Research on Credibility and Immersive Virtual Environments
Virtual Information Behavior Environments (VIBE) Project

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Phase II Investigation: *The Future of Information Seeking & Services Expo*

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Executive Summary

What do virtual worlds bring to the information problem-solving table? What do immersive, virtual environments make possible that 2D, web or database-centered information systems cannot? How can general users as well as information services and providers take advantage of the rich, immersive experience for effective, credible, and effective information problem-solving?

Phase II of the VIBE project explored these questions and some of the opportunities and limitations found in Phase I of the project through design, exploration, interaction, and observation in a major exposition in Second Life. We called this event the *Future of Information Seeking & Services Expo, (*abbreviated as *Future InfoExpo).* The *Future InfoExpo* was conceived, designed, implemented and studied by the VIBE research team and 2b3d, a virtual worlds development and research company.

Figure 1: The *Future InfoExpo* in Second Life

Information and communication systems are becoming more immersive and pervasive. Concurrently, new affordances and uses are possible, which users and information providers will need to learn and adopt to become efficient and effective. Therefore, this *Future InfoExpo* was a milestone in enabling users and information providers to experience and envision the future of their information practices and to provide feedback on their experiences.

The Future InfoExpo was important because it offered "proof of concept" to a number of engaged users with new functions and capabilities. Users and information providers experienced, envisioned, and evaluated possible information practices in virtual environments and provided feedback on their experience.

The VIBE team and 2b3d designed new virtual world tools and functions that supported a variety of information practices in virtual worlds—from organizing information to assessing information sources. Through six distinct exhibits, participants were able to experience the approaches and capabilities first-hand, take part in evaluations, raise key concerns and issues, and make recommendations about features, functions, or approaches. The six exhibits were:

(1) **Orientation**: Setting a baseline of similar user experiences.

(2) **Who Do You Choose**: Use of current Second Life profiles to assess credibility and trust.

(3) **SL Suggests**: Trust based on an enhanced dynamic recommender system.

(4) **Smart Access**: In-world access to web-based information sources and search systems

(5) **Sorting Soirée**: Organizing in 3D for use of information

(6) **Virtual Study Room**: Information problem-solving incubator.

The team collected and documented the actions and reactions of participants, evaluated the designs that worked, those that didn't, and determined how to improve these in order to enhance information seeking and use practices in virtual worlds.

Key findings and conclusions from Phase II of the project:

- Designing and implementing a unified "virtual exposition" is an effective and efficient research approach for demonstrating and testing new or expanded technological capabilities and functions.

- A number of special tools were adapted or newly developed for the *Future InfoExpo.*
  - ✓ The orientation exhibits were effective in setting baseline competencies for participants.
  - ✓ The Heads-Up Display (HUD) is a highly effective tool for gaining consent, coordinating activities, tracking progress, administering surveys, capturing data, and ensuring privacy and security.

- For trust and credibility:
  - ✓ SL users typically rely upon recommendations by others in seeking and trusting others for information.
  - ✓ SL residents do not value SL search tools for credible information seeking.
  - ✓ Profile fields are important in determining the credibility and potential usefulness of other residents.
  - ✓ Role or Position in SL is also a factor and so is the willingness to share first life descriptions including "About Me" and "Expertise." About Me was judged the most important description for credibility.
  - ✓ Adding a "recommender system" would improve the SL Profile . The important types of information to provide include positive (and negative) comments from reviewers, comments about other avatars, and information about expertise.

- ✓ A star rating system (based on averaging user ratings) was rated less important and should be studied further as this finding may have implications for the many web and app-based rating systems that currently exist.

- For expanded access to resources and information beyond the virtual world:
  - ✓ Easy access to information and resources beyond virtual worlds is definitely important.
  - ✓ There is strong overall preference for tools that facilitate accessing web-based information from within SL. In the future, this may also relate to information stored on smart phones, tablets, and other devices.
  - ✓ New SL capabilities for accessing web-based information and search tools were well-received. All three tools developed were uniformly regarded as easy to use, helpful for accessing web-based information, fun to use, novel, and useful for sharing information with others.
  - ✓ Results indicate that users value any tool that can afford this capability, rather than any one tool in particular.
  - ✓ Some participants reported difficulties when using the tools. Tools need to be easy to learn and use.

- In terms of organizing information for effective and efficient use,
  - ✓ The 3D virtual environment offers unique capabilities for representing, organizing, and manipulation of information and this was recognized and valued by participants.
  - ✓ Information organization—possibly combined with 3D visualization—has the potential to be one of the "killer app" capabilities of SL and other virtual worlds.
  - ✓ The Posted Note and Matrix approaches are ready to be refined and implemented as tools in virtual worlds.
  - ✓ The concept of representing information on multi-sided objects as represented by the InfoCube requires further development, particularly in terms of simple and direct manipulation of objects.

- Regarding the concept of the Virtual Study Room,
  - ✓ The *FutureInfoExpo* successfully demonstrated the concept of user-centered virtual study rooms that facilitate information problem-solving and focused study and work.
  - ✓ Participants immediately grasped the potential, usefulness, and value of having separate spaces for different projects, problems, and work, and not having to use the same space for multiple tasks.
  - ✓ A large majority of respondents would use the Virtual Study Room if available in SL (or another virtual world) or would seek out a virtual world to specifically use a Virtual Study Room.

In sum, the *Future InfoExpo* highlighted exciting new capabilities for the information problem-solving in terms of access, evaluation, and use of information in a 3D immersive environment, and offers clear directions for future research.

PROBLEM STATEMENT

From Phase I of the Virtual Information Behavior Environments (VIBE) project, we learned that at present, the majority of Second Life (SL) users do not turn to Second Life for information purposes. Most Second Life users (referred to as "residents" in Second Life) use SL primarily to attend events, for activities, and to interact socially with others, individually or in groups. These social interactions may include querying other users about how to use different SL functions or serendipitous everyday life information sharing. Information exchange is generally a by-product of social interactions, not a prime motivation. Phase I concluded that Second Life is not used or perceived first and foremost as an environment for information problem-solving—i.e., to address the need of seeking, assessing, organizing, synthesizing, and sharing information in everyday life situations. We concluded that given the current state of development of Second Life as well as the experiences and perceptions of residents, most would not choose Second Life to seek and use information to address information problems related to work, school, or even everyday life. VIBE Phase I focused specifically on health- or politically-related information needs, e.g., treatment for a disease or the latest development of political debates. We sought out experienced SL residents' knowledge about the average or typical SL resident, and found that the typical SL resident does not naturally think of looking for or finding such information in Second Life.

However, even though Second Life is currently perceived and used primarily as a social environment[1] rather than an environment for information seeking or access to information services, it does have a rich potential as an information problem-solving setting because of emerging patterns of use and expectations, unique, immersive and 3D capabilities, and integration of cutting edge technologies in SL.

Adoption of a technology first for social purposes and later for purposeful information seeking, use, and transfer is observed with other technologies as well—for example with Twitter. Initially used primarily for social purposes[2], Twitter's power as a key environment for sharing and seeking late-breaking news information in crisis situations did not become evident until the Iranian election protests in June 2009. Crises events and the need for immediate, first-hand information, validated

[1] Second Life is a social environment because the majority of users engage in social activities (affiliating with common interest groups, attend events and meetings) rather than in competitive gaming (with a win/lose paradigm; see Ostrander, 2008).

[2] Evidence that Twitter was initially used primarily for casual social communication rather than to spread and seek timely news can be seen in early publications about Twitter. For example, Java et al. (2007) describe Twitter content in terms of people's "activities, opinions, and status". While topics describe "range from daily life to current events, news stories, and other interests", "most posts are about daily routine or what people are currently doing." Note also the focus on friends, family, and coworkers in Huberman et al. (2009)'s description of twitter, omitting public affairs, crisis news, and uses which have made twitter known worldwide: "an online social network… to stay connected to their friends, family member and coworkers."

Twitter's key affordances—e.g., free, highly mobile, very personal, very quick, built to spread, enabling topic clustering (e.g., through hashtags[3]), and hard to control centrally (Grossman, 2009).

Emerging technologies seem to follow (over varied time frames) a pattern of positive hype (through early adopters and media frenzy, but not yet substantiated by stable widespread use) followed by negative expectations (when the technology does not meet the expectations set by the initial hype), and eventually gaining stability in expectations and adoption maturity—when enough evidence and acceptance exists on the benefits of the technology. (Gartner, 2009; 2003).

Phase II of the VIBE project started from this premise—that social virtual worlds like Second Life have not yet reached a plateau of maturity and promise, and that their affordances are not well explored, experienced, understood, or communicated. We believe that immersive, 3D virtual environments will become valued and even preferred settings for information problem-solving for specific information seeking, use, and communication activities. In addition, various virtual capabilities (e.g., avatars, 3D, immersive, interactive, able to move in virtual space) will become commonplace in computer, communication, and recreational systems.

To highlight and study new features and capabilities that support information problem-solving in virtual worlds, we designed and presented an in-world *Future of Information Seeking & Services Expo.* This Future InfoExpo showcased proofs of concept of creative and interactive information experiences. Additionally, through the design of alternative SL tools, we addressed some of the limitations observed during Phase I of the VIBE project and offered alternative futures. These experiences were aimed to:

1) Engage resident users and information services providers (e.g., Q&A services, libraries, database providers, search and social media utility providers) in the use of current SL tools and new prototypes aimed at supporting diverse information practices.

2) Offer information providers approaches for delivering integrative services and resources across multiple media formats.

3) Get participants' feedback on their interaction with the showcased designs.

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[3] Hashtags on Twitter are identified by the "#" symbol, used to "mark keywords or topics in a Tweet" or a microblogging message posted on twitter. This is a way to dynamically categorize messages. See http://support.twitter.com/entries/49309-what-are-hashtags-symbols

BACKGROUND: A SOCIAL VIRTUAL WORLD, LIMITED INFORMATION PROBLEM-SOLVING

Second Life can be regarded as a 3D *social virtual world*. Virtual worlds are computer and communications environments which support networks of individuals who interact through the virtual world, via distributed computers, for similar uses and purposes. The uses and purposes can be set either by the interacting individuals or by the unified structure reflected in the design of the virtual world (e.g., combat others or challenges to win). Virtual worlds are distinct[4] from other online forms of social interaction such as independent discussion forums, or web-based social networking tools[5], in that VW can bring users to a state of *immersion,* or being engrossed in the environment to the extent that the awareness of oneself (physical and mental) is transformed from one's original state to one deeply vested and surrounded by the environment[6]. Therefore, virtual worlds are also referred to as *immersive virtual worlds.*

In addition, a virtual world often takes the form of a computer simulated environment (objects and activities in the virtual world simulate a real or fantasy world's physics, economy, and social structure). Virtual worlds existed in textual forms, but today, virtual world systems typically offer graphical representations of data in the simulated environment, and users are typically represented as 3D avatars in virtual worlds.

Like other virtual worlds, Second Life affords users extraordinary capabilities in an immersive 3-dimensional environment. However, unlike Virtual worlds known as MUDs (multi-user domains) or MMOGs (massively multiplayer online games), Second Life is not based on a win/lose competitive paradigm[7]. Rather, the bulk of Second Life activity is in its residents' social interactions through groups, activities, events, and meetings[8]. Therefore, Second Life is a *social virtual world.*

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[4] Some other researchers highlight the "persistent" characteristic of virtual worlds—that the world exists even after a user has logged off. We purposefully avoid such distinction because other online communities formed around stand-alone discussion forums also exist even if a user logs off.

[5] While online communities (also referred to as virtual communities) may form through online discussion forums or social networks, it is important to distinguish between an online/virtual community and a Virtual World. An online community refers to the relationships and by-products of relationships between collections of people who use the computer system as a substantial medium for social interaction (Lin & McDonald 2006).

[6] The term "immersive environment" may have originally been used for "virtual reality," where the user feels physically placed within a virtual simulation of an environment (usually by wearing a device on their bodies, such as goggles, gloves, etc.) However, immersion is multidimensional, involving mental states. The present definition of immersion is based on various texts: (a) Nechtaval's 1999 dissertation http://www.eyewithwings.net/nechvatal/iicd.pdf; (b) Varney's 2005 article in *the escapist* magazine http://www.escapistmagazine.com/articles/view/issues/issue_57/341-Immersion-Unexplained, and (c) Adams' 2004 article in Gamasutra.com on "Postmodernism and the Three Types of Immersion" http://designersnotebook.com/Columns/063_Postmodernism/063_postmodernism.htm

[7] Ostrander (2008).

[8] See Second Life FAQ https://jira.secondlife.com/browse/WEB-330? A small percentage of users engages in multiplayer role-playing games (RPGs), but that is only a small percentage. Another aspect that distinguishes Second Life, is enabling users to build their own objects (land, clothing, etc.). However, such creations are still confined within the Second Life architecture. For example, users are unable to change the way in which communication channels work. In addition, based

Consistent with this definition of social virtual world, we find that for users deeply embedded in Second Life's social networks, call them *core users,* considerable information sharing occurs. However, core users are in the minority; and pre-requisites and outcomes of such information flow are the formation of common-interest Second Life Groups[9], simultaneously supported by other online media (e.g., email lists, wiki's, blogs, and personal communication channels like instant message and email off Second Life). Core users and those who use Second Life to extend their first life professional and life practices may create groups, events, talk shows, or educational tools aimed at distributing information which complements associated first life efforts. However, the majority and average users do not typically join Second Life for information seeking/sharing to address first life needs. Rather, they join Second Life to explore and/or find common interest groups/social relationships. With the exception of individuals and organizations that use Second Life to extend their first life professional practices, if self-motivated purposeful information seeking originates in Second Life, it tends to be for Second Life specific uses (e.g., how to build objects in Second Life, manage privacy, use communication tools, find/build Second Life groups/activities, or run an event in Second Life).

From Phase I, we noted that some of the current technological features in SL limit its value and use. Some of the barriers to more widespread use of SL include:

a) *Barrier to entry is high.* Barrier to entry or more wide-spread use of SL exists for at least 3 reasons:

(a.1) The time/effort required for registration and customization for acculturated use: users must be registered and spend considerable time developing their avatar before they can explore Second Life. Part of the selling point of SL is the highly customizable avatars. At the same time, even though canned looks are provided, such looks identify "newbies", and users tend to spend time customizing their avatars to showcase unique looks.

(a.2) Integrating other applications to use with/within Second Life is not user-friendly enough: Some of the uses that Linden Lab markets about Second Life are business meetings and socializing. However, the integration with software applications to successfully do each of these two functions is difficult for the average user, requiring multiple steps or hacking code. Although developers have made their code or applications available for using other applications (like power point, Facebook, or Twitter) with/within Second Life, Second Life has gone through numerous upgrades, resulting in non-functioning mashup applications[10], which developers have not upgraded, probably due to reason (a. 4) below.

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on our extensive observations, and in line with other researchers' observations, the social aspects are still what define Second Life for the average user. Any object building is done in support of other social activities, be it educational, organizational, or leisure.

[9] Most Second Life users do join Second Life groups, however being a member of a group or groups does not make someone a "core user."

[10] Much of the online information about merging applications dates back to 2006/2007. Based on comments from interested people, the code or application for integration no longer works. See for example, comments in http://oreilly.com/pub/h/5239 for how to give a power point presentation in SL, a discussion post on the SL Facebook page

(a.3) Track record within an outside of SL is not dynamically updated: This lack of easily mashable applications can also affect dynamic reputation building/management. Even though users can put information about themselves on their profile entry, and their SL group affiliations are part of the profile information other users see, there is no live update of user's accomplishments/creations within and outside of SL.

(a.4) Lack of critical mass and division between idiosyncratic subcultures: Second Life has been a gathering "place" for communities with scarce members (such as transgender individuals, those suffering multiple sclerosis) and with idiosyncratic subcultures which benefit from the ease of appearance manipulation in SL (such as Gorean, steampunk, cyberpunk, furry, or Vampire). Based on the extensive time our research team spent in SL, we believe that these idiosyncratic subcultures do not really interact with each other[11] and it is an open question on whether such lack of interaction creates a barrier to more wide-spread sharing of SL usage practices).

b) *Barrier to export is also high.*

Information created in SL cannot be easily linked to other popular social media or exported to other online environments, making SL a world disjoint from other social media. This can be particularly important for users' impression management and reputation building, particularly for those who have developed a high reputation in SL.

c) *Social navigation is difficult* despite the relevance of social interactions to the nature of SL's use:

(c.1) Avatar reputation is highly dependent on word-of-mouth: Even after using SL's search function to find other users and looking at their SL profile[12] information, users still depend on word-of-mouth recommendations to find out whether the SL user searched is a trustworthy source.

(c.2) Limited recorded and crowd sourced information about an avatar's reputation: When information or people resources are found, there is limited support for evaluating these resources. For example, there are no metrics to evaluate the credibility and trustworthiness of an information source in SL.

(c.3) Second Life tools, such as the SL map, do not efficiently support the social nature of behavior: Currently, the SL map enables users to see where other unidentified users are located, by dynamically representing users' location with a green dot on the map. However, the green dots do not reveal any other information about the avatars in that location. While privacy

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www.facebook.com/apps/application.php?id=10242435556#!/apps/application.php?id=10242435556&v=app_2373072738 and this SL Twitter mashup http://sl-devcorner.blogspot.com/2007/03/second-life-twitter.html.

[11] This lack of interaction between the SL subcultures is described also in a Wikipedia entry about community in Second Life, as of January 31, 2001 http://en.wikipedia.org/wiki/Second_Life#Community

[12] In SL, users can see information of other users (length of SL residence, partner, groups, and personalized description of self) through the user's "Profile" tab. This information (the other user's Profile) is available by right clicking on the avatar (if co-located), right clicking on the avatar's name on the user's "My Friends" list, or from a search result.

concerns need to be accounted for in technology design, the current SL map is an example of not using this 3D social virtual world to its potential. In our Future Information Seeking & Services Expo, we describe how the SL map can be put to more efficient use in the social virtual world of Second Life.

d) Limited support for information organization/evaluation: Textual information in SL does not take advantage of the immersive, 3D qualities. While SL enables users to build their own objects, currently, there is no readily available functionality that enables users to easily organize information in the 3D space. Organizing information, categorizing it, and visualizing it in multiple ways is part of evaluating information; and taking advantage of the 3D immersive environment can facilitate information organization and assessment in ways that current information systems are unable to do.

e) Limited support for information organization/evaluation: Textual information in SL does not take advantage of the immersive, 3D qualities. While SL enables users to build their own objects, currently, there is no readily available functionality that enables users to easily organize information in the 3D space. Organizing information, categorizing it, and visualizing it in multiple ways is part of evaluating information; and taking advantage of the 3D immersive environment can facilitate information organization and assessment in ways that current information systems are unable to do.

THE FUTURE OF INFORMATION SEEKING & SERVICES EXPOSITION

The *Future InfoExpo* was designed, implemented, and presented to have existing SL residents and other potential users experience and evaluate new virtual world features that support information problem-solving and to address some of the limitations observed in Phase I. The *Future InfoExpo* aimed at enabling users and information providers to experience and envision future information practices and provide feedback on their experience.

ADDRESSING PHASE I LIMITATIONS

We sought to tackle the limitations uncovered in Phase I by taking advantage of the immersive, interactive, and social qualities of the social virtual world of Second Life.

Conceptually, *immersion* refers to the state of being mentally and/or physically engrossed in the environment to the extent that the person being immersed changes her or his awareness of self. Feeling immersed is a conscious state that can be experienced at various levels: spatial, by feeling that one is “there” in the virtual world; sensory, by feeling engaged and stimulated by the environment through the various senses (visual, auditory, and tactile—even if through an avatar representation),

psychological, by being emotionally vested in the happenings of the environment (e.g., a narrative, problem-solving, and the social relationships unique to that world).[13]

Technologically, *immersion* refers to the "multisensory and multimedia"[14] experience provided by the technology design, which embeds users amidst interactions with/through multimedia and the virtual environment itself (i.e., the elements that make the virtual world, including sense of spatial setting) utilizing multiple senses (e.g., auditory, visual, spatial orientation, and virtual touch through the avatar). Users are embedded but not encapsulated away from other multimedia outside the virtual world; thus the multisensory experience is not limited to tools that originally accompany (come with) the virtual world application, as outside applications can be integrated for use within the virtual world, and contribute to the sense of immersion.

The sense of immersion is a very interactive experience. To reach immersion, three types of interaction may take place: interaction with the environment, interaction with objects, and interaction with other users. In order to describe these properly, we first define "interaction." Not all types of interaction are necessary for sense of immersion to exist. For example, early textual role-playing gamers found themselves immersed in the narrative of the game and in their social interactions without the need of 3D objects. Therefore, when evaluating immersion, assessing each type of interaction can provide a good sense of the more abstract notion of immersion.

Interaction refers to the two-way flow of information between the two entities that act upon each other. With this in mind, the three types of interaction mentioned can be described as follows.

Interaction with the environment (IXE) refers to the two-way flow of information between the user and the space, place, and setting of the virtual world. Users sense being spatially engrossed visually, aurally, and by their avatar's presence in the world. For example, a user may interact with the space and place by moving about and the space/place responds by changing the field of view and reception of sound.

Interaction with objects (IXO) refers to the two-way flow of information between the user and objects in the virtual world, such as virtual furniture, bots, and other interactive objects. For example, the user may click on a chair, and it responds by giving the user the option to sit on it, or directly transforming the user's state into being seated on the chair. Or, the user may click on a virtual board, and it responds by providing more information. The user may also create objects, and the technological features used to create these objects respond by feeding back information on what is being created.

Interaction with users (IXU) refers to the two-way flow of information between users of the virtual world, which may be mediated by interaction with objects in the virtual world. For example, users may chat with each other through the SL chat tool, or send a user an object, and when the object is received, the sender gets a notification of acceptance. Interaction with users can be for collaborative

[13] Conceptualization adapted from Adams (2004) and Björk (2004) based on personal experience.
[14] The "multisensory and multimedia" terms were drawn from chapter 8 in Moggridge's (2007) book *Designing Interactions*.

purposes, and is critical to a sense of immersion, particularly in engaging users in mental and emotional effort.

Table 1 illustrates conceptually technological solutions that might address the limitations described above. The first two columns list the limitations observed in Phase I and the associated issues, and the first two rows, list the technological design/services that may address the limitations listed. The cells between these first columns/rows are filled if the proposed technological solution addresses the particular limitation. The acronyms in the cells indicate the type of immersive quality applied for each solution.

Notice that in addition to IXE, IXO, and IXU described above, two additional interactions are added: IXXA or interaction with external applications, and IXXU or interaction with users of other applications. These are described in the next section.

Table 1. SL Limitations and Proposed Solutions

	Technological Solutions →	(A & B) Integration with other technologies		(C) Supporting the assessment of information sources	(D) Effective social use of SL map	(E) Effective use of VW qualities for information organization/evaluation
		(A) social mashup	(B) information mashup	reputation system		
Limitations	**Associated issues** ↓					
(a) High barrier to entry	(a.1) need to register	IXXU (IXXA)				
	customizing avatar is time consuming	IXXU (IXXA)				
	(a.2) using other applications from SL is compicated	IXXA	IXXA, IXU, IXO (IXU, IXE)			
	(a.3) track record in other applications are not importable to SL	IXXA, IXXU	IXXA, IXXU			
(b) High barrier to export	track record in SL is not accessible from other technologies (e.g., social network sites, wiki's)	IXXA, IXXU	IXXA, IXXU, IXO (IXU, IXE)			
(c) Difficult social navigation	(c.1) avatar reputation is highly dependent on word-of mouth; no way to leave track of others' opinion of an avatars reputation (trusworthiness, credibility)			IXO IXU		
	(c.2) no readily available crowd source (aggregate) information of an avatar's reputation	IXXU, IXXA		IXU IXXU		
	(c.3) map does not support the social nature of behavior			IXU IXO	IXE IXU IXO	
(d) Limited support for information organization			IXE, IXO (IXU)			IXE IXO IXU

IXE = Interaction with the environment (space, place)
IXO = Interaction with objects
IXU = Interaction with users
IXXA = interaction with external applications
IXXU = interaction with users of other applications

UNDISRUPTED IMMERSION: PURPOSEFUL INTEGRATION WITH OTHER APPLICATIONS AND USERS

Interaction with external applications (IXXA) or applications outside of Second Life is critical for an undisruptive sense of spatial immersion in the virtual world. An undisruptive sense of immersion can be important to retain users of VWs because a changed sense of oneself while engrossed in the environment can occur when individuals find "flow[15]" in their activity, typically successful when undisrupted. While it may be argued that by using applications outside of Second Life the sense of immersion is disrupted, our observations in Second Life suggest that Second Life works best when complemented by other technologies. This is because Second Life is for many, an extension of their first life activities (such as corporate meetings, exhibition of artistic installations), and for others, an extension of their other online presence (e.g., blogs, other virtual worlds, etc.).

Unfortunately, currently, there is a lack of seamless integration with other computer applications in Second life. There are three aspects to emphasize in the seamless integration with other computer applications.

(1) **Supporting distributed collaboration in a collocated virtual world place:**
Enabling the use of other applications within SL can be beneficial in group meeting situations, so that SL participants can more easily see what other participants are viewing/doing, and can have a common experience with the object being manipulated. Currently, while other applications can be used in Second Life, their use is not seamlessly integrated. For example, power point presentations can be imported into Second life, but to do so, requires setting up a board in world and various other steps to display and navigate a power point. More seamless integration of various applications, through 1 – 2 clicks of effort, is needed for collocated use within SL.

(2) **Super-real integration:**
Integration of SL with other computer applications should not be thought simply in terms of enabling access of other application through Second Life. Simply making an application accessible in its original representation in Second Life does not take advantage of the 3D immersive qualities that characterize and often "hold" users in a virtual world. Therefore, when integrating other applications, designers must push the boundaries, so that the application integrated into SL simultaneously exploits all the immersive VW and digital qualities and is adapted in its representation and manipulation to the super real. For example, information resources (be it links to stored documents or other SL objects) could be represented and organized more dynamically utilizing the sensory qualities of 3D virtual objects, but having the advantage of meta data and fluidity that physical objects do not possess. We elaborate on this in our proposed solutions.

[15] "Flow" refers to the state of being fully involved and focused in successful activity. The term was proposed by Ccikszentmihalyi (1991).

(3) **Social interaction across platforms:**
Research provides evidence that people use multiple applications with similar functions to complement each other or interact with different social relationships (Hampton & Wellman, 2000). Therefore, collaboration and integration should not just support use within Second Life with other Second Life users, but also support interaction with users from other social computational systems, thus creating the ***IXXU (interaction with external users)*** activity supported by the proposed solutions. This issue is related to the barrier to entry and barrier to export. Integration across other computation and social media applications can be designed to reduce such barriers.

THE *FUTURE INFOEXPO* AS A DESIGN RESEARCH METHODOLOGY

Iterative design strategies used in research are valuable for improving technologies over time. The *Future InfoExpo* was based on a design methodology to simultaneously demonstrate capabilities and evaluate improvements in support of diverse information practices through a particular technology—Second Life. The design approach also saved time in identifying (from empirical feedback from users' evaluations) those specific design features requiring revision or worthy of further development.

Therefore, our methodology centered on designing and developing six distinct exhibits that showcased a range of capabilities and functions in virtual worlds.

EXHIBITS OF THE *FUTURE INFOEXPO*

Based on Table 1, we planned a set of six exhibits that demonstrated immersive, virtual qualities of information seeking and use along with addressing some of the limitations previously observed. We developed the following structure and approach:

- All exhibits were presented as part of a unified "virtual exposition" in the *Future InfoExpo* virtual land in the VIBE area of Second Life.
- There was a single entrance to the Expo leading to the Exhibit 1—Orientation (see Figure 1).
- After orientation (see Figures 2 and 4) participants entered a common area with equal and easy access to any of the 5 additional exhibit rooms (see Figure 6).
- The *Future InfoExpo* was open for 3 consecutive days (Thursday – Saturday) for a total of 18 hours.
- Participants were invited to visit the *Future InfoExpo* and required to go through the orientation exhibit (Exhibit 1).
- After successfully completing the orientation, participants could experience as many of the exhibits as they wanted, even returning at a later time.
- The exhibits included scenarios to contextualize and motivate users' actions. The scenarios were pre-tested to confirm that they were plausible and authentic, i.e., situations in which participants might someday encounter.

- After reading the scenarios, participants were asked to complete a task or set of tasks (e.g., choose an information source, reorganize information, etc.) or to try out various capabilities as part of the exhibit experience.
- At the end of each exhibit, participants were asked to complete a short questionnaire administered online and in-world.

The six exhibits are listed in Table 2. Then, each exhibit is explained in more detail below in terms of: problem space, purpose, description, assessment, research questions, results, and conclusions.

Table 2: *The Future InfoExpo:* Exhibits

Exhibit	Title	Capabilities	Focus
1	**Orientation**	Setting a baseline of similar user experiences	Interactions, movement, communication
2	**Who do you choose?**	Use of current SL profiles to assess credibility and trust	IXU = Interaction with users
3	**SL Suggests**	Trust based on an enhanced dynamic recommender system	IXU = Interaction with users
4	**Smart Access**	In-world access to web-based information sources and search systems	IXXA = interaction with external applications
5	**Sorting Soirée**	Organizing in 3D for use of information	IXO = Interaction with objects
6	**Virtual Study Room**	Information problem-solving incubator	IXO = Interaction with objects IXE = Interaction with the environment (space, place)

IXE = Interaction with the environment (space, place)
IXO = Interaction with objects
IXU = Interaction with users
IXXA = interaction with external applications

Welcome Area: The *Future InfoExpo* Entrance

To enter any of the exhibits, participants first go through the *Future InfoExpo* Entrance (see Figure 1). The entrance spot is the general welcome area in front of the "consent bot" (named "HUGO")—an automated system represented by a bot-like avatar, which facilitates the informed consent process.

Figure 2: The *Future InfoExpo* Entrance

Signs greeted participants and conveyed the following information:

> Welcome to the Future InfoExpo! Please read the notecard you received to learn more about:
>
> - the exciting 6 exhibits of this research study
> - your voluntary participation
> - the associated Linden dollar gift.
>
> Click on Hugo if you need another notecard or you want to enter the consent process again.

EXHIBIT 1—ORIENTATION: SETTING A BASELINE OF SIMILAR USER EXPERIENCES

Problem Space:

Participants in the *Future InfoExpo* came with a variety of abilities and Second Life experiences. In addition, many of our exhibits had features that did not currently exist in SL. For example, we needed to provide new ways for navigating menu items in certain contexts. Therefore, in order to facilitate participation in our exhibits and use of the various tools and capabilities showcased, we had to ensure

that participants had certain baseline competencies. Exhibit 1 was designed to help participants gain skills and demonstrate competence.

Purpose:

In Exhibit 1, participants engaged in a series of tutorial-style exercises and also viewed illustrations to gain familiarity and proficiency with the tools and environment needed to participate in the exhibits.

Description:

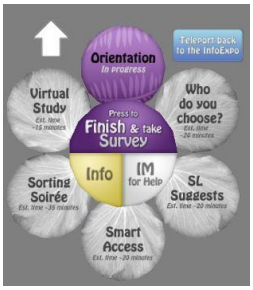
After having completed the informed consent process, those consenting were placed on a white list. Only participants on the white list were able to continue, i.e., to enter Exhibit 1, the Orientation exhibit which included two sections:

Section ONE—General SL Orientation: To help participants reach a common, baseline level of familiarity in navigating, interacting, and communicating in SL. Even experienced users went through this exhibit (see Figure 3) which emphasized functionality that was used in other exhibits. Experienced users were able to skip some activities of the exhibit by demonstrating competence. Participants will also need to be able to distinguish between current SL functions and the prototype functions.

Figure 3: General SL Orientation

Section TWO—*InfoExpo* HUD Orientation: The HUD or "headsup display" is a unique feature adapted for the *Future InfoExpo* to guide and assist each participant through the exhibits and survey instruments. The HUD is an attachment on the screen (appearing above the avatar) that stays with each participant and is only visible to that participant (see Figure 4).

Figure 4: The HUD – Heads Up Display



The HUD Orientation (see Figure 5) provides an orientation and introduction to the HUD to familiarize every participant, regardless of experience, on the functions of the HUD and how it is used in our exhibits.

Figure 5: HUD Orientation

Assessment:

After performing certain tasks in the exhibit, the participants completed a short survey about the orientation experience, their prior SL experience and self-perceived level of SL expertise.

Research Questions:

The research questions for this exhibit were:

- How can we most effectively and efficiently help participants reach a common, baseline level of familiarity in navigating, interacting, and communicating in SL, and in using the heads-up display (HUD) used in the exhibits?
- Who are the participants in the study?

Results:

The VIBE research team and 2b3d were able to effectively design and implement a two-part orientation exhibit that prepared participants for interacting successfully with the full *Future InfoExpo.*

In particular, the HUD proved to be an efficient and effective mechanism for coordinating participant permissions, activities, actions, navigation, survey responses, and help.

The *Future InfoExpo* was conducted in Second Life over three days for a total of 18 hours.[16] Participants were recruited via SL e-mail lists, group messages, event listings, and word of mouth within SL, via UW Information School e-mail lists, print postings, and word of mouth outside of SL.

A total of 113 participants completed one or more surveys during the course of the *Future InfoExpo* (see Table 3).

The majority of respondents to the Exhibit 1 survey described themselves as:

- very experienced 52%
- frequent users (>10 hours per week) 54%
- very experienced in navigating in SL or using the various functions and features 61%
- very comfortable navigating in SL or using the various functions and features in SL 64%.

Table 3: Current level of experience with Second Life

	Frequency	Percent
not experienced	4	4%
somewhat experienced	24	21%
experienced	26	23%
very experienced	59	52%
Total	113	100%

By contrast, very few respondents described themselves as:

- not experienced 4%
- an infrequent user (<1 hour per week or none) 7% and 2% respectively
- not experienced in navigating in SL or using the various functions and features in SL 5%
- not comfortable in navigating in SL or using the various functions and features in SL 5%.

Overall, those participating in the *Future InfoExpo* and responding to this survey were experienced, frequent and comfortable users of SL. Additionally, a significant majority (71%) of respondents to the survey reported that that the orientation activities were "very easy" ($\chi^2(3, N=113)=132.98$, significant at the $p<0.01$ level (see Table 4).

[16] Thursday, June 23, 2011from 3:00 pm to 9:00 pm. PST; Friday June 24, 10:00 am to 4:00 pm; and Saturday June 25, 10:00 am to 4:00 pm.

Table 4: Ease of completing the orientation activities

	Frequency	Percent
very difficult	4	4%
somewhat difficult	7	6%
somewhat easy	22	20%
very easy	80	71%
Total	113	101%[17]

Conclusions – Exhibit 1:

Participants in the Future InfoExpo were experienced, frequent, and comfortable users of SL. This was the kind of test population that we sought (rather than new or novice users) in order to focus on newly designed capabilities of information seeking and use in SL along with addressing some of the limitations from Phase 1.

Results also indicated that the orientation exhibit did effectively and efficiently help participants reach a common, baseline level of familiarity in navigating, interacting, and communicating in SL, and in using the heads-up display (HUD) used in our exhibits.

After orientation was completed, participants were able to enter a common lobby area offering easy access to any of the 5 additional exhibit rooms (see Figure 6).

Figure 6: Lobby Entrances to Exhibits

[17] Total percent does not equal 100% due to rounding.

EXHIBIT 2—WHO DO YOU CHOOSE? USE OF CURRENT SECOND LIFE PROFILES TO ASSESS CREDIBILITY AND TRUST

Problem Space:

In Phase I of the VIBE project, we found that avatar credibility and reputation is highly dependent on word-of-mouth. There is no readily available metric or indicator of an avatar's reputation as an information source. SL users concerned with the trustworthiness and credibility of an avatar as information source are either involved in potentially unreliable, "on-the-fly" assessments, or must spend considerable time and effort finding information about the avatar/information source.

Based on extensive interviews with SL residents during Phase I, we found that their decisions about what actions to take in relation to their trustworthiness assessment of the information source was based on something; but they had a hard time verbalizing that in retrospective; or may have provided retrospective rationalizations that do not fairly reflect what happened. In addition, while some Phase I interviewees thought that having connections to first-life identifiers were crucial, others thought that wasn't the main determinant, as long as the avatar had honest work practices and ideologies that resonated—something interviewees determined over time. However, we do not know what SL residents currently do (if anything) to determine another avatar's trustworthiness, for example, at the time of choosing whether to interact with or use information from this avatar.

Figure 7: Exhibit 2 – Who Do You Choose?

Purpose:

Exhibit 2 (see Figure 7) sought to determine, given the current state of SL, what users do within a short time-frame to determine whether to trust an avatar as an information source.

Questions addressed include:

- What information (personal description, First Life profession, groups, etc.) does a resident use to make decisions of whether to interact and/or trust another avatar?
- Is the current information in SL sufficient for users to make assessments about other avatars' trustworthiness?
- What other information do users seek when attempting to make assessments of other avatars' trustworthiness?

Description:

Although we found (from Phase I) that Second Life is not a first choice as an environment for information seeking and use, we did observe that residents with very specific interests or needs (e.g., transgender, multiple sclerosis) do use SL for social support, experiential information, or even treatment and coping strategies. We therefore selected a scenario for this exhibit on a sensitive topic of potential interest to SL residents.

Participants in this module read the following scenario.

> *Hello! Welcome to the "Who do you Choose?" exhibit, where you will be asked to select an avatar based on the following scenario. Please read the following scenario, including the task assigned to you. Then, answer the questions provided. Thank you!*
>
> *SCENARIO:*
>
> *The problem: The exploitation of violent imagery, including imagery of domestic abuse, war, and animal abuse, can be a sensitive issue because it can negatively affect both the viewers and the victims. Some people have taken advantage of the ease with which dramatic yet realistic imagery can be reproduced in virtual worlds like Second Life. Youth online safety advocates are particularly concerned about this issue now that teens (16-17 years of age)[18] can officially access the main Second Life grid. [19]*
>
> *Your current situation and goal: Teen online safety has always been of concern to you. You recently volunteered for a grassroots movement in Second Life against the exploitation of violent imagery. You and members the grassroots movement are looking*

[18] Additional information that might be provided via mouse-over/hover: In early 2011, Teen Second Life (originally restricted for access by teens only) ceased to exist. Now, teens 16 and 17 are allowed to access Regions of the main Second Life grid that are designated "General" (rather than "Moderate" or "Adult", the other two types of maturity ratings in SL. See http://ow.ly/4aeXO for Second Life's official information on maturity ratings in Second Life. However, designating a Second Life Region is left to the Region owner's discretion and responsibility.

[19] The main Second Life grid hosts content that can be designated "General", "Moderate", or "Adult". While an age verification system is in place, so that only adults verified to be 18 and over can access Regions designated as "Adult", a Region's designation is left to its owner's responsibility. Furthermore, concerns exist that adult content is still viewable via adjacent lands, without accessing the adult-designated regions (see: http://searchenginewatch.com/3641846)

<u>for someone who has a track record in organizing successful, well attended events in Second Life to help raise awareness against the exploitation of violent imagery in Second Life.</u>

It may be important that the "right" person be knowledgeable about producing successful Second Life events for this type of movement—someone who, in addition to being successful at organizing well attended events in Second Life, is trustworthy among a variety of Second Life communities.

Your task is to <u>choose</u> someone to be <u>the main co-organizer</u> for this movement. You will be provided with 4 SL resident profiles. After you take some time to look through them, you will be asked a series of questions about how do you went about choosing this person.

Once the participant indicated that she or he was finished reading the scenario and instructions, the HUD displayed 2 avatar profiles (see Figure 8) as choices.

Figure 8: Example of a summary profile. Participants would see 4 of these listed either one after the other. The order in which the profiles appear was randomized.

The avatar profiles differed on 2 options for 2 variables:

- Variable 1: Revealed first life (whether first life information is revealed) –yes/no
- Variable 2: Focused SL activity (whether resident in profile has a focused SL activity) –yes/no.

This resulted in 4 possible avatar profiles (see Table 5).

Table 5: Variable Combination Possibilities for Avatar Profiles

	Related SL activity: YES	Related SL activity: NO
Reveals FL: YES	Avatar A	Avatar B
Reveals FL: NO	Avatar E	Avatar F

Assessment:

Participants answer survey questions.

Research Questions:

The research questions for this exhibit were:

- Given the current state of SL, what do users do within a short time-frame to determine whether to trust an avatar as an information source?
- Which information does a resident use to make decisions of whether to interact and/or trust another avatar?
- Is the current information in SL sufficient for users to make assessments about other avatars' trustworthiness?
- What other information do users seek when attempting to make assessments of other avatars' trustworthiness?

Results:

A total of 107 participants completed the surveys for both parts of Exhibit 2. In the first part of Exhibit 2, participants were asked to consider the current state of SL profiles and features in determining whether to trust another avatar for the purpose described in the scenario.

Across subjects, there was no clear preference for or against using the search tool (see Table 6). Responses were not significantly different at the p=0.01 level ($\chi 2(3, N=107)=3.09$, $p=0.38$). However, when asked whether they would ask others in SL for suggestions about the best candidate, 57% of participants were "very likely" to seek out and ask others they trusted within SL (see Table 7), significantly different at the $p<0.01$ level ($\chi^2(3, N=107)=59.69$).

Table 6: Likelihood of using SL's search tool to find the best candidate to raise awareness against the exploitation of violent imagery in SL?

	Frequency	Percent
very unlikely	27	25%
somewhat unlikely	22	21%
somewhat likely	24	22%
very likely	34	32%
Total	107	100%

Table 7: Likelihood of asking others in SL for suggestions on the best candidate to raise awareness against the exploitation of violent imagery in SL?

	Frequency	Percent
very unlikely	11	10%
somewhat unlikely	16	15%
somewhat likely	19	18%
very likely	61	57%
Total	107	100%

In the second part of Exhibit 2, participants were shown the profile information for two different avatars, and asked to choose the best potential candidate to help raise awareness against the exploitation of violent imagery in SL. Regardless of whether the participant found another avatar through SL's search tool or through asking others, a large majority of respondents (68%) were "very likely" to look at the avatar's profile information ($\chi^2(3, N=107)=107.32$, $p<0.01$), see Table 8.

Table 8: Likelihood of looking at avatar profiles in choosing the best candidate.

	Frequency	Percent
very unlikely	14	13%
somewhat unlikely	8	8%
somewhat likely	12	11%
very likely	73	68%
Total	107	100%

The willingness (or not) of displaying first life personal information was represented in two fictitious profiles: Tiffany Moore and Jessica Davis. Tiffany Moore's profile willingly displayed first life information while Jessica Davis's profile did not willingly share first life information. Respondents significantly preferred a profile that included first life information ($\chi^2(2, N=107)=13.59, p<0.01$), with 49% choosing Tiffany Moore over Jessica Davis (32%) and "can't make a choice" (20%), see Table 9.

Table 9: Preference regarding willingness to share first life information.

	Frequency	Percent
Jessica Davis (not willing to share first life information)	34	32%
Tiffany Moore (willing to share first life information)	52	49%
Can't make a choice	21	20%
Total	107	101%[20]

Survey questions about the type of information used by participants were also revealing:

- About Me Descriptions: 74% of participants responded that "About Me" descriptions were important or very important in choosing a trusted avatar ($\chi2(4, N=107)=53.05$, significant at $p \leq 0.01$).
- Role or Position in SL: 58% of participants responded that the "Role or Position in SL" description was important or very important in choosing a trusted avatar ($\chi2(4, N=107)=20.43$, significant at $p \leq 0.01$).
- Expertise: 54% of participants responded that the "Expertise" descriptions were important or very important in choosing a trusted avatar ($\chi2(4, N=106)=18.81$, significant at $p \leq 0.01$).

Conclusions—Exhibit 2:

The findings from Exhibit 2 indicate that the Second Life search tool is not valued, while actively seeking out recommendations from others in SL is an important information seeking strategy in SL. Respondents also confirmed that the information provided in various Profile fields is important in determining the credibility and potential usefulness of other residents. Role or Position in SL is also a factor and so is the willingness to share first life descriptions including "About Me" and "Expertise." About Me was judged the most important description for credibility.

[20] Does not add to 100% due to rounding.

Unfortunately, the results comparing the 4 profiles (2 each for Tiffany Moore and Jessica Davis) were confounded by methodological difficulties associated with randomization and tracking. Further analysis is warranted although it may be necessary to re-run the study comparing treatments.

EXHIBIT 3—SL SUGGESTS: TRUST BASED ON AN ENHANCED DYNAMIC RECOMMENDER SYSTEM

Problem Space:

Avatar reputation and credibility in Second Life is highly dependent on word-of-mouth. There is no readily available metric of an avatar's reputation as an information source. Therefore, the SL user concerned with the trustworthiness and credibility of the information source (avatar) is either involved in a risky on-the-fly assessment, or must invest considerable time and effort finding information about the information source. This investment acts as a barrier for residents who do not have the time to successfully build desirable social networks (or networks of social relationships).

With the social nature of use of Second Life and the wide-spread use of recommendation systems which take advantage of user's relational behavior (e.g., people we follow on twitter, who else buys similar items, rated similar movies highly, etc.), it is surprising that such a future-looking technology as Second Life does not have an dynamic social recommendation system in place.

Figure 8: Exhibit 3 – SL Suggests

Purpose:

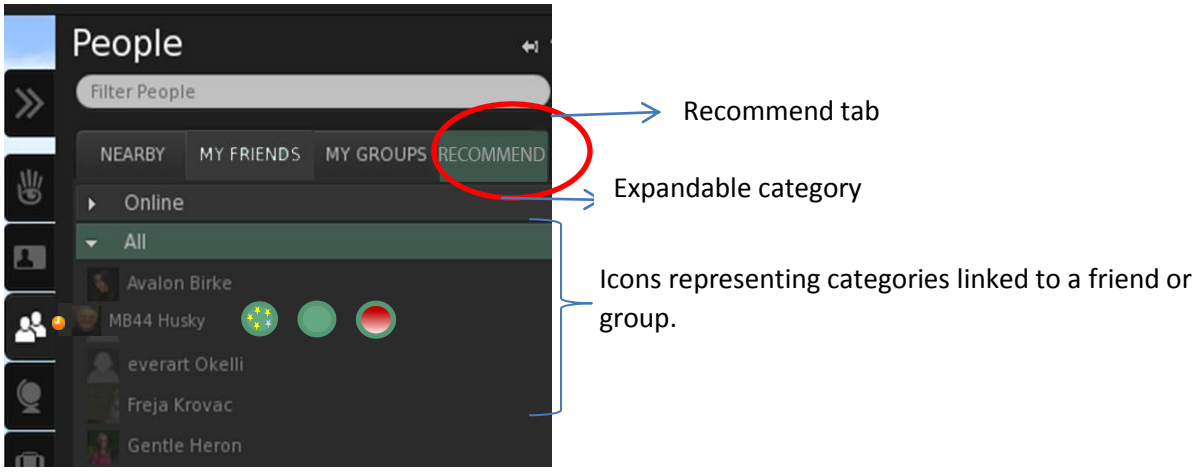
To improve information seeking and use in SL in terms of decisions of credibility and trustworthiness through designing and implementing a test dynamic social recommendation system enhancing the resident avatar profile in SL. The purpose is to build a mock recommender system and to evaluate how useful the system and features were in helping participants determine whether or not someone is credible and trustworthy.

Description:

Exhibit 3 builds upon the investigation into the determination of trust in other avatars developed in the prior exhibit by adding an enhanced dynamic recommender system to the avatar profile. For this module, we first designed and implemented a mock dynamic recommender system of friends and groups based on aggregate similarity comparison of residents' friends, groups, history of interactions, self-descriptions on profiles, and user-provided ratings of these interactions. Figures 9-11 show the design and features of the dynamic recommender system.

Figure 9 shows how a "recommend" tab is added to the "People" right-hand panel in SL. This is where recommendations are listed. Expandable categories (currently showing only "online" and "all," can be added to show "local friend recommendations", "global friend recommendations", and "group recommendations." Figure 10 is a close-up view of one recommended friend.

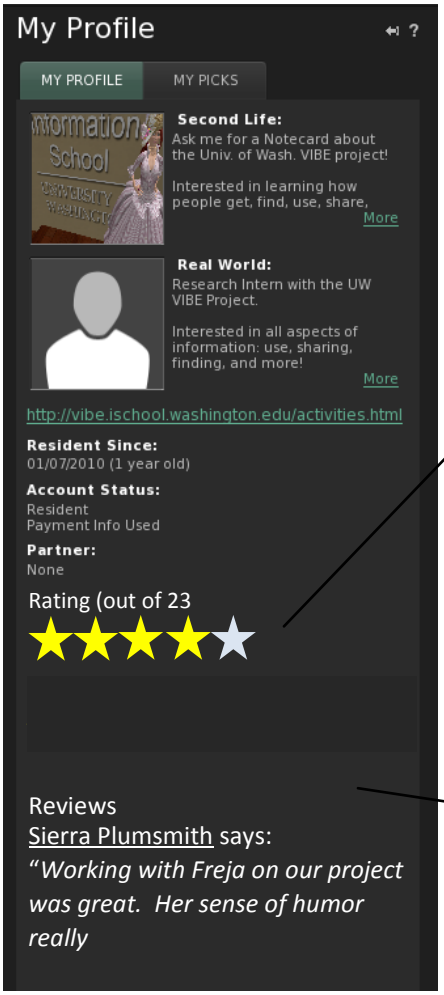
Figure 9: Location of the Recommender Tab and Icons



In a fully operational recommender system, each piece of information (i.e., circle) would be expandable (see Figure 10):

- Clicking on the avatar picture or name displays the avatar's profile view (as SL currently functions); but the recommender profile would now contain additional information: the aggregate average rating, a rating on the avatar's expertise in a particular topic area, and highlighted review text (can be selected by the avatar).
- Clicking on the rating would display the specific details about that rating, such as the number of times the recommended friend has been rated, and written reviews.

Figure 10 –View of an Enhanced Resident Profile



Aggregate average rating: This is the same information that is viewable in the first circle of the summary of a recommended friend.

Additional information provided includes how many ratings were aggregated. Clicking on this opens up more detailed information. Rating per rater, and associated review if any.

Reviews highlighted: The avatar being viewed can select the reviews to be highlighted in her profile. Clicking on it links to the full review, embedded within the rest of the reviews.

Participants in Exhibit 3 were given the same scenario described in Exhibit 2. In this exhibit, however, average star ratings and recommendations were included in the Profile. Participants were presented the following instructions.

We are asking you to try some new tools we have developed based on the scenario you read.

Remember, your task is to choose the right person to be the main co-organizer for a successful, well-attended event to raise awareness against the exploitation of violent imagery. How do you go about choosing this person?

Before you proceed, please remember that not all features provided in this booth exist in Second Life. Therefore, please proceed using the menu and panels provided in the heads up display.

Now, suppose you decided to search for people based using term "advocate against violence."

We've provided the same two avatars you've already seen. However, each profile contains additional information. Please use this information as much or as little as you would like or feel comfortable.

Assessment:

Successful design and implementation of a mock recommender system. Participants answered survey questions.

Research Questions:

The research questions for Exhibit 3 were:

- What would an enhanced dynamic recommender system for credibility and trustworthiness of avatars look like?
- How useful is the enhanced dynamic recommender system in helping participants determine whether or not someone is trustworthy?
- Which types of information included in an enhanced dynamic recommender system would be most useful to participants?

Results:

The VIBE research team and 2b3d were able to effectively design and implement a mock recommender system and exhibit. Participants were shown an average star rating and reviewer comments for each of two avatar profiles, again named Jessica Davis and Tiffany Moore. When asked again which avatar they would choose as the best candidate to help raise awareness against the exploitation of violent imagery in SL given this additional information, there was no significant preference ($\chi 2(1, N=89)=0.559$, $p=0.458$, non-sig at the $p \leq .01$ level).

Subsequent survey questions sought details about the type of information used by participants in choosing a trusted avatar:

- Positive comments from reviewers
- Negative comments from reviewers
- Comments available about the other possible avatar
- Expertise
- Average star rating.

Results (see Table 10) indicated that each of these types of information were judged to be significantly important or very important (at $p \leq .01$ level) except for the last type – Average star rating.

Table 10: Importance of Types of Recommender Information (N=95)

	Important	Very Important	Combined
Positive Comments from Reviewers	26%	61%	87%
Negative Comments from Reviewers	23%	45%	68%
Comments Available About the Other Possible Avatar	27%	48%	75%
Expertise	31%	53%	84%

Responses to the question of the importance of the "Average Star Rating" were not significantly different ($\chi 2(4, N=93)=10.50$, $p=0.033$, non-sig at the $p \leq .01$ level). This indicates that there were mixed reactions to the average star rating information, and that this type of information was not as valuable to the participants as a whole as the other 4 types.

Conclusions—Exhibit 3:

The VIBE research team and 2b3d were able to effectively design and implement an exhibit based on an expanded resident avatar profile that included a mock recommender system. The exhibit allowed participants to view alternatives, make choices, and give their opinions of important capabilities, features, and types of information provided.

Participants were very positive about the value of adding a recommender system to the SL profile. The important types of information to provide include positive (and negative) comments from reviewers, comments about other avatars, and information about expertise.

The mock average star system was rated less important. This finding should be tested further in virtual worlds and other online contexts as it has implications for the plethora of rating systems that currently exist on e-commerce and other systems.

EXHIBIT 4—SMART ACCESS: IN-WORLD ACCESS TO WEB-BASED INFORMATION SOURCES AND SEARCH SYSTEMS

Problem Space:

Access to and use of applications and information resources external to Second Life (including the Web) for productivity, communication, and particularly for information seeking should be easy and seamless. However, currently there are no simple capabilities within Second Life for accessing and using web-based resources, search tools, or applications. Right now, residents must exit Second Life or

leave their avatar and session idle, open a separate window (or windows) and launch a web browser, search tool or other application.[21]

This exhibit showcased options for seamless, in-world access and use of 2-D, web-based resources and tools in Second Life.

Purpose:

This exhibit was primarily a demonstration of approaches and capabilities for seamless portals (or jumping off points) to resources and tools outside of SL—and then back again. We also sought participant reactions to options and alternatives for access and use of external information tools.

Description:

The exhibit presented 3 different in-world approaches to information search and access:

1. Fixed screen/window on wall.
2. Wearable or attached to avatar.
3. Mobile (may be picked up or dropped anywhere in-world).

Participants entered the Smart Access exhibit (see Figure 11) and were given the following scenario and task:

You recently attended an event sponsored by the Autism and Asperger's Forum (AAF) in Second Life. The purpose of the event was to bring together professional and lay persons to discuss and learn more about the topic of misinformation about causes and treatment of Asperger's syndrome. About 20 people attended the event which lasted about an hour and was informative and interesting.

However, you and other attendees were frustrated because the nature of the topic and interests of the people required continual accessing of web-based resources and search tools. The only way to use and share information and sources was to temporarily leave Second Life and open a separate window to use the web and various tools. But, the unintended consequence of this was that people were not present in-world for various lengths of time. They missed parts of the conversation, created awkward moments when they re-engaged, or interrupted with new information that they found. Even though the additional or new information was highly useful, the means of getting it was problematic.

[21] This was true through 2010 and into mid-2011 when this project was conceived, developed, and implemented. More recently, Linden Lab has made some improvements to lessen the difficulties described here. We know that some at Linden became familiar with our project and our intentions, so it is possible that the VIBE project identification of concerns and issues had some influence on improvements to SL.

You (and a few other attendees) agreed to look into alternative ways of accessing, searching, and using web-based information from within Second Life. You heard about this Info Expo, and decided to explore the possibilities offered here.

Thus, your task is to try out the 3 approaches offered for in-world access to external information resources and tools. Your specific purpose is finding information about "misinformation about causes and treatment of Asperger's syndrome," and sharing this information with others during AAF events.

Figure 11: Exhibit 4: Smart Access

Assessment:

Successful design and implementation of 3 unique approaches to providing in-world access to external information resources and tools. Participants answered survey questions based on their experiences using the 3 different approaches.

Research Questions:

The research questions for this exhibit were:

- What approaches can be developed to provide in-world access to external information resources and tools?
- How useful and effective are the 3 alternative approaches for seamless portals, or jumping off points, to resources and tools outside of SL?

Results:

This exhibit successfully designed and implemented three fully-functional tools which served as portals, or "jumping-off points," to web-based information and search tools outside of SL:

(1) a wall-mounted, fixed media board

(2) a wearable media board attached to the avatar
(3) a mobile media board which could be picked up or dropped in any location.

In terms of preference (see Table 11), there was no clear significant difference or favorite among respondents ($\chi^2(2, N=82)=1.85$, $p=0.396$, non-sig at the $p \leq .01$ level). This means that some respondents preferred the wall-mounted fixed board while others liked the wearable or the mobile media board.

Table 11 also shows judgments of respondents about their favorite approach—relating to other factors: ease of use, helpfulness, fun, novelty, and usefulness for sharing. Collectively, regardless whichever tool they selected as the one they liked the best, indicated that their preferred tool was "easy to use" (93%), helpful for accessing web-based information" (90%), fun to use (88%), novel (75%), and "useful for sharing information with others" (88%).

Looking more closely at differences among ratings for each tool, a smaller percentage of those preferring the Fixed Board (57%) rated it lower on novelty as did those who chose the Mobile Board (73%). Almost all of those who chose the Wearable Board rated it high on novelty (91%). Those choosing the Wearable Board rated it high on all factors. A lower percent of those who chose the Fixed Board (71%) rated it fun to use than those who chose the other approaches.

Table 11: Preferred Approach

		Frequency	Percent	Easy to Use	Helpful	Fun to Use	Novel	Useful for sharing
	Fixed, Wall-Mounted	28	34%	93%	82%	71%	57%	82%
	Wearable/Attached to Avatar	32	39%	88%	94%	97%	91%	88%
	Mobile Board	22	27%	100%	96%	96%	73%	96%
	Total	82	100%					

We also collected responses about each approach from all those participating in this exhibit.

Fixed, Wall-mounted Media Board

For the fixed, wall-mounted media board, 73% of participants were either "somewhat likely" or "very likely" to use this tool if it was available in SL, but one-third (34%) encountered difficulties when using the tool. More specifically, for the wall-mounted, fixed media board, the percentage of participants responding favorably on the factors were:

- 59% "very easy" to use overall
- 90% helpful in accessing web-based information from within SL
- 70% fun to use
- 81% useful in sharing information with others in SL
- 50% novel.

When asked what they liked most about this tool, the most frequent responses include "easy to use" (37%), "useful for sharing information with others" (23%), and "helpful in accessing web-based information within SL" (21%).

Wearable Media Board

For the wearable media board, participants were mixed as to whether they would use this tool if it was available (59% were "likely" or "very likely" to use the tool if available). The largest percentage of respondents (42%) reported they encountered difficulties when using the tool. More specifically, for the wearable media board, the percentage of participants responding favorably on the factors were:

- 50% "very easy" to use overall
- 79% helpful in accessing web-based information from within SL
- 65% fun to use
- 69% useful in sharing information with others in SL
- 78% novel.

When asked what they liked most about this tool, participants were equally divided between "easy to use" (26%) and "helpful in accessing web-based information within SL" (24%).

Mobile Media Board

The mobile media board received favorable ratings by the highest percentages of participants. 76% of participants were either "somewhat likely" or "very likely" to use this tool if it was available in SL, while one-third (33%) did encounter difficulties when using the tool. More specifically, for the wearable media board, large percentages of participants responding favorably on the factors:

- 63% "very easy" to use overall
- 90% helpful in accessing web-based information from within SL
- 82% fun to use
- 88% useful in sharing information with others in SL
- 72% novel.

When asked what they liked most about this tool, the most frequent responses include "easy to use" (35%), and "helpful in accessing web-based information within SL" (18%).

Conclusions—Exhibit 4:

Based on the responses of participants, this was a highly successful exhibit. Easy access to information and resources beyond SL is definitely important. There is strong overall preference for tools that facilitate accessing web-based information from within SL. Exhibit 4 demonstrated a range of approaches for tools that provide in-world access to external information resources and tools.

When asked directly to choose among the tools, there was no clear favorite approach among participants.

The Mobile Media Board received the most consistent percentage of favorable ratings from all participants. Approximately 3/4 of respondents indicated that they were likely to use the Mobile Board or the Fixed, Wall-Mounted Board if they were available to use, while the Wearable Board was less likely to be used, although it was judged "novel" by the highest percentage of participants.

The tools were also "fun" to use, especially when a tool was selected as a preferred approach. Across all participants, the Mobile Media Board again favored by the largest percentage of respondents.

For each tool, at least 1/3 of participants did report difficulties when using. This indicates that more work needs to be done to simplify use and learning and use the tools.

EXHIBIT 5—SORTING SOIREE: ORGANIZING IN 3D FOR USE OF INFORMATION

Problem Space:

Phase I of the VIBE project revealed a number of constraints within the SL platform—including limited support or tools for information organization. For example, the current inventory system is inadequate to organize and store information in meaningful ways.

At present, the representation of information in SL is still grounded in first life principles–inventory lists of notecards, calling cards, landmarks, a series of file folders with multiple purposes, etc. The challenge was to envision and test new ways of organizing information—approaches that take advantages of 3D immersive capabilities.

Purpose:

Exhibit 5 of *Future InfoExpo* (see Figure 12) sought to develop and study 3D, virtual world alternatives for organizing and manipulating information in a 3D virtual space. This exhibit focused on the use of 3D affordances for information organization for the purposes of comparison, discovery, synthesis, and sharing.

Three new organizing tools, representing different capabilities, were designed and implemented. Participants were asked to explore and employ these tools in the completion of a task, and then to assess them and give feedback.

Figure 12: Exhibit 5: Sorting Soiree

Description:

Three different types of tools for organizing were developed based on insights from prior research.

Jonassen (2003) suggests the use of tools in externally representing an information problem for the purpose of generating a successful solution, and offers 3 examples: semantic networks, expert systems, and systems modeling.[22] In an effort to understand the usefulness of spatial diagrams in reasoning and knowledge structures, cognitive psychologists Novick & Hurley (2001) conducted a structural analysis of three specific diagrams: the matrix with rows and columns, the network system with paths, and the hierarchy/branching structure.[23]

These three approaches were shown to facilitate learning and problem-solving (Novick & Hmleo, 1994) and served as 2D models for conceptualizing and designing each 3D tool in Exhibit 5 (see Figure 13). The 2D Matrix formed the basis for our 3D Matrix-Spreadsheet, the Network morphed into Exhibit 5's InfoCubes and the Hierarchy/Branching was represented in our 3D Posted[24] Notes:

(1) **The Matrix:** a 3D spreadsheet with cells that could be movable like "floating shelves" (card catalogue-style); information was contained in each cell, and attributes that were manipulated here could have included location of cell, size of cell, and color of cell.

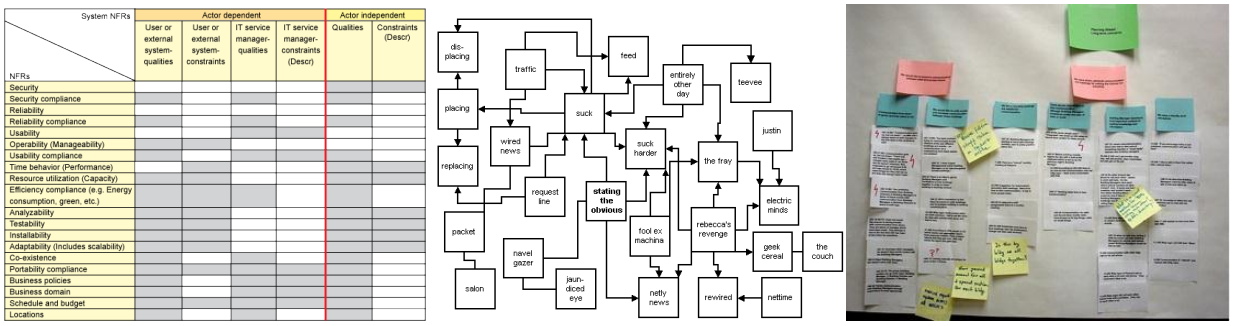
(2) **InfoCubes:** each cube has an information item on each side, but sides were movable/replaceable; the attributes that might be manipulated by the participant could have

[22] Jonassen, D. (2003). Using Cognitive Tools to Represent Problems. Journal of Research on Technology in Education, 35(3).
[23] Novick, L. R., & Hurley, S. M. (January 01, 2001). To Matrix, Network, or Hierarchy: That Is the Question. Cognitive Psychology, 42, 2, 158-216.
[24] We use the term Posted Notes because Post-it is a registered trademark of the 3M company.

included: location of cube, size of cube, location of info item on sides of cube, and color of cube.

(3) **3D Posted Notes:** information was contained on posted notes that were placed on the walls; notes could have been moved and stacked; attributes that were manipulated here could have included location of posted note, size, and color.

Figure 13: 2D Approach for 3D Conceptualizations:



2D Matrix **Network** **Hierarchy**

Participants experienced (in random order) each of the three types of tools for organizing information, and considered ways in which this information might be manipulated to highlight categories, relationships, and hierarchies. The tools allowed a user to assign information to a 3D object; they could then move, manipulate, change, organize, store, and share the configuration of information objects.

Participants were initially given a set of information items (in the form of text, graphics, etc.) related to the given scenario concerning cancer treatment and guided through 3 stages in the exhibit. These stages were completed 3 times – once for each tool:

(1) Introduction to the scenario, task, and features unique to each room.
(2) Use of the tool for organization and manipulation of information.
(3) Completion of a short survey on the tool.

Participants also completed an exit survey related to their overall experience.

Scenario: Cancer Treatment

Hello! Welcome to the Sorting Soiree Exhibit! This exhibit will help us understand how information within SL may be represented and organized. We would like to begin with a scenario. We have chosen a situation that is unfortunate, but realistic—dealing with the information related to a breast cancer diagnosis. Breast cancer is a topic that most everyone is aware of, and can likely affect someone we know. We know from breast cancer patient research that patients have trouble organizing their breast cancer information.

Please read the following scenario, including the task assigned to you. Then, answer the questions provided. Thank you!

Your Task: Suppose your mother has just been diagnosed with breast cancer. She is overwhelmed by the amount of information she has collected and has asked for your help in organizing all of this information in order to help her choose the best treatment. Helpful categories she has determined include: treatment decisions (including health risks and benefits, side effects, etc.), health insurance coverage, hospitable personnel communications, and health status monitoring.[25]

Members of your Cancer Caregivers Support Group in Second Life have developed tools for helping to organize this type of information. These tools take advantage of SL's 3D capabilities and you want to try them out. The support group has helped you to import some of your mother's treatment information into SL.

One of the tools that have been developed is a room that displays the information on cubes. You can customize these cubes in ways that are helpful for you. Another tool is a 3D matrix, like a spreadsheet, in which information is presented in cells that can be reorganized, just as in a 2D spreadsheet, except in three dimensions . The third tool displays information on notes which may be grouped and ordered in ways you see fit. You will experience each of these rooms in a random order, but your task will remain the same in each room. After you are done a room, please click the Ready button so we may ask you a few questions before moving on to the next room.

OK! When you are ready, go ahead and begin by entering through this door.

Assessment:

Assessment was three-fold:

(1) Successful design and implementation of 3 unique tools representing 3 different approaches organizing and manipulating information.
(2) Survey questions based on their experiences using the each tool/approach.
(3) Exit survey about the overall experience.

Research Questions:

The research questions for this exhibit were:

- What would 3D information organization tools based on the 3 approaches (matrix, network, and hierarchy/branching) look like?
- How useful and effective are tools for 3D information representation and organization?
- How do participants assess the tools in terms of ease of use, helpfulness, fun, and novelty?

[25] Categories identified in the work of Klasnja, P., A. C. Hartzler, et al. (2010). Blowing in the wind: unanchored patient information work during cancer care. Proceedings of the 28th international conference on Human factors in computing systems. Atlanta, Georgia, USA, ACM: 193-202.

Results:

This exhibit successfully designed and implemented three unique, fully-functional information organization tools for 3D information representation and organization.

As in Exhibit 4, this exhibit introduced three alternative tools to accomplish a function in SL. In Exhibit 5, these tools offered 3D affordances in organizing information within SL: (1) a 3D matrix organized as a spreadsheet, (2) InfoCubes with information able to be stored, viewed, or changed on any of the 6 sides, and (c) Posted Notes able to be attached to a wall space that could be organized in any manner.

When asked to compare the three tools (see Table 12), more respondents favored the Posted Notes (47%) and the Matrix (37%) tools. The InfoCubes tool (17%) was clearly less preferred.

Table 12 also shows judgments of respondents about their favorite approach—relating to other factors: ease of use, helpfulness, fun, similarity to the way they think, and novelty. Collectively, regardless whichever tool they selected as the one they liked the best, they indicated that their preferred tool was "easy to use" (91%), "helpful for organizing information" (94%), "fun to use" (87%), "similar to the way I think" (87%), and "novel" (79%).

Respondents were "somewhat likely" (33%) or "very likely" (37%) to use their preferred tool if it was available in SL; there was no significant indication that they would enter SL in order to use the tool ($\chi^2(3, N=85)=3.61$, $p=0.307$, non-significant at $p \leq 0.01$).).

Table 12: Preferred Approach

		Frequency	Percent	Easy to Use	Most Helpful	Fun to Use	Similar to way you think	Novel
	Matrix	31	37%	94%	90%	87%	81%	74%
	InfoCubes	14	17%	65%	93%	86%	71%	79%
	Posted Notes	39	46%	97%	97%	87%	97%	82%
	Total	84	100%					

($\chi^2(2, N=84)=11.64$, significant at $p<0.01$).

Looking more closely at differences among ratings for each tool, the Posted Notes were favored by more participants (almost half—46%) and almost all of these rated the Posted Notes "easy to use," "helpful," and "similar to the way you think. "The Matrix was also favored by many (37%) and "easy to use" with fewer (but still 81%) finding it "similar to the way you think." The InfoCubes seemed less "easy to use" and less similar to the way they think, but the percentages were still a majority—65% judging easy to use and 93% helpful.

Conclusions—Exhibit 5:

This exhibit confirms that it is feasible and desirable to offer virtual 3D tools that provide alternative ways of representing, organizing, and manipulation of information. Participants clearly recognized the

unique capabilities of 3D virtual environments for information organization. Information organization—possibly combined with 3D visualization—has the potential to be one of the "killer app" capabilities of SL and other virtual worlds.

On reflection, participants' preference for the Posted Notes is not surprising as they are very familiar--use in Exhibit 5 was more intuitive than either of the other approaches. The Matrix also benefitted from participants' likely familiarity with spreadsheets. Both of these approaches are ready to be refined and implemented as tools in virtual worlds.

The InfoCubes were less preferred than the other approaches, possibly because they represent a new way of thinking about and organizing data, information, and knowledge. Additionally, our implementation of the concept was somewhat clunky and cumbersome. On the positive side, participants did seem to understand the purpose and function of the InfoCubes. Being able to easily store related information on 3D objects that can be edited, sorted, stacked, and moved has promise, particularly for keeping track of multi-dimensional information about an entity (such as a reference or link to a factual piece of information) or for combining, sorting, and connecting ideas and concepts.

EXHIBIT 6—VIRTUAL STUDY ROOM: INFORMATION PROBLEM-SOLVING INCUBATOR

Problem Space:

Space for work and study is precious in the physical world. We create or seek out offices, cubicles, study carrels to support focused study and work—places to think, to carry out various information activities (e.g., search and collect, store and organize, process and create), and to meet with others and share. It's valuable to have an office or study space partially because it's mine: I can use and organize it any way I want, and I'm able to leave and return, and find my materials and work exactly as I left them.

There are, however, drawbacks to offices and study spaces in the physical world including limited size, shelves or table-top space, furniture, and costs. And, of course, not everyone has a private office or study space—we sometimes have to share offices or use facilities in libraries or other public entities. We even "share" our own office and private spaces with ourselves—using them for multiple purposes, expending time and effort in a constant flow of moving things around, taking things out or putting them away as we change from one task or focus to another.

Again, we do this because space in the physical world is precious. It's not feasible to have a different space for every major task, project, or topic. But, we *can* do this in virtual space. In virtual worlds, it's possible to have multiple work or study areas—spaces that lets me gather resources, materials, and tools for a specific purpose, and to keep those things exactly in place so that I can use them whenever I want.

This exhibit tackles the problem of limited space in the physical world by investigating the possibilities of flexible study spaces in virtual worlds.

Purpose:

The purpose of this exhibit is to create a proof of concept: a virtual study room that facilitates information problem-solving and focused study and work. The goal is to offer participants a sense of the nature and scope of such virtual spaces, demonstrating some of the capabilities, functions, and uses.

Description:

The Virtual Study Room (see Figure 14) is a flexible and customizable Second Life space to facilitate individual (or group) information problem-solving. Similar in purpose to the small, private, isolated, and highly popular study rooms found in some public and university libraries in the physical world,[26] the SL Virtual Study Room can offer the same advantages of the physical study rooms (e.g., a place for focused study and thought, to store and organize gathered resources and materials, to be able to leave and return to find your materials and work exactly as you left them).

At the same time, the SL Virtual Study Room can overcome the constraints of restricted numbers of physical study rooms, the small size and limited furniture and contents, and the need to eventually give up the study room so others can use them. In a virtual world, users can even have a different study room for every major topic, project, or question they wish to investigate. Virtual study rooms help to immerse users in their work—easily remembering where they left off, surrounded by content, self-organized for their own work styles, and conditioned to focus, think, and write while in the room.

Exhibit 6 presents participants with a model virtual study room to experience. Participants first view a 10 minute video (see http://www.youtube.com/watch?v=s9iBSlNICGo for the actual video) based on the scenario of "Mike," a university teacher who has been suffering from chronic back pain and has decided to address his problem as a major research task—to do a relatively comprehensive investigation in order to find out more about the nature of back pain and treatment. After the video, the participants completed a survey (with multiple-choice and open-ended questions) about their reaction to the Virtual Study Room. They then entered the Virtual Study Room and explored the exhibit's features, tools and artifacts. Afterwards, they again gave their feedback in a multiple-choice and open-ended survey.

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[26] (Wikipedia, http://en.wikipedia.org/wiki/Carrel_desk)

Figure 14: Exhibit 6—the Virtual Study Room

Assessment:

Successful design and implementation of a model Virtual Study Room concept. Participants answered survey questions based on their viewing the video and experiencing the room.

Research Questions:

The research questions for this exhibit were:

- What would a Virtual Study Room look like and what are some capabilities and functions to be included?
- How do SL residents view the concept of the Virtual Study Room in terms of usefulness, ease of use, and their likelihood of using one?

Results:

As we were most interested in reactions to the overall concept of the Virtual Study Room, we asked the participants a series of open-ended, qualitative questions after viewing the video and again after experiencing the exhibit itself.

For example, participants were asked, “Was the Virtual Study Room what you expected? Please tell us why or why not?” Many participants reported the introductory video was helpful in envisioning a virtual study room, and they were positive about the concept. After entering and experiencing the room, many participants were equally positive. Representative open-ended responses include:

- No it wasn't what I expected, it's so much cooler, Very interactive, I brought a couple of pictures right into the TWIDDLA, and also browsed the web too.
- It was basically what I expected. Numerous screens granting the ability to keep many projects open at once. Resources surround Mike. He is immersed.
- This is a nice way to combine several different methods of research into one area.

For the question, "Do you see the Virtual Study Room as useful? Please tell us why (and how it might be useful) or why not?" most participants saw the room as useful and began to envision the potential for 3D virtual worlds to enhance information problem-solving.

- Yes because so many people use google docs but this gives you the real time capability of chat, communication, and interactivity via avatar to make changes and complete documents- many steps above google docs which is quickly becoming a standard.
- It is useful to have the browser, the notes and the 3D models in once place. Everything that is needed for research is just at your fingertips.
- [Y]es - You can fill an entire room with notes etc and not take up any space.
- [S]ure, it could be. I like the part in the video that says what a pain it is to get out info for projects etc then have to pack it away. Never thought about using sl to solve that problem
- VW are persisitant. [sic] I can leave materials out and not fear that they will be lost or changed. He can change the size of boards or notes to emphasize priority. Again...Immersion. The content surrounds.

While many were also excited by the opportunities for collaborative work, some expressed concern that the communication features of SL could be distracting, for example, "It could have some useful aspects for onlne [sic] shared use but the community interaction and other aspects of second life can be distracting."

In terms of the likelihood of using a Virtual Study Room if it were available in Second Life, after viewing the video, 69% of participants (N=98) were "likely" or "very likely" to use a tool. Participants were equally positive after experiencing the Virtual Study Room: 72% responded that they were "likely" or "very likely" to use such a tool if it was available in Second Life. Open-ended responses as to why they might use the Virtual Study Room included:

- I create a lot of machinima[27] and I feel when making Second Life training videos, a big call for measure is an interactivity board to jot information on to interact in the video- this is usually a big request. This tool would b eperfect! [sic]
- I find it helpful to be able to visualize projects im [sic] working with if i lay out a miniature mock up of it.
- I love the idea of not having to put things away - that a flexible study are would be already set up for me, and not have to be cleared for other projects, work etc.
- I have a lot of projects and at any given time I could be working on more than one. It's useful to be able to back and forth from working spaces to designing spaces and vice versa.
- As a person used to being in SL a lot, this is a great way to arrange notes and thoughts.
- I like to step away from ideas and return to them. Leaving a project in place and easily editing/adjusting them in such an environment gives me time to reflect. Also, the value of having others "drop by" to give you feedback on work is invaluable.

[27] Machinima is a video or film-like recording in Second Life or other virtual environments.

- Well, I already do to a certain extent. I have used skyboxes for certain projects in which I kept all my work.
- Available wherever I am; all my stuff is there, and my RL desk is a disaster area.
- Im [sic] very busy and work on many projects at the same time, when i do mock up in SL, it just waits for me patiently to pick up where i left off .. lol
- The overriding reason is that I have but one monitor on my desk, and I can have as many as I like here.

Participants were also asked whether they would seek out a Virtual Study Room capability, i.e., would they enter SL expressly for the purpose of using a tool such as the virtual study room. After just viewing the video, a majority of participants (62%, N=100) were "somewhat" or "very" likely to enter SL in order to use such a room; and 72% (N=81) felt the same way after experiencing the Virtual Study Room. Qualitative explanations were positive and similar to those reported above, although some could see the potential, but felt that the current Virtual Study Room design may be too cumbersome to supplant their current practices, reporting:

- The room is nice, but the user needs to be inside SL to access it. If the user has an idea while not in SL, they would have to remember it, write it down and add it later.
- If it just replicates my existing desk environment, it only offers marginal utility. If instead it can short circuit some of the manual steps one has to make in research, then it has unique value.
- I see the potential not being reached, but may be in the future.

After viewing the video and experiencing the Virtual Study Room, participants were surveyed concerning ease of use: 83% (N=77) reported that the Virtual Study Room was "very" or "somewhat" easy to use. When asked to explain if they encountered any difficulties when using the Virtual Study, those participants who responded mostly commented about technical problems in the exhibit, for example :

- Not familiar with the interface; there's a learning curve.
- The Posted Notes are not easy to move around.
- Even with the virtual environment being a lot less restrictive, other people still managed to be in the way.
- No, I did not encounter any difficulties. My only qualm about the Virtual Study Room is that it would be better if I could see the print more clearly.

To the open-ended question, "From an ease of use perspective, how could the Virtual Study Room be improved?" responses included:

- Posted Notes should be drag-able and shouldn't need a separate control panel (right-click shoud [sic] bring up a menu); browser should have more of the options of modern browsers, like tabbed browsing
- Ditch the models[28], get more content screens, put them in clusters close.

[28] The "models" were 3D objects of human skeletons or spines as shown in (see Figure 14).

- If there were any way to physically draw, like on a real whiteboard (i.e. chemical compounds is not easy to make on a keyboard) that would be a plus.
- Assume someone will already have a browser next to their SL window in many cases. Focus only on what SL can UNIQUELY offer, don't just blindly replicate the RL.

And, "From a usefulness perspective, how could the Virtual Study Room be improved?" we heard:

- What you have done here is very nice and visually appealing. As it stands, it is a very useful tool.
- Save/Load from harddrive.
- Im not sure but it is easy the way it is now
- Depending on the situation, a larger room may be needed. Also a way to draw dirctly on a whiteboard, perhaps to doodle out ideas or pictures that are hard to make on a standard keyboard.
- Not sure - will need to try it out on a real task.
- Elements to facilitate interaction with people doing parallel research, like the idea mentioned in the video of a "library" of topics - have the room start assembling information dynamically as the work progresses. Link to the text in post it's, trac. [sic]
- showing the community what is useful, either through groups, news, note card, email.

Lastly, we asked participants to share any final thoughts about the Virtual Study Room concept or implementation. Responses included:

- if it's avalible [sic] for us, please send one over to me ASAP.
- i really think the 3d models are the best thing about it.
- a great concept and I do think will be the way of the future.
- It is an awesome concept, but an idea that takes a while to wrap one's head around. Have to be able to slide those Posteds with my mouse, or move them in 3D as objects.
- I see it as having more application for collaboration than solitary use.
- Fantasic [sic] concept!
- This seems like an inventive and promising way to share information.

Conclusions—Exhibit 6:

Exhibit 6 successfully demonstrated the concept of the Virtual Study Room and how it might function in a virtual world. Participants quickly grasped the purpose and functions from the video introduction, and responded favorably both to the video and to experiencing the proof of concept exhibit afterward. A large majority of responses to surveys (both before and after directly experiencing the Virtual Study Room) were very positive in terms of willingness to use or seek out, ease of use, and usefulness of the Virtual Study Room.

Participants saw the value of separate spaces for different projects, problems, and work, and not having to use the same space for multiple tasks. The comment, "I love the idea of not having to put things away - that a flexible study are would be already set up for me, and not have to be cleared for other projects, work etc." captures this sentiment. Respondents also noted the usefulness of bringing together various tools, "It is useful to have the browser, the notes and the 3D models in once place.

Everything that is needed for research is just at your fingertips." Others saw the value of the Virtual Study Room in terms of engaging others, "…having others "drop by" to give you feedback on work is invaluable."

In some ways, Exhibit 6 is a culmination of the entire *Future InfoExpo*. The various tools designed and demonstrated in the exhibits (e.g., expanded profiles, in-world access to external resources and tools, and 3D information organization tools) can be integrated into flexible, easily customized, personal spaces in virtual worlds.

CONCLUSION

Phase II of the VIBE project sought to extend our understandings of information problem-solving in virtual environments and how general users, as well as information providers, can take advantage of immersive, 3D capabilities for effective and efficient information seeking, use, organization, and sharing. Information and communication systems are becoming more immersive and pervasive. Concurrently, new affordances and uses are possible, which users and information providers will need to learn and adopt to become efficient and effective.

The VIBE research team and 2b3d, a virtual worlds development and research company, engaged in an ambitious design, implementation, and investigation project—the *Future InfoExpo*—to push the limits of Second Life for information seeking and use. We designed and implemented new virtual world tools that supported a variety of information practices in virtual worlds—from organizing information to assessing information sources. Through six distinct exhibits, participants were able to experience the approaches and capabilities first-hand, take part in evaluations, raise key concerns and issues, and make recommendations about features, functions, or approaches.

The project team designed new virtual world tools that supported a variety of information practices in virtual worlds—from organizing information to assessing information sources. Through six distinct exhibits, participants were able to experience the approaches and capabilities first-hand, take part in evaluations, raise key concerns and issues, and make recommendations about features, functions, or approaches. The VIBE team collected and documented the actions and reactions of participants, evaluated the designs that worked, those that didn't, and determined how to improve these in order to enhance information seeking and use practices in virtual worlds.

A summary of the results and conclusions were presented in the Executive Summary and are repeated here as well:

- Designing and implementing a unified "virtual exposition" is an effective and efficient research approach for demonstrating and testing new or expanded technological capabilities and functions.

- A number of special tools were adapted or newly developed for the *Future InfoExpo.*
  - ✓ The orientation exhibits were effective in setting baseline competencies for participants.

- ✓ The Heads-Up Display (HUD) is a highly effective tool for gaining consent, coordinating activities, tracking progress, administering surveys, capturing data, and ensuring privacy and security.

- For trust and credibility:
  - ✓ SL users typically rely upon recommendations by others in seeking and trusting others for information.
  - ✓ SL residents do not value SL search tools for credible information seeking.
  - ✓ Profile fields are important in determining the credibility and potential usefulness of other residents.
  - ✓ Role or Position in SL is also a factor and so is the willingness to share first life descriptions including "About Me" and "Expertise." About Me was judged the most important description for credibility.
  - ✓ Adding a "recommender system" would improve the SL Profile . The important types of information to provide include positive (and negative) comments from reviewers, comments about other avatars, and information about expertise.
  - ✓ A star rating system (based on averaging user ratings) was rated less important and should be studied further as this finding may have implications for the many web and app-based rating systems that currently exist.

- For expanded access to resources and information beyond the virtual world:
  - ✓ Easy access to information and resources beyond virtual worlds is definitely important.
  - ✓ There is strong overall preference for tools that facilitate accessing web-based information from within SL. In the future, this may also relate to information stored on smart phones, tablets, and other devices.
  - ✓ New SL capabilities for accessing web-based information and search tools were well-received. All three tools developed were uniformly regarded as easy to use, helpful for accessing web-based information, fun to use, novel, and useful for sharing information with others.
  - ✓ Results indicate that users value any tool that can afford this capability, rather than any one tool in particular.
  - ✓ Some participants reported difficulties when using the tools. Tools need to be easy to learn and use.

- In terms of organizing information for effective and efficient use,
  - ✓ The 3D virtual environment offers unique capabilities for representing, organizing, and manipulation of information and this was recognized and valued by participants.
  - ✓ Information organization—possibly combined with 3D visualization—has the potential to be one of the "killer app" capabilities of SL and other virtual worlds.
  - ✓ The Posted Note and Matrix approaches are ready to be refined and implemented as tools in virtual worlds.

- ✓ The concept of representing information on multi-sided objects as represented by the InfoCube requires further development, particularly in terms of simple and direct manipulation of objects.

- Regarding the concept of the Virtual Study Room,
  - ✓ The *FutureInfoExpo* successfully demonstrated the concept of user-centered virtual study rooms that facilitate information problem-solving and focused study and work.
  - ✓ Participants immediately grasped the potential, usefulness, and value of having separate spaces for different projects, problems, and work, and not having to use the same space for multiple tasks.
  - ✓ A large majority of respondents would use the Virtual Study Room if available in SL (or another virtual world) or would seek out a virtual world to specifically use a Virtual Study Room.

The *Future InfoExpo* was important because it demonstrates "proof of concept" of new or expanded functions and capabilities in 3D, immersive virtual environments and offers clear directions for future research. Users and information providers experienced, envisioned, and evaluated possible information practices in virtual environments and provided feedback on their experience.

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