site is considered accessible when it is designed and implemented so that its contents and services are available for any person, independently of his/her navigation context. This initiative not only benefits handicapped people, but also users with technological obstacles either because of using obsolete equipments or latest new ones. Moreover, accessibility can improve the web experience for any user, handicapped or not, as it is closely related to usability.

Despite its youth, web content accessibility is a major concern nowadays, and the guidelines promoted by the W3C Web Accessibility Initiative have widely spread. Legal and ethical issues support this initiative, as the information society cannot exclude an important percentage of its citizens simply due to a disability. Thus, different countries have developed laws which regulate web accessibility, such as Section 608 in USA, European

¹ *But what about World Of Warcraft (WOW)? Doesn't it even have higher user numbers? Yes we know that, but we don't refer to WOW as a Web 3D, because – while clearly facilitating social interaction – it lacks the possibility for own content contribution. Also WOW has clear global game rules and goals to be achieved and therefore it is a game, not a web.*

Directive, etc. As Tim Berners-Lee, Director of the W3C puts it:

“The power of the Web is in its universality. Access by everyone regardless of disability is an essential aspect.”

Based on the same principles, accessibility should be a requirement for Web 3D too and some initiatives are appearing in order to fulfill it. In fact, from its beginnings, Web 3D characteristics have been considered a powerful opportunity for improving accessibility; real buildings can be simulated and avatar gestures can represent Sign Language expressions. However, two main barriers obstruct this objective. On the one hand, Web 3D accessibility poses obvious technical challenges. On the other, there is an important lack of awareness about the problem among 3D users.

Whereas web content accessibility is continuously spreading and there is an increasing awareness of its need and convenience, there is a worrying lack of accessibility awareness in other fields, being games a characteristic example. Web 3D users show the same problem and there is an important lack of awareness about accessibility issues, as discussions in on-line forums show [11]. In this sense, it is considered unnecessary (“*it's a game*”, “*it's not mandatory*”). However, as Web 3D evolves and more and more services are offered, discrimination will become critical; e.g. nowadays there is already an embassy in SL. It's also considered a non-sense, impossible mission: web 3D is considered visual, thus it's a non-sense trying to adapt it to blind people; that would be just chat. However, accessibility is not impossible, as it has been demonstrated in similar contexts like 3D games (for example the game *Terraformers*, a 3D game able to be played by blind people, see www.terraformers.nu) and in Second Life itself. It is not only about blind people either, but benefits non-handicapped users too. More important, being a complete, alternative world, it should not be closed for real-life handicapped people.

In conclusion, rising accessibility awareness is a critical task, as Web 3D is mostly generated by the users themselves. Even if the platform were accessible, the generated content should also consider accessibility issues. Thus, a critical work on user education is needed. In addition to accessible interfaces, providing tools which facilitate the development of accessible content as well as objective evaluation metrics can help to achieve a non-discriminative Web 3D. Providing a simple and holistic metric can help achieving these objectives.

INTO THE DETAIL

Software quality rises and falls with the degree of usability. Web 3D, since aiming far into VR direction, poses a number of specific aspects to be taken into account for the

evaluation of usability. We will first cover Characteristics of Web 3D by looking at the SL interface and some sample applications. Then, from that end, we will develop a usability metric helping to soundly assess the quality of Web 3D applications. We will elaborate on accessibility as a very important but often overlooked criterion to be accounted for in an overall rating of such a system.

Characteristics of Web 3D

The first widely noted (VRML based) Web 3D “Active Worlds” went online back in 1994. However, it never became a huge success, due to various problems, most of which were caused internally by corporate politics [2]. Nevertheless Active Worlds stayed on, and is still running.

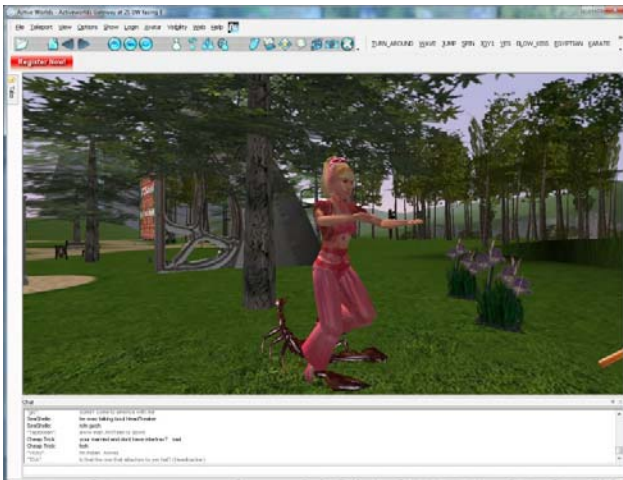


Figure 2: Version 4.1 of Active Worlds (released 2006)

There are two sides of comparing an “old school” Web 3D like Active Worlds with the “state of the art” SL. For once we can state that the system’s look and feel is not much different from each other (compare *figure 1* to *figure 2*). Both systems are avatar-based, you can walk around and fly, text-chat with other people publicly or privately, and, if signing up for an “advanced” account, design and contribute content. Many of the concepts have not changed over a long time, and therefore can be considered persistent architectural principles. The other side of the coin, however, arouses the question why SL is so much more successful if it is so similar to Active worlds.

There is no easy answer to this, but (supported by [15]) we can bring forward a theory: Active Worlds was too early. 3D hardware was not developed enough to make VR experience fun. Therefore Active Worlds was brand marked as slow and clumsy and even though development both of soft- and hardware would progress, that reputation persisted. SL on the other hand was new, people gave it a chance, and behold, despite all bugs and breakdowns, it worked out, simply because it still was better than anything else around, functioning quite well on most current computer hardware.

One of the key properties of a Web 3D environment is that in order to make it accessible to the casual non-disabled

user with only standard computer equipment (2D monitor, mouse, keyboard, sound support), a certain degree of abstraction is necessary. A 3D world has to be projected to 2D, real world body motion control has to be translated to keyboard shortcuts and mouse input, and then augmented by “super-natural” attributes like flying or teleporting which to a certain extent make up for the inconvenience. This HCI issue is, by the way, a reason for the persistence of architectural principles not having changed over a long time. Fancy user interface enhancements like data gloves (or suits) have remained as stifling and expensive as 10 years ago [4]. (The latter, though, become interesting again if Web 3D content is to be made accessible to blind people.)

Web 3D typically uses a “thin client, thick server” concept, which accommodates for user’s limited computer resources and at the same time accounts for centralized maintenance of dynamic content. The possibilities of financial exploitation of a centralized server architecture plays a major role in Linden Lab’s (SL founder company) market strategy.

Usability Metrics

The criteria for the evaluation of software usability differ between each (type of) application. In order to benchmark appropriately, also a standardization of evaluation methodology [3] is indicated. However, in this approach we focus on *what* to evaluate and how to rate it. We will now propose a usability metric, accounting for the specific characteristics of Web 3D.

Before unfolding a formal metric that will be used to ultimately conceive a universal formula for measurement of Web 3D software quality, we would like to explain about the chain of reason that deductively leads us to our somewhat holistic approach.

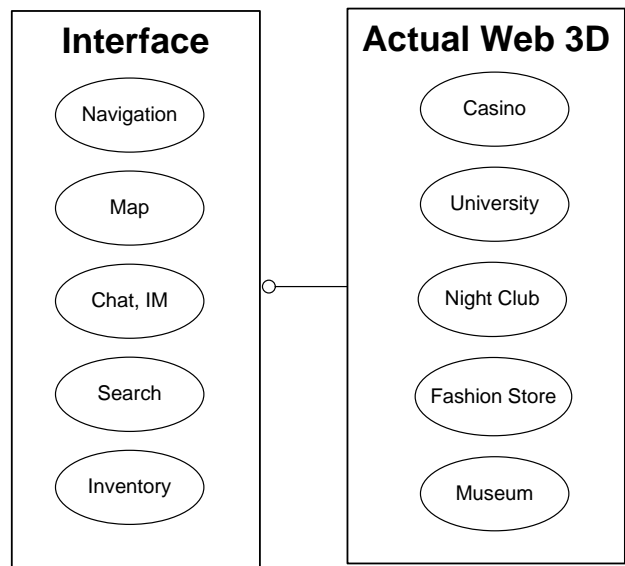


Figure 3: Web 3D Interface / Application Framework example.

Our approach is rooted in a generic principle of Web 3D interface/application architecture (*figure 3*):

To access actual Web 3D applications the user has to employ the interface application, commonly called “viewer”. Thus, the degree of usability of a Web 3D application is always to be normalized against the degree of usability of the interface and its sub-applications. A general metric would therefore yield a usability quality indicator U with

$$U = \|\varphi \cdot \omega \cdot S\|$$

where φ denotes the general interface usability score and ω denotes the application usability score. S denotes the “specification” score achieved by the sub-applications of the interface to be employed for use in the Web 3D application. For example the “chat” sub-application will be used more frequently for using a dating service (or night club, like illustrated in *figure 3*) than a museum, therefore has to be weighted with a higher factor in this context. Therefore we have

$$S = \sum_{i=1}^n \mu_i a_i$$

where out of a total of n sub-applications μ denotes the i -th sub-application’s individual usability and a the factor of applicability (frequency and importance of use on a specific application).

Social function as specific performance indicator

In order to also assess social function to factor into above equation we are proposing that for obtaining the ω factor an additional score bonus should be added if the application is frequented by a certain minimum number of users. Considering usability, the presence of other users is particularly important because it is possible to get “howto” information as simple as by just asking other users. The more intuitive and easy to use the functions for finding or contacting other users are, the more the aspect of socializing gets facilitated. This also should be considered in obtaining the “specification score” defined above, by adding weight to sub-applications like Chat/IM.

Accessibility Metrics

Nowadays, the most widespread web content accessibility measure is the qualitative levels proposed in the WCAG 1.0 by the WAI [19]: 0, A, AA and AAA. Some quantitative metrics have also been proposed [6, 7, 14, 16], most of them based on the WAI guidelines and automatic assessment tools. However, WAI WCAG 1.0 mainly applies to static html web pages. Specific guidelines are being developed for dynamic content based on Javascript [1] and WCAG 2.0 [20] is being developed to apply broadly to different technologies now and in the future; be easier to use and understand; and to be more precisely testable with automated testing and human evaluation, as documented in Requirements for WCAG 2.0 [12].

Despite its name, Web 3D information is not compiled in simple HTML files, but in a complex, interactive, immersive 3D environment. Thus, specific accessibility guidelines and evaluation criteria need to be developed, but accessibility requirements application to both interface and content remains as well as main principles [20]:

- Principle 1: Perceivable (p) - Information and user interface components must be perceivable by users
- Principle 2: Operable (o) - User interface components must be operable by users
- Principle 3: Understandable (u) - Information and operation of user interface must be understandable by users
- Principle 4: Robust (r) - Content must be robust enough that it can be interpreted reliably by a wide variety of user agents, including assistive technologies

A global accessibility indicator can be obtained considering all these factors:

$$A = \|p \cdot o \cdot u \cdot r\|$$

Accessibility metrics provide a measure of how accessible the information is and the operation and interaction with the system for any user, independently of the user’s navigation context. Logically, accessibility errors correspond to different priorities depending on how critical they are. However, not all content or activity are equally relevant. For example, it is less critical that a user cannot use a VoIP application if (s)he has an alternative chat. Accessibility errors should be weighted by the relevance of the information lacked in addition to the priority of the error itself. This, of course, introduces a semantic component in the metric, which is unavoidable.

On the other hand, although a global measure is necessary, it is also convenient distinguishing the accessibility degree for a specific disability. A handicapped person would probably be more interested in a personalized accessibility metric, which evaluates his/her specific problems. In consequence, we encourage breaking down this global measure into a more detailed vectorial metric, whose components correspond to specific accessibility measures for different handicaps.

Each accessibility component can be analyzed regarding specific disabilities:

$$\vec{P} = (p_v, p_a, p_m, p_t)$$

with p_v, p_a, p_m and p_t being components each representing specific accessibility indicators regarding visual, auditory, motor and technical handicaps, respectively. An individualized metric for a given user (\mathcal{A}_u) can be calculated from a user model vector, which weights the importance of each disability for such user, and the accessibility measures projected into each disability axis:

$$\mathcal{A}_{ui} = (u_v, u_a, u_m, u_t) \cdot \begin{pmatrix} p_v & o_v & u_v & r_v \\ p_a & o_v & u_v & r_v \\ p_v & o_v & u_v & r_v \\ p_v & o_v & u_v & r_v \end{pmatrix}$$

$$= (p_{ui}, o_{ui}, u_{ui}, r_{ui})$$

Hence, a holistic personalized accessibility indicator can be calculated from the general formula:

$$\mathcal{A}_{ui} = \| p_{ui} \cdot o_{ui} \cdot u_{ui} \cdot r_{ui} \|$$

Universal Quality Metrics

If a system is non-accessible to users with certain disabilities, naturally it is also non-usable to them. On the other hand an accessible system is not very helpful to anyone if the design of its “actual purpose” application is flawed or a total failure. Considering additionally the specific legal aspects and the VR aspects discussed above we propose a metric that accounts for a universal quality measure Q , bringing together Web 3D usability and accessibility scores including all their subsets and criteria:

$$Q = \| A \cdot U \| + c$$

We also include a variable c that can be used for bias or tolerance because, as argued above, usability and accessibility are never completely independent. A classification derived from this metric may e.g. include four levels of quality, spanned by the two axes of a graphic representation of the A and U dimension.

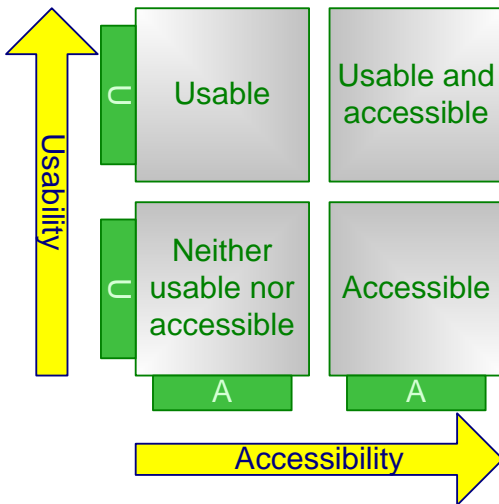


Figure 4: Two dimensional quadrant classification (schematic)

Considering A and U as support vectors of a two-dimensional vector space we can re-interpret c as a base transformation matrix for visualizing the interference between A and U (c has to be two-dimensional in that case, resulting from looking at values obtained from both sides of

mutual interference between U and A). The result would be a shear strain of the vector space as illustrated below.

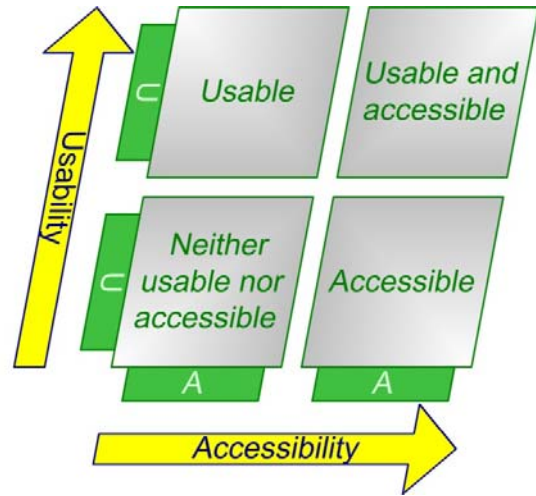


Figure 5: Sheared 2 dimensional quadrants after interference-induced base transformation (schematics)

CONCLUSION

Concluding we would like to remark that the metric we are proposing is very general and cannot be used without carefully being fitted to the respective characteristics of an application and/or its users. We have tried to account for this in terms of accessibility, but in usability this incorporates so many factors that any further specification will be subject to future research. In Web 3D, special factors have to be considered, such as social factors and VR specific aspects predominantly concerned with characteristics of interaction design. By specifically including accessibility issues in our discussion we hope to raise awareness toward the importance of a non-discriminative development of Web 3D.

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