

## VIRTUAL SPACE AND PLACE: THEORY AND TEST

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## Appendix A

### The Terminology Used to Develop and Test the VSP Theory

	Terminology	Definition	Synonym	Operationalization
Concept of Virtuality	Second Life User	Person having an avatar in the SL virtual World	Virtual World denizens, Second Life user, social actor, visitor, user, friend	Participants
	Avatar	Animated characters that are graphical representation of people (Davis, et al. 2009)	Animated characters	Avatar
	Virtual world(s) (VW(s))	An electronic environment that visually mimics complex physical spaces, where people can interact with each other and with virtual objects, and where people are represented by animated characters (Bainbridge 2007, p. 472)	Digital world, social virtual, world, virtual environment, apparent three dimensional environment	Second Life (SL)
	Virtual Object	Object designed using apparent three dimensionality displayed in VWs	IT tools, Interactive work tools, virtual tools, VW tools	Tools namely, brainstorming tool, idea organizer, voting floor

Terminology		Definition	Synonym	Operationalization
Concepts of Space	Space	The sum of all places (Norberg-Schulz 1971, p. 10) Bounds and structures the world (Harrison and Dourish 1996) Man unifies bodily conceptions of spatial relationships into a "space concept (Lakoff and Johnson 1999)	Topos	Tools that are designed to operate in three-dimensional space
	Directionality	The extent to which movement is possible across a range of motion The shape and posture perception of space, vertical-horizontal, front-back and right-left, of the human body (Based on Tuan 1977)	Characteristic of space, range of motion	
	Perceptual Space	That which can be seen or sensed at one place and at one time (Couclelis and Gale 1986, p. 2)	Perception of space	
	Cognitive Space	The large-scale space beyond the sensory horizon about which information must be mentally organized, stored, and recalled (Couclelis and Gale 1986, p. 2)	Cognition of space	
	Physical Space	Sum of the cognitions and perceptions of the bodily experience that together form a mental representations of the physical world	Real world, physical world	
	Virtual Space	Sum of the cognitions and perceptions of the experience of the apparent three dimensional space  It is built on the mental representation of the physical space and form another mental representation of the virtual world	Apparent three-dimensional world of Second Life	
Place	<p>The perception of bounded space imbued with meaning</p> <p>The psychologically meaningful domain where identifications of people to locations are formed through the sharing of experiences within a space and socially co-constructed through repeated interactions (Sarker and Sahay 2004)</p> <p>A container in the space and holds mental representation of experiences that are derived from social interactions and interactions with objects</p> <p>Comprised of setting, meaning and interactions (i.e., activities) (Relph 1976)</p> <p>Space + meaning (Harrison and Dourish 1996)</p> <p>Differentiation in six directions (i.e., up, down, right, left, forward, and backward) and objects move in these six directions (Aristotle in Lang 1998)</p>	Familiarity, novice, expert, imagined reality (in SL)	High versus low experience of place in the VW	

Terminology		Definition	Synonym	Operationalization
Presence	Immersion	A psychological state characterized by perceiving oneself to be enveloped by, included in, and interacting with an environment that provides a continuous stream of stimuli and experiences (Witmer and Singer 1998)  Alternatively referred to as telepresence when a person experiences physical presence mediated by the system interface (Minsky 1980)	Telepresence, engagement	Focused immersion with SL
	Social presence	The perception that there is personal, sociable, and sensitive human contact in the medium (Short, et al. 1976)	Social presence mediated, co-presence	Social presence in SL

## Appendix B

### Main Conceptual Foundations about Space and Place and Their Primary Contributors

Critical Foundations	Key Sources
<b>Place:</b> "a set of interconnected nodes which represent the view and other facts, beliefs, etc., defining that place." Psychologically meaningful domain where identifications of people to locations are formed through the sharing of experiences within a space.	Couclelis and Gale 1986, p. 9; Sarker and Sahay 2004
<b>Space:</b> a complex concept. We view it as an openness and freedom that does not have a locally-specific meaning identified with it; sum of all places.	Norberg-Schulz 1971, p. 10
<b>Perceptual and cognitive space</b>	
Space has been conceived in terms of physical, cognitive and perceptual.	Couclelis and Gale 1986
Individuals use spatial relations concepts unconsciously and impose them via perceptual and conceptual systems.	Lakoff and Johnson 1999; Piaget 1955
<b>Directionality in three-dimensional space</b>	
The human body defines perceptions of space in terms of directionality.	Aristotle in Morison 2002; Lakoff and Johnson 1999; Tuan 1977
The concept of space is human-centered when it is grounded in an individual's own perceptual and motor systems.	Nitschke 1968 in Norberg-Schulz 1971
The cognitive view of space exists independently of any one person and, thus, is absolute (unlike Nitschke's view).	Lefebvre 1991; Norberg-Schulz 1971
Perceptions are important in adapting an individual's cognition of spatial relations and orientations. Adaptation consists of assimilation and accommodation.	Piaget 1954
<b>Concepts of space versus place</b>	
The concept of space is often related to the concept of place.	Harrison and Dourish 1996; Tuan 1977
Place may be viewed as a container within space.	Aristotle in Lang 1998; Hartford and Leonard 2006; Lakoff and Johnson 1999
The container view of place within space may be too simplistic because it does not take into account the fact that boundaries of the container are permeable and dynamic.	Gustafson 2001
Place requires a locally-specific meaning.	Harrison and Dourish 1996; McCullough 2004; Sarker and Sahay 2004;

# Appendix C

## Design Iterations

Design Iteration	Object	Use of Space/Presence	Design Documentation	Evaluation
1. Feasibility	1. Yes/no vote 2.1. Brainstorming pole (one direction) 3.1. Voting floor 4. Voting board 5. Instant voting board 6. Connection to database	Yes/no vote and voting board did not use space—just buttons placed in a virtual world. <i>Low presence.</i> Voting floor was the only tool that used simulated three-dimensional space from the start (and did not change in its basic idea through the iterations). <i>Allowed presence in terms of how avatar's body relates to others on the voting floor.</i> Brainstorming tool provided only a list of ideas (one direction). <i>Low presence.</i>	Manual on how to use, flat text description of background of the tools	Informal evaluation by students and by experts.
2. Better use of space in brainstorm and improved text display	2.2. Brainstorming tool using simulated three-dimensional space	Brainstorming started to use space by displaying text on the object and moving ideas around. Avatars and ideas became objects in space. Primary directions used: front, right-left. <i>Allowed presence of other avatars by letting them see others in circle.</i>	Plain text specification of tools, manuals and global design	By experts (who also provided the spec at the start).
3. Complete overhaul of idea organizer. Technical design of the voting	2.3. Idea organizer tool 3.2. Voting floor	Space was used to organize ideas in categories and to sort ideas in the categories. Avatars could walk around working area to look at the different ideas from different angles. Primary directions used for idea organizer: front, right-left, up-down. <i>Presence more in terms of interactions with objects than social interactions.</i> Primary directions used for voting floor: front-back, right-left, up-down. <i>Allowed presence in terms of how avatar's body relates to others on the voting floor.</i>	Message sequence charts (MSC) and specification description language (SDL)	Actual use in one-hour meeting by 150 professionals and survey (n = 150). Novice SL professional were in a low place condition (n = 95) and experts SL professional were in a high place condition (n = 55).
4. (future) Easier to use qualitative tool, connection to database	to be decided	(1) Manipulating ideas more freely and more fully in three-dimensional space. (2) Using the total island as the agenda (brainstorm, ski, vote and skate) (3) Encouraging creating a place where avatars return frequently.	To be decided, most likely MSC and SDL	Longitudinal usage by groups of students in Fall 2011 and continued use by professionals.

## Appendix D

### Propositions, Hypotheses, Direction of the Expected Results, and Rationale for Using VSP Theory

Label	Proposition	Hypothesis	Direction	Rationale from the VSP Theory	
1a	Objects in virtual space that provide higher directionality are perceived to be easier to use than those that have low directionality.	H1a: The voting floor (i.e., the tool with the most directionality) is perceived as easier to use than the idea organizer (i.e., the tool with moderate directionality), which, in turn, is perceived as easier to use than the brainstorming tool (i.e., the tool with the least directionality).	Voting floor > idea organizer > brainstorming tool	The more similar the virtual space is to existing cognitions about the physical space, the easier the adaptation is and the faster the user can move on in mastering the new environment. Where there is a full range of motion such as in the voting floor (front, back, right, left, up, down) similar to physical space, the tools will be easier to use and more enjoyable than tools with most limited directionality such as the brainstorming tool or the idea organizer (front, right, left).	Directionality (Independent Variable) Perceived ease of use, perceived enjoyment (Dependent Variables)
1b	Objects in virtual space that provide higher directionality are perceived to be more enjoyable than those that have low directionality.	H1b: The voting floor (i.e., the tool with the most directionality) is perceived as more enjoyable to use than the idea organizer (i.e., the tool with moderate directionality), which, in turn, is perceived as more enjoyable to use than the brainstorming tool (i.e., the tool with the least directionality).			
2a	Users who have a heightened experience of place when using a virtual object find it significantly easier to use than do those who have a diminished experience of place when using a virtual object.	Participants in the high place condition find each tool significantly easier to use than do participants in the low place condition.	High place voting floor > low place voting floor  High place idea organizer > low place idea organizer  High place brainstorming tool > low place brainstorming tool	In order to create a place in virtual space, an individual must interact with tools within that space. The interaction with the objects in the VW over time creates familiarity. Those who are more familiar with the VW have already adapted their perception and cognition to the VW, and consequently experience less mental burden and enjoy the three tools more than do those unfamiliar with the VW. The users unfamiliar with VW need to integrate their perception of the three dimensionality and directionality to fully master and enjoy the three tools.	Place (Independent Variable) Perceived ease of use, enjoyment (Dependent variables)
2b	Users who have a heightened experience of place when using a virtual object find it significantly more enjoyable than do those who have a diminished experience of place when using a virtual object.	Participants in the high place condition find each tool significantly more enjoyable to use than do participants in the low place condition.			

Label	Proposition	Hypothesis	Direction	Rationale from the VSP Theory
3a	Users who have a heightened experience place when using a virtual object attribute more social presence to the VW than do those who have a diminished experience of place when using a virtual object.	Participants in the high place condition experience more social presence than do participants in the low place condition.	High place social presence > low place social presence  High place focused immersion > low place focused immersion	Those who are familiar with an island are ready to experience the high place condition in the VW. In contrast, those who are unfamiliar with the VW environment and are still learning to interact with the virtual tools are ready to experience the low place condition.
3b	Users who experience place when using a virtual object attribute are more immersed in the VW than do those who do not experience place when using a virtual object.	Participants in the high place condition experience more focused immersion than do participants in the low place condition.		Therefore, those who are unfamiliar with the VW are inclined to experience presence mediated by the VW than are those who are familiar with an island. The more a user becomes familiar with a place in a VW, the more he/she will experience social presence and focused immersion.

Place (Independent variable)  
 Social presence, Focused immersion  
 (Dependent variables)

# Appendix E

## Operationalizations of Manipulation Checks and Dependent Variables

Items	k	Cronbach's Alpha	Construct
You are very skilled at using Second Life.	4	.981	Familiarity with Second Life (adapted from Novak et al. 2000)
You know how to control your avatar action on Second Life.			
You know more about Second Life than other users.			
You have used Second Life extensively in the past.			
Using the brainstorming tool was easy.	2	.768	Perceived Ease of Use – Brainstorming (adapted from Pavlou and Fygenson 2006)
Using the brainstorming tool was clear and understandable.			
Using the idea organizer was easy.	2	.825	Perceived Ease of Use Idea Organizer (adapted from Pavlou and Fygenson 2006)
Using the idea organizer was clear and understandable.			
Using the voting floor was easy.	2	.798	Perceived Ease of Use Voting Floor (adapted from Pavlou and Fygenson 2006)
Using the voting floor was clear and understandable.			
Using your avatar was easy.	2	.861	Perceived Ease of Use Avatar (adapted from Pavlou and Fygenson 2006)
Using your avatar was clear and understandable.			
Using the brainstorming tool was fun.	2	.840	Perceived Enjoyment – Brainstorming (adapted from Koufaris 2002)
Using the brainstorming tool was entertaining.			
Using the idea organizer was fun.	2	.861	Perceived Enjoyment Idea Organizer (adapted from Koufaris 2002)
Using the idea organizer was entertaining.			
Using the voting floor was fun.	2	.829	Perceived Enjoyment – Voting Floor (adapted from Koufaris 2002)
Using the voting floor was entertaining.			
Using your avatar was fun.	2	.768	Perceived Enjoyment – Avatar (adapted from Koufaris 2002)
Using your avatar was entertaining.			
The three-dimensional space in Second Life is especially good for brainstorming.	3	.858	Directionality (new)
The three dimensional space in Second Life is especially good for organizing ideas.			
The three dimensional space in Second Life is especially good for voting.			
There is a sense of human contact in Second Life.	5	.957	Social Presence (adapted from Gefen and Straub 2004)
There is a sense of personalness in Second Life.			
There is a sense of sociability in Second Life.			
There is a sense of warmth in Second Life.			
There is a sense of human sensitivity in Second Life.	3	.930	Focused Immersion (adapted from Agarwal and Karahanna 2000)
When using Second Life you block out most of the distraction.			
When using Second Life you were immersed in the task you were performing.			
When using Second Life you were absorbed in what you were doing.			

# Appendix F

## Manipulation Check of Place Condition Using Familiarity and Directionality

Since it is difficult to measure place, we tried to create two conditions of place that were clearly distinguishable. Further, we used familiarity as a proxy in performing a manipulation check for low and high conditions of place.

As a manipulation check, we measured each participant’s level of familiarity using the adapted version of the web skills scale (Novak et al. 2000) anchored on seven-point Likert scales (from 1 = strongly disagree to 7 = strongly agree). The operationalizations of familiarity, as well as the manipulation checks related to avatar use and directionality can be found in Appendix D. The Cronbach’s alpha is .981 and above .95 could be challenged on the grounds that it may be the result of common method variance and not assessing measurement error (Straub et al. 2004).

We also asked two items each to measure the perceived enjoyment and ease of use of the avatar. The Cronbach’s alphas for perceived enjoyment and perceived ease of use of the avatar are .768 and .861, respectively. Finally, we used the items about the appropriateness of the use of three-dimensionality (k = 3) to address the relative directionality of each of the tools. The Cronbach’s alpha is .858.

The results of the Mann–Whitney test results indicated that participants in the high place condition (mean rank = 111.7) were more familiar with using SL than were participants in the setting designed to create a relatively low place condition (mean rank = 49.3, U = 298, z = -8.7, p = .0001). Those in the high place condition (mean rank = 91.74) also perceived the avatars to be easier to use and more enjoyable than did those in the low place condition (mean rank = 63.41, U = 1495.5, z = -3.9, p = .0001). Table F1 presents the descriptive values for the manipulation check of the place condition.

As a manipulations check on directionality (see Table F2), the participants were asked to rate three-dimensionality of each tool. The results of the Friedman test indicate that the tools were rated significantly different (Chi-square = 32.079, d.f. = 2, p = .0001). The results of the Friedman test suggest that using three-dimensionality was rated more appropriate for the voting floor (mean rank = 2.3) than for the brainstorming tool (mean rank = 1.85) and than for the idea organizer (mean rank=1.84). This means that the voting floor which was designed to use three directions was perceived by the participants to have a greater range of motion than the other two tools which were designed to require fewer directions.

**Table F1. Mean, Standard Deviation, Median and Modal Values for the Manipulation Check of Place**

Condition Place		Familiarity with Second Life	Perceived Enjoyment, Avatar	Perceived Ease of Use, Avatar	Three-Dimensionality Appropriateness
High	N	52	53	52	53
	Mean	5.6	5.6	5.5	5.5
	Median	6	6	5.5	5.6
	Mode	6	6	5.5	5.7
	SD	1.36	1.18	1.14	1.1
Low	N	91	94	94	95
	Mean	2.3	4.4	4.48	3.7
	Median	2	4.5	4.5	3.6
	Mode	2	6	5	3.7
	SD	1.2	1.7	1.6	1.3

**Table F2. Mean, Standard Deviation, Median and Modal Values for the Manipulation Check of Directionality**

3-Dimensionality	Brainstorming	Idea organizer	Voting floor
N	148	148	148
Mean	4.19	4.15	4.8
Median	4	4	5
Mode	4	4	6
SD	1.68	1.62	1.76

## Appendix G

### Factor Analyses: Rotated Component Matrix

	Component			
	1	2	3	4
Using the brainstorming tool was easy			.772	
Using the idea organizer was easy			.723	
Using the voting floor was easy			.769	
Using the brainstorming tool was clear and understandable			.751	
Using the idea organizer was clear and understandable			.778	
Using the voting floor was clear and understandable			.714	
Using your avatar was entertaining	.818			
Using the brainstorming tool was entertaining	.796			
Using the idea organizer was entertaining	.755			
Using the voting floor was entertaining	.725			
Using your avatar was fun	.803			
Using the brainstorming tool was fun	.736			
Using the idea organizer was fun	.765			
Using the voting floor was fun	.671			
There is a sense of human contact in Second Life		.768		
There is a sense of personalness in Second Life		.832		
There is a sense of sociability in Second Life		.848		
There is a sense of warmth in Second Life		.830		
There is a sense of human sensitivity in Second Life		.824		
When using Second Life you were able to block out most other distractions				.751
When using Second Life you were immersed in the task you were performing				.740
When using Second Life you were absorbed in what you were doing				.658
Age				
EIGENVALUES	12.54	2.19	1.76	1.009

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

Rotation converged in six iterations.

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