Usability Design and Psychological Ownership of a Virtual World

YOUNGHWA LEE AND ANDREW N.K. CHEN

YOUNGHWA LEE is an associate professor of information systems at the University of Northern Iowa. He received his Ph.D. in information systems from the University of Colorado at Boulder in 2005. His research interests focus on technology acceptance, and Web site and virtual world usability. His research has appeared in *Communications of the ACM, Decision Support Systems, European Journal of Information Systems, Journal of Organizational Computing and Electronic Commerce, MIS Quarterly,* and other journals. He is an ICIS 2003 Doctoral Consortium fellow.

ANDREW N.K. CHEN is an associate professor of information systems in the School of Business at the University of Kansas. His teaching and research interests include knowledge management, IT business value, computer interface design, database management, and business and Web programming applications. His research work appears in *Decision Sciences, Decision Support Systems, European Journal of Operational Research, Journal of Electronic Commerce Research, Journal of Management Information Systems,* and *MIS Quarterly.*

ABSTRACT: Virtual worlds, immersive three-dimensional virtual spaces where users interact with projected identities of other users (avatars) and objects, are becoming increasingly popular and continue to grow as highly interactive, collaborative, and commercial cyberspaces. However, extant research in this context has not paid much attention to usability design of a virtual world and corresponding effects on users' psychological desire to own and control the space and objects within it and subsequent behavior intention. In this study, we apply concepts of Web site usability and psychological ownership to develop a model that illustrates the relationships between seven usability factors (legibility, firmness, coherence, variety, mystery, classic, and expressive visual aesthetics), four antecedents of psychological ownership (cognitive appraisals, perceived control, affective appraisals, and self-investment), psychological ownership, and use intention. A cross-sectional study with 239 Second Life users was conducted. The results demonstrate that designing a usable virtual world that induces strong psychological ownership is crucial to attract users to spend more time, participate in more activities, and revisit the virtual world. This is an important finding for forward-looking e-business managers looking to invest their limited resources in designing a usable virtual world. In addition, by using our model and corresponding survey items, designers can benchmark and evaluate the usability of their current virtual worlds, compare the results to the designs of competitors, and upgrade the offerings of virtual worlds, as needed, by allocating available resources to the most influential design factors to suit their specific needs.

KEY WORDS AND PHRASES: architectural quality model, human–computer interaction, landscape preference model, psychological ownership, usability, virtual worlds.

Journal of Management Information Systems / Winter 2011–12, Vol. 28, No. 3, pp. 269–307.

0742–1222 / 2012 $9.50 + 0.00.
DOI 10.2753/MIS0742-1222280308

VIRTUAL WORLDS, DEFINED AS IMMERSIVE THREE-DIMENSIONAL (3D) VIRTUAL SPACES where users interact with projected identities of other users (avatars) and objects, are becoming increasingly popular and have garnered considerable attention from both researchers and social network practitioners (e.g., [10]). A number of virtual worlds such as Second Life, Entropia Universe, Habbo Hotel, and ActiveWorlds have been launched and continue to grow as highly interactive, collaborative, and commercial cyberspaces. Within these virtual worlds, users select and reside in their preferred virtual places, including online communities and educational institutions. In addition, commercial companies, including IBM, are strategically investing in virtual world projects, which are considered to be the essential tool for helping people work, live, and play to their fullest potential (e.g., [12, 19, 23]). Virtual worlds have grown exponentially, and it has been projected that by the end of 2012, 900 virtual worlds sites will be built and $6 billion in revenue will be generated (e.g., [25]).

One of the intriguing phenomena reported about virtual worlds is that, compared to traditional Web site users, virtual world users have a stronger sense of ownership toward virtual worlds and show a greater tendency to own and control the space and objects within it, called "psychological ownership" (PO) [60]. PO represents "the state in which individuals feel as though the target of ownership or a piece of it is 'theirs' (i.e., 'It is MINE!')" [60, p. 299]. We conjecture that, compared to Web sites, individuals' need for possession and control becomes more salient in virtual worlds where the 3D graphic technologies provide a more vivid, imaginary, and realistic experience, resulting in creating or purchasing virtual objects such as buildings, cars, or islands; customizing avatars with a variety of decorations; and participating in group activities. From this perspective, we investigated four plausible antecedents of PO (i.e., control, self-investment, cognitive appraisals, and affective appraisals).

Recently, information system (IS) researchers have investigated the influence of PO in the IS acceptance and implementation context and found that it has a significant influence on systems usage [3, 6, 53, 57]. Since a virtual world is an IS (i.e., object) that users want to possess, designing and implementing an environment that can induce greater PO among users, and subsequently affect their future behavior, is a critical issue for both designers and providers of virtual worlds.

Meanwhile, as with traditional Web sites, a critical factor for a successful virtual world is its usability [47], defined as the extent to which a virtual space enables specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use. This is because users feel, search, navigate, and experience products (or services), and interact with other avatars in the virtual space; thus, users' perceptions of a particular virtual world are significantly influenced by its usability.

Previous studies have mainly focused on (1) providing back-end technical solutions to create the 3D virtual environment or (2) proposing or testing the applicability of virtual worlds in various domains such as education [11], marketing [74], and virtual teamwork [15]. Thus, there is a fundamental lack of attention to usable virtual worlds designed to attract users to participate in virtual worlds and to provide them with

compelling experiences [20]. Even though some speculation has been offered with regard to what constitutes a usable virtual world design [51], empirical evidence resulting from rigorous studies conducted using scientific methodologies is unavailable. In the absence of scientific evidence of what makes up a usable virtual world design, designers have developed virtual worlds by relying on their intuition or experience, resulting in designs that are inconsistent, non-testable, and non-reusable. Further, the complexity of designing a virtual world increases dramatically because of massive development of advanced 3D design artifacts by users who were not directed by usability guidelines.

Based on the above reasoning, this study examined the relationship between usability, PO, and subsequent user behavior with regard to designing a usable virtual world. Usability represents design guideline(s) to develop virtual worlds to help users perceive effectiveness, affect, and control from the virtual world. These perceptions are fundamental to eliciting users' sense of ownership, which in turn influences subsequent user behavior.

To develop the research model, we adopted two usability models, the landscape preference model [35] and the architectural quality model [40], based on the analogy between a virtual place and a physical place. These models were originally developed to address usable and attractive physical space (or artifact) design, but have recently been adopted in Web usability research for building usable Web sites (e.g., [43] for the landscape preference model; [37] for the architectural quality model). A virtual world consists of both artifacts (e.g., buildings, avatars, cars, and their embellishments) and the surrounding system environment (e.g., backgrounds, mountains, and oceans). People develop their perceptions of a place by integrating their perceptions toward virtual artifacts and virtual background. The architectural quality model and landscape preference model are both well suited for capturing perceptions of artifacts in a virtual space as well as the virtual space itself, respectively [77]; therefore, we propose an integration of these models as a plausible effort to help design usable virtual worlds.

The contributions of this study are manifold. First, we integrate relevant and essential theories (i.e., PO, architectural quality, and landscape preference) to develop the proposed model for examining plausible usability designs of virtual worlds. Integration of these theories is unique, and we conjecture that such integration is especially appropriate for supporting the nomological networks and constructs under investigation in this study. This theoretical development approach helps contribute to and justify our research designs and goals. Second, to address the absence of studies on usable virtual world design, our study looks into factors that affect usability that is specifically suitable in a virtual world environment. In particular, contrary to previous Web usability theories, which examined the direct relationship between usability factors and user behavior on the Internet, we incorporated and investigated PO in a virtual world as a mediating variable that intervenes with this relationship. By confirming the substance of PO, we can provide a richer understanding of how to design a usable virtual world that users want to own. Finally, our study is believed to be the first to

examine the relationship between usability, PO, and user behavior in a virtual world environment. Thus, we empirically test the antecedents as well as the consequences of virtual world users' PO; therefore, our findings can offer valuable implications and guidelines for virtual world users and designers.

Theoretical Background

A Metaphor of Place

CYBERSPACE IS OFTEN DEPICTED AS A VIRTUAL EMBODIMENT of physical space (or artifacts) based on a "place" ("space" or "building") metaphor [5]. The spatial metaphor is one of the dominant themes in the field of Web site usability since a cyberspace is an emulation of a physical space and an embodiment of one's experiences of physical places in a virtual environment, particularly with 3D virtual worlds [81]; that is, a virtual world can be depicted as a real place in the virtual environment where people visit and navigate, interact with others, actively participate and engage in activities or events, or create and own land, artifacts, or information. Researchers (e.g., [30]) have found that visitors express a high degree of preference for a certain virtual place when they have a clear mental representation of the place and a strong sense of belonging. Further, studies have found that many features of physical and virtual places overlap, and successful online stores implement features from the brick-and-mortar world into their virtual sites [39].

For example, people develop their perceptions of a physical place by combining perceptions from its directly perceived features with those of its inferred features. The inferred features invoke perceptions of what would happen while walking into and experiencing the space. Similarly, online users develop direct perceptions from their experience with the first element of a virtual "place" they view, the home page [70]. Further, visitors develop their perceptions about the inferred features by navigating and experiencing a wealth of information and features embedded in the underlying "cyber place." Thus, architectural metaphors can be applied to virtual worlds. Therefore, every "place" in virtual environments can be uniquely designed with different artifacts so that online visitors can perceive a different sense of place and locality in the virtual space. Based on this "place" analogy, this study refers to two theoretical models, Kaplan's landscape preference model from environmental psychology and Vitruvius's architectural quality model [65] from architecture, to propose and validate a model for designing a usable virtual world.

Virtual worlds offer unique system environments that are distinct from traditional Web environments; that is, they provide an immersive environment where users can use an in-world representation (i.e., avatar) to conduct a variety of social interactions along with economic and commercial activities in their shared space [51]. Virtual worlds also convey a more realistic and natural layout that renders diverse cues that trigger natural cognition and actions better than traditional Web environments [72]. Thus, in a tangible physical environment with depth, distance, and geographic boundaries,

users can perceive a great sense of telepresence, which is lacking in traditional Web environments [30]. Even more, virtual worlds enable users to produce and possess virtual artifacts through real-time collaboration with other inhabitants. Finally, virtual worlds offer a variety of innovative navigation means (e.g., teleport, fly, local chat) and artifacts (e.g., customizable objects and landscape, attachment of avatars) that are not provided in traditional Web environments.

Two usability theories anchored in the analogy of place are used to design usable place or artifacts: the architectural quality model and the landscape preference model.

Architectural Quality Model

Researchers in the field of architecture [26, 28, 64] have developed conceptual models of architectural quality. The Swiss art historian Siegfried Giedion claimed that architects were encouraged to use their powers of "thought" and "feeling" to an equal degree and, in turn, combined art and technology as a whole for the quest of high quality [26]. Rasmussen [64] followed Giedion's model and referred to the famous Roman architecture critic, Vitruvius, who identified three aspects of designing and evaluating a building: *firmitas* (firmness), *utilitas* (utility), and *venustas* (beauty).

More recently, a line of research has referred to these three aspects in the post-occupancy evaluation literature (e.g., [63]) as a way to evaluate the quality of buildings. *Firmness* represents the structural firmness of a building, measuring the extent to which a building is "firm" enough to protect its residents from environmental threats such as rain, heat, or snow. *Utility* refers to the appropriate allocation of space in a building. A building provides satisfaction to residents when its spaces and components (e.g., furniture) are suitably allocated to meet their needs. Finally, *beauty* represents the visual appeal of a building. A building characterized as having strong firmness, suitable space allocation, and a pleasant appearance will be evaluated as attractive and of high quality. Previous studies have found that firmness, utility, and beauty positively influence the emotion and perceived effectiveness of buildings (e.g., [28]).

Creating a Web site in a virtual space can be similar to constructing a building in a physical space. As Kim et al. [37] suggested, Web sites may be regarded as buildings in cyberspace because both Web sites and buildings need to be constructed to serve similar objectives such as being a place attracting people to visit. As a builder constructs a building using a variety of materials and then selectively combines them to create a firm, utilitarian, and beautiful physical space, a Web designer creates a Web site using a variety of design components and then selectively combines them to create a reliable, usable, and visually attractive virtual space. We extend this theoretical model to investigate a virtual world, Second Life, which can be depicted as artifacts consisting of a variety of buildings. Table 1 summarizes the definition of architectural quality factors in both a physical space and a virtual world context and their implementation in the Second Life environment [44].

Table 1. Summary of Architectural Quality Factors and Their Implementation in Virtual Worlds

Factors	Physical space	Virtual worlds	Second Life features
Firmitas (strength)	The extent to which a building is firm enough to protect its residents from all environmental threats	The solidity of the system components of virtual worlds in overcoming all expected and unexpected threats	Backup blog servers, inventory operations reliability enhancement patch, open source Linden server code, abuse report, copyright protection, terms of service, and community standards
Utilitas (utility)	The appropriate allocation of space in a building	Effectiveness (e.g., easy of navigation, convenience) of design components of virtual worlds for the users to interact with the system and people	Help Islands, Orientation Islands, Landmark, Teleport, Fly, Mini-map
Venustas (beauty)	The visual appeal of a building	The visual attractiveness of artifacts in virtual worlds	Avatars, buildings, surroundings, and other virtual objects that are vivid, fascinating, sophisticated, and realistic

Landscape Preference Model

Kaplan and Kaplan [33] proposed the landscape preference model, which examines physical environments in an attempt to identify design patterns that incorporate the end users' utilization of environmental cues, thus making it easier for people to process information and function effectively and enjoyably. The authors examined landscape preference using the concepts of making sense (or understanding) and involvement (or exploring). *Making sense* refers to "the concern to comprehend, to keep one's bearings, to understand what is going on in the immediate here and now and often in some larger world as well," and *involvement* refers to "the concern to figure out, to learn, to be stimulated" [35, p. 47]. In other words, making sense relates to the perceived structure of the environment, which includes stimuli that would make the environment easier to characterize and summarize to oneself (coherence), and easier to map (legibility). At the same time, the supportive environment of involvement contains rich landscape components (variety) and is also related to the process of engaging and sustaining one's interest in an environment (mystery).

Considering these four factors of landscape preference, legibility, coherence, variety, and mystery, this model draws on 2D and 3D visual perception, and depicts humans as cognitive creatures who can "compute" the future possibilities of present landscape choices. The computation consists of both immediate and future calculations, which can occur quickly but sequentially; that is, immediate (2D) perceptions are related to coherence and variety, whereas future (3D) perceptions are related to legibility and mystery. The primary level of the model represents immediate perceptions of the elements in a landscape, which allow rapid assessment based on a surface examination. Settings that are orderly (coherent) increase the individual's ability to make sense of the landscape, and richness of the elements (variety) enhance involvement.

This immediate assessment is followed by an inference of what lies deeper within a landscape. Landscape components that help visitors to not be disoriented (legibility) and provide perceived expected curiosity and fancy (mystery) assist in understanding an unfamiliar landscape and encourage further navigation. Previous studies have validated the model in various contexts, including home page design (e.g., [27, 34, 70]). Results showed that when visitors of a place saw landscapes consisting of legible, coherent, diverse, and fascinating components, they perceived pleasantness and usefulness, which in turn triggered their intention to stay longer, revisit, or even make purchases.

We predict that this model is pertinent in the usable design of virtual worlds since, as with physical space, virtual worlds contain a virtual landscape. Thus, major constructs of the original model are pertinent for assessing online visitors' preference for a virtual world. Online visitors develop a positive attitude toward virtual worlds when they can grasp their structure, content, and features in a few seconds (coherent); can easily navigate without becoming disoriented (legibility); can enjoy vivid and dynamic images and other multimedia (variety); and are stimulated by features inspiring their curiosity (mystery). Table 2 summarizes the definition of the landscape preference model in both a physical space and a virtual world context and its implementation in the Second Life environment [44].

Table 2. Summary of Landscape Preference Model and Its Implementation in Virtual Worlds

Factor	Physical space	Virtual worlds	Second Life features
Legibility	Ease of navigating a scene with centrality of orientation	The capability of virtual worlds to provide easy interaction and navigation	Landmark: a geographic location in Second Life Teleport: instantaneous travel between one point on the grid and another Fly: 170 meters above the terrain, and Mini-map
Coherence	The ease of grasping the organization of the scene	The capability of virtual worlds to provide consistent and orderly contents, structures, and multimedia components within and across sites/ pages	Consistent menus, help, navigation, walk, chat features Repeating structures and unifying textures that contribute to a good gestalt
Variety	Diversity in a scene	The capability of virtual worlds to provide diverse components that create vivid interaction and communication with online customers	Diverse communication methods: local chat (shout and whisper): between two or more avatars within 20 meters; global instant messaging: between two avatars or among the member of a group; voice chat using technology by Vivox Customize avatars and their shape, skin, hair, eyes, and attachments
Mystery	The curiosity perceived while investigating a concealed landscape, which was unseen at first glance	The capability of virtual worlds to invoke curiosity and interest and stimulate further navigation	A variety of unseen and unexplored avatars, places, and transportation Flash arrow, Continue, Exit

Theory of Psychological Ownership

PO has received considerable attention from scholars of management and psychology [60]. The crux of PO is a feeling of possessiveness and psychological attachment to an object, either a physical or a nonphysical entity. Pierce et al. [60] suggested that three main "routes" (experiences, paths, or mechanisms) lead to the state of PO: controlling the object, investing the self into the object, and coming to intimately know the object; that is, when developing feelings of PO toward an object, individuals tend to experience a basic motivation to possess and control it, devote significant energy and resources to it, and feel cognitively connected and emotionally attached to it.

From this perspective, four antecedents of PO (i.e., control, self-investment, cognitive appraisals, and affective appraisals) can be established and used for this study. Pierce et al. defined *perceived control* as "the ability to use and to control the use of objects" [60, p. 301] and *self-investment* as "the investment of an individual's energy, time, effort, and attention into objects" [60, p. 302]. In addition, Pierce et al. [61] suggested that "coming to intimately know the target" should be both cognitive and affective in nature. For this aspect, we use *cognitive appraisals,* which refer to evaluations of an object based on beliefs and knowledge structures, and *affective appraisals,* which refer to evaluations of an object based on emotions, feelings, and gut reactions [7, p. 1191] to represent the end result of "coming to intimately know the object."

According to Furby, "a central feature of possession is the ability to affect and control the object in whatever way one wishes" [24, p. 60]. Similarly, Pierce et al. [60] suggested that control is an important structural component that contributes to the development of the experienced state of ownership. Wood [83] also referred to PO as *empowerment,* which gives individuals control over the work they are required to do. Therefore, perceived control toward a target object is believed to induce positive feeling of PO toward it.

Humans naturally have a tendency to spend time, money, or effort on objects (e.g., office cubicles, communities, online forums) that they would like to retain. Past studies found that through investment of time and effort (e.g., participation) on an object (e.g., a community), individuals perceive that they have had a significant influence on the object and, therefore, develop a higher level of PO toward it [4, 6, 57]. Pierce et al. further noted that "investment of the self allows individuals to see their reflection in the target and to feel their own effort in its existence" [61, p. 93]. Therefore, it is believed that self-investment is a plausible antecedent of PO.

In the context of our study, PO of a virtual world can be defined as the psychologically experienced phenomenon in which an individual derives possessive feelings from a virtual world. By having a personally owned space (e.g., a virtual island) in which to create and decorate avatars and other objects (e.g., a building, a garden) in a virtual world environment, individuals seem to satisfy their need to be efficacious (i.e., exploring their environment, producing desirable outcome in it, and expressing themselves) and to construct and extend their own identities; that is, these activities are ultimate ways for individuals to know and connect to the virtual world (cognitive appraisals) as well as feel emotionally and pleasantly attached to the virtual world (affective

appraisals). Following these arguments, it is believed that both cognitive appraisal and affective appraisal are good indicators of PO feelings toward a virtual world.

PO has recently received great attention from IS researchers as an important motivational factor affecting users' acceptance and use of technology. For example, Anderson and Agarwal [3] investigated the impact of PO of one's own computer as well as the Internet on users' behavioral intentions on security measures in an individual and voluntary use context. Moon and Sanders [53] proposed to study the impact of PO on personalized spaces (specifically, "virtual" Web space) and user behaviors in the context of e-commerce sites. Paré et al. [57] found that PO significantly affects physicians' acceptance of clinical information systems, called a *computerized physician order entry system.* Similarly, in an information systems implementation context, Barki et al. [6] found that users' active participation during system development increases their PO toward the system, which is positively associated with the system use.

Against this background, we expect that the concept of PO can be successfully applied in the context of usable virtual worlds based on a metaphor of place. When users perceive they have control over a virtual environment, spend a significant amount of time there, and discover the effectiveness and attractiveness of the virtual world, they develop PO toward the virtual world, which triggers a willingness to visit/use the site. Therefore, we refer to the theory of PO to examine the relationship between users' cognitive and affective appraisals of a particular virtual world, perceived control, self-investment and their PO as well as the relationship between PO and future use intention.

Hypothesis Development

BASED ON A REVIEW OF TWO THEORETICAL MODELS of usable place designs along with the theory of PO, we developed a model of usable virtual world design as a new lens for examining and explaining important constructs and their associations. Our model first depicts a relationship between PO and future use intention. The model also shows relationships between (1) affective and cognitive appraisals and self-investment, and (2) affective and cognitive appraisals and PO. In addition, the model shows the relationship between the usability factors (i.e., legibility, firmness, coherence, variety, mystery, classic visual aesthetics, and expressive visual aesthetics) and cognitive appraisals, affective appraisals, and perceived control. Each hypothesis is described below.

Relationship Between Psychological Ownership and Future Use Intention

Previous studies of the theory of PO have found that an individual with strong PO of an object is highly likely to engage in territorial behaviors toward that object [8]. Territorial behaviors represent an individual's behavioral expression of his or her feelings of ownership toward an object, including active use, decoration, and protection of the

object [22]. For example, Anderson and Agarwal [3] found that people with strong PO toward their personal computers showed high intention to engage in security-related behavior to protect their computers. Similarly, Fraine et al. [22] noted that individuals who have high PO toward their cars like to decorate them with racing strips, stickers, personalized plates, or dolls. In addition, Paré et al. [57] found that physicians with strong PO built through participating in the development of a clinical information system were more willing to use the system in the future.

In the same vein, Pierce et al. [61] proposed that individuals are inclined to maintain the continuity of the self across time. From this perspective, people who have a positive feeling of PO toward an object would be more willing to take actions or exhibit behaviors thought to maintain this feeling. Thus, we can expect that when people perceive ownership toward a certain virtual world site, they have a stronger desire to revisit the site in the future; that is, individuals with high PO toward a virtual world tend to revisit the site frequently to participate in social gathering/meetings/voting, decorate their avatars, or develop sharable artifacts. Thus, we hypothesize:

> *Hypothesis 1: PO positively influences future use intentions to visit the virtual world site.*

Relationship Between Cognitive and Affective Appraisals and Self-Investment

In the past couple of decades, researchers in social psychology and marketing have suggested that human attitude can be better understood by combining two facets of human experience: cognitive appraisals and affective appraisals [76]. Recently, as hedonic system features such as playfulness, fun, and excitement have become more important in developing IS, researchers have started to recognize the importance of affective appraisals [73, 79]. In particular, researchers in the area of Web site design have pointed out the critical value of affective Web design components [73, 75]. For example, Te'eni noted that "the model should capture both aspects (cognitive and affective appraisals), so as to build a more accurate representation of actual behavior" [73, p. 253]. On this basis, we divide attitude into cognitive appraisals (i.e., evaluations based on beliefs) and affective appraisals (i.e., evaluations based on feelings and emotions). It is believed that users experiencing enjoyment/fun and effectiveness/convenience from a virtual world tend to spend more time in the virtual world and put more energy into it.

Several studies (e.g., [36, 43]) have found significant effects of cognitive and affective appraisals on the investment of time and energy. For example, Lee and Kozar [43] noted that online users who experienced fun and enjoyment as well as effectiveness and efficiency from a Web site made more visits to and use of a given site. Kim et al. [36] suggested that when individuals find virtual community activities cognitively pleasurable, it influences their knowledge acquisition effort (self-investment) to not only acquire the new knowledge but also integrate it with their existing knowledge.

Therefore, we hypothesize that users who have higher affective appraisals and cognitive appraisals toward a virtual world (i.e., virtual world designs meet users' hedonic and utilitarian needs) will invest more time and effort in activities of the virtual world. Specifically,

Hypothesis 2: (a) Cognitive appraisals and (b) affective appraisals positively influence self-investment.

Relationship Between Cognitive and Affective Appraisals and Psychological Ownership

Researchers of PO maintain that the ownership of an object can be treated as a cognitive and emotional bond with an ownership object [4]. Cognitively, PO of a target seems to arise when an individual gets to know and connect with the target; in turn, this cognitive appraisal leads to a sense of belonging. Affectively, feelings of ownership are said to be pleasure producing per se. According to Pierce et al., "the state of Psychological Ownership (i.e., 'mine-ness' or 'our-ness') is composed of a cognitive and affective core. . . . It reflects an individual's awareness, thoughts, and beliefs regarding the target of ownership. This cognitive state, however, is coupled with an emotional or affective sensation" [61, p. 86]; that is, PO is described as a state with both cognitive and affective elements. In the same vein, Van Dyne and Pierce noted that "PO consists, in part, of an emotional attachment to the target that transcends the mere cognitive evaluation of the target" [80, p. 442]. Furby's seminal piece on possession suggests that "two of the most common reasons why individuals want to possess certain objects are convenience and positive affect" [24, p. 59].

Based on the findings or arguments of previous studies, we believe that both cognitive and affective appraisals are plausible indicators of an individual's PO feelings toward a target (i.e., a virtual world); that is, we expect that when people find hedonic and utilitarian values from a virtual world, they are more likely to perceive ownership toward it. This leads to:

Hypothesis 3: (a) Cognitive appraisals and (b) affective appraisals positively influence PO.

Relationship Between Perceived Control and Self-Investment and Psychological Ownership

Researchers have investigated the antecedents and consequences of PO. For example, perceived control and the amount of effort (time, money, or attention) that individuals put into using/visiting the target (or object) ("self-investment") were two representative antecedents of PO [60].[1] In a virtual world, individuals tend to have substantial control of their use of and navigation to a given site; that is, navigation-supporting features (e.g., landmark, teleport, and fly), diverse communication-supporting tools (e.g., voice chat), and relatively reliable and secure virtual world environments all give

users a perception of control while visiting a site. This perception of increased control is directly associated with users' inclination to own the virtual world or its artifacts. Not surprisingly, many past empirical investigations of the antecedents of PO used perceived control as an important construct (e.g., [4, 62]).

The positive influence of self-investment on PO has also been widely acknowledged. For example, according to Pierce et al., "investment of the self allows individuals to see their reflection in the target and to feel their own effort in its existence" [61, p. 93]. Rochberg-Halton [66] suggested that the investment of an individual's self into objects causes them to become one with the object and to develop feelings of ownership toward the object. This concept of self-investment in an object can be naturally extended to the context of PO. Further, Pierce et al. stated that "the most obvious and perhaps the most powerful means by which an individual invests himself or herself into an object is to create it" and "creation involves investing time, energy, and even one's values and identity" [61, p. 93].

In the context of virtual worlds, individuals are likely to spend a lot of time and effort in virtual worlds by interacting with others, participating in events, and creating or decorating their own objects. Therefore, self-investment in objects can generate positive feelings of PO toward these objects. Thus, we hypothesize that:

Hypothesis 3c: Perceived control positively influences PO.

Hypothesis 3d: Self-investment positively influences PO.

Effect of Legibility on Cognitive Appraisal and Perceived Control

According to the landscape preference model, *legibility* in physical space represents the ease of navigating a scene with centrality of orientation [43]. Previous studies indicated that orienting factors such as landmarks, old roads, and paths significantly aid observers in finding their way around the scene, creating positive perception toward it (e.g., [18]). Similarly, in the virtual space, legibility refers to the capability of cyberspace to provide easy interaction and navigation. It helps users acquire more of the information they are seeking, since the information is easier to find [48]. Diverse navigation assistant tools such as the fly, teleport, landmark, flash arrow, and mini-map options are examples of legibility implementation in a virtual world. Not surprisingly, studies have found that online consumers experience low cognitive load when navigating, low error rates, and less disorientation at an easy-to-navigate and easy-to-interact Web site (e.g., [56]), and they like to stay longer at such a site. In the same vein, we propose that users experience better cognitive appraisals in a virtual world where they can find the avatars, location, or information efficiently and effectively. Users also perceive more control in using the virtual worlds when they find it easy to search, navigate, move, and interact in virtual worlds. Therefore, we hypothesize that:

Hypothesis 4: Legibility of virtual worlds positively influences (a) cognitive appraisals and (b) perceived control.

Effect of Firmness on Cognitive Appraisal and Perceived Control

Previous studies of the architectural quality model define *firmness* in virtual worlds as the operational stability/reliability and robustness of systems to protect the residents from possible attacks. Since virtual worlds are relatively new, 3D virtual environment implemented by integrating not completely proven state-of-the-art technologies such as 3D graphics, high-performing processors, and virtual reality techniques and devices, system errors, bugs, slowness, and frequent downtime have often been reported [41]. In addition, vandalism and violence, privacy and security breaches, and virus and malware attacks have occurred frequently, which makes users insecure while staying in those areas [51].

To respond to these concerns, virtual world developers must devise and implement diverse system features that enhance their internal reliability and external security. Abuse reports, copyright protection, privacy protection, terms of services, and community standards are ways to improve external security. Findings show that users feel in control of the system [16] and appraise high usefulness [31] when they experience a sense of security while using an interactive system. Therefore, we hypothesize that:

> *Hypothesis 5: Firmness of virtual worlds positively influences (a) cognitive appraisals and (b) perceive control.*

Effect of Coherence on Cognitive Appraisal and Perceived Control

Researchers of the landscape preference model refer to *coherence* in a physical space as the ease of understanding the organization of the scene. When scenery components stand in a row and are connected, individuals tend to find and remember buildings, roads, and streets more effectively. Similarly, in virtual space, coherence refers to the capability of cyberspace to provide consistent and orderly contents, structures, and multimedia components within and across the space. Previous studies (e.g., [70]) found that online consumers easily grasp the organization of a Web site that provides a common look and feel on each page, which in turn positively affects their attitude toward the site; that is, to increase coherence, Web sites often use Cascade Style Sheets to provide the same structure, color, font, and frames across the Web pages. For example, visitors can then see the same menu bar, navigation bar, company logo, search engine, font, and white space in the same location across Web pages. This results in faster searches, less disorientation, and ease of learning (e.g., [55]), which triggers positive cognitive appraisals.

The same results can be expected when a virtual world provides a consistent structure and a unifying texture that contributes to a good gestalt. In addition, a virtual world where design components are well connected, rendering better comprehension among visitors, provides a greater feeling of control. Thus, visitors will complete tasks with confidence and comfort. Therefore, we hypothesize that:

> *Hypothesis 6: Coherence of virtual worlds positively influences (a) cognitive appraisals and (b) perceived control.*

Effect of Variety on Cognitive and Affective Appraisals

Researchers of the landscape preference model describe *variety* in physical space as diversity in a scene. They insist that a scene with multiple environmental components provides people with rich information and experiences that keep them interested and occupied [27]. Similarly, in virtual space, variety refers to the capability of cyberspace to provide diverse Web site components that create vivid interaction and communication with online users. Various site design components help customers develop a sense of presence in a virtual environment created by a computer/communication medium, resulting in greater engagement in the navigation. Web designers use multiple design components to increase this perception of variety. For example, some Web sites offer diverse search mechanisms (e.g., menu bar, search engine, sidebar, and hyperlink) with a number of search options, classifying products based on brand, price, best seller, service provider, and whether the product is used or new. They also often provide customers with diverse ways to see the products by including pictures showing a front, side, back, top, or bottom view, or video clips that allow 360-degree rotation of the products.

This type of variety brought about by implementing various virtual world design features is positively related to cognitive and affective appraisal; that is, people perceive more enjoyment when they visit a virtual world that includes vivid 3D images of the artifacts and allows them to review the objects from various angles. At the same time, people perceive usefulness or effectiveness when they can gather rich information by using various navigation and communication options and can see various information or images of the artifacts in a virtual world. Therefore, we hypothesize that:

> *Hypothesis 7: Variety of a virtual world positively influences (a) cognitive appraisals and (b) affective appraisals.*

Effect of Mystery on Affective Appraisals

Mystery is another important dimension to take into consideration when assessing preference toward a physical space representing the opportunity to gain new information while investigating a concealed landscape, which was unseen at first glance [34]. Hubbard and Kimball defined the effect of mystery on a preferred scene as follows: "it is a pleasant challenge to the imagination which sets the observer to trying to determine for himself by closer investigation what is concealed from his first glance, or if this is impossible, to filling in and completing the unseen landscape according to the play of his own fancy" [32, p. 82]. In a virtual space, mystery refers to the capability of a virtual world to invoke curiosity and interest, and stimulate further navigation. For example, a variety of unseen and unexplored avatars, places, modes of transportation, flash arrows, continue signs, and exit signs may make users navigate a virtual world further because of a greater sense of curiosity, which positively affects their affective appraisals [46]. Therefore, we hypothesize that:

> *Hypothesis 8: Mystery of a virtual world positively influences affective appraisals.*

Effect of Classic and Expressive Visual Aesthetics on Affective Appraisals

Finally, researchers of human–computer interaction (HCI) have recently adopted the construct of beauty from the architectural quality model to assess the visual appeal of a Web interface. As contemporary IS include more hedonic features, HCI researchers who previously mainly focused on efficiency and effective aspects of the interface design have now turned their attention to the aesthetic aspects of design [54]. Aesthetic revolution in computing of the Apple iMac and emotional design by Norman [54] are good examples indicating that the visual appearance of products is a critical factor shaping individuals' attitudes and purchase decisions, in particular in the context of cyberspace (e.g., [80]).

In the context of Web site design, Lavie and Tractinsky [42] classified visual aesthetics of interfaces into classic aesthetics and expressive aesthetics. *Classic aesthetics* refers to the visual clarity dimension of a Web site, including the following design attributes: aesthetic, pleasant, clean, clear, and symmetrical. *Expressive aesthetics,* in turn, captures the visual richness of a site, referring to "users' perceptions of the creativity and originality of the site's design" [42, p. 288], assessed by sophisticated, fascinating, and original characteristics. Researchers (e.g., [31]) have found a positive influence of visual aesthetics on users' affective appraisals of a site. Along the same lines, we conjecture that users' perceptions are affected when they visit a virtual world that provides visual clarity and visual richness; that is, well-designed virtual worlds tend to arouse individuals' affective appraisals when they contain vivid artifacts and beautiful backgrounds, look clear and clean, and display creativity and sophistication. Therefore, we hypothesize that:

> *Hypothesis 9: (a) Classic visual aesthetic and (b) expressive visual aesthetic positively influence affective appraisals.*

Research Methodology

To validate measurement instruments for this research model and to investigate nomological networks between endogenous and exogenous variables, a questionnaire-based field survey was distributed to experienced virtual worlds users. Instruments were developed using the standard instrument development processes [71]. Instrument items were based on an extensive literature review of previous studies of Web usability, the landscape preference model, the architectural quality model, and PO.

The content validity of all instrument items was tested by five experts familiar with Web site usability, virtual worlds, and instrument development (two IS faculty members, one IS doctoral student, one marketing doctoral student, and one industry Web designer). The wording, item order, content, and format of the questionnaire were examined and modified based on the suggestions of these experts.

In addition, 41 undergraduate students from an IS class at a large Midwestern university, who had at least one prior experience visiting virtual worlds, were recruited to pretest the instruments. Without being informed about the goal of the study, par-

ticipants were asked to navigate Second Life before completing a questionnaire. We conducted an exploratory factor analysis with an oblique rotation and found that they were grouped well into their own constructs with a greater than 1 eigenvalue except for one variety, one control, and one PO item, which were not included in the main survey. Each item was formatted into a seven-point Likert-type scale. The instrument items employed for the main survey are listed in Table 3.

Second Life, one of the most popular and successful virtual worlds, was the target for our study. Since its launch in 2003, Second Life has grown explosively and currently boasts 21 million registered users worldwide. We selected this well-known virtual world because testing of the proposed model required enough subjects having experience with the site to assess the quality of virtual world design components. Subjects would experience less stress when they knew the site ahead of time. Also, familiarity with the site reduced the need to train subjects to ensure they understood design features, thereby decreasing the total time of conducting the study. Furthermore, using the same target site allowed us to compare our findings with those of previous studies. Studies on virtual worlds have been conducted mostly in the Second Life environment.

We recruited research subjects by advertising the study in student newspapers and announcing it at business classes at a large Midwestern university. A total of 352 subjects expressed an interest in participating in the study; out of these, 264 actually participated in the experiment and completed the questionnaire. After removing unusable responses (e.g., incomplete questionnaires), we ended up with 239 usable questionnaires for a net response rate of about 68 percent (239/352). Females constituted 54.6 percent of the participants. Their average age was 21.3 years. More than 93 percent of users had over 5 years of Internet use experience.

Participants navigated Second Life following a scenario provided by the researchers before they completed the questionnaire.[2] A summarized scenario is provided in Appendix A. Participation was voluntary and took approximately 40 minutes. The subjects were compensated with course credits (less than 1 percent of their total grade).

Results

STRUCTURAL EQUATION MODELING was used to perform measurement and structural model analysis simultaneously. The measurement model analysis was used to validate psychometric properties of the measures, while structural model analysis was used to investigate nomological networks between constructs in the structural model. Data were analyzed using Amos 18.0 [9].

Measurement Model Analysis

A confirmatory factor analysis (CFA) was conducted to validate the psychometric properties of the instrument. Results suggest that the measurement model adequately fit the data. Psychometric properties were measured by (1) examining whether the measurement model had an acceptable goodness of fit and (2) investigating its unidimensionality, convergent and discriminant validity, and reliability. Overall, goodness

Table 3. Instrument Items

Construct	Adapted from	Coding	Items
Legibility	Shumaker and Reizenstein [69]	LEG1	It is clear where I can go in the virtual world (e.g., using fly and teleport).
		LEG2	It is easy to get around the whole virtual world (e.g., using fly and teleport).
		LEG3	It does not take much time to figure out a way of moving around the virtual world (e.g., using fly and teleport).
		LEG4	I can always figure out where I am while navigating the virtual world.
Coherence	Kaplan [34]	COH1	Each component of the virtual world is well related to each other.
		COH2	Components of the virtual world work well together.
		COH3	Each component of the virtual world seems to hang together.
		COH4	Components of the virtual world harmoniously hang with each other.
Variety	Rosen and Purinton [67]	VAR1	The virtual world does not contain enough components to interest me. (R)
		VAR2	The virtual world contains a good variety of components that keep me involved.
		VAR3	I feel drawn in by the variety of information or artifacts the virtual world offers.
Mystery	Real et al. [65]	MYS1	The virtual world makes me feel there is something interesting to explore.
		MYS2	As I navigate through the virtual world, an increase in curiosity inspires me to continue to explore.
		MYS3	I expect the virtual world will provide interesting things to increase my curiosity as I explore.
		MYS4	I feel I will find interesting things if I navigate more in the virtual world.
Firmness	Hong and Kim [31]	FIR1	The virtual world has strong protection against any unauthorized access attempts from outside.
		FIR2	The virtual world exercises enough precaution to provide a safe place in the virtual environment.
		FIR3	The virtual world has a strict policy to protect private information of its members.

Classic aesthetics	Lavie and Tractinsky [42]	CLAS1	This virtual world is visually attractive.
		CLAS2	The virtual world is beautifully designed.
		CLAS3	The virtual world contains vivid artifacts and background.
		CLAS4	The virtual world looks clean and clear.
		CLAS5	The virtual world appears professional.
Expressive aesthetics	Lavie and Tractinsky [42]	EXP1	The virtual world is creatively designed.
		EXP2	The virtual world looks fascinating.
		EXP3	The virtual world is designed sophisticatedly.
Cognitive appraisals	Lee and Kozar [43]	COG1	The virtual world is effective to achieve the goals of any future visits.
		COG2	The virtual world is convenient to attain the goals of any future visits.
		COG3	I feel comfortable using the virtual world to achieve the goals of any future visits.
		COG4	The virtual world is helpful to achieve the goals of any future visits.
		COG5	It is easy to use the virtual world site in general.
Affective appraisals	Ajzen [2]	AFF1–AFF4	I would describe my overall experience while visiting the virtual world as exciting (AFF1), pleasant (AFF2), interesting (AFF3), enjoyable (AFF4).
Perceived control	Agarwal and Karahanna [1]	PC1	I felt in control while moving around the site.
		PC2	When using the virtual world I feel in control.
		PC3	I feel that I have no control over my interaction with the virtual world. (R)
Self-investment	Moon and Sanders [53]	SI1	Number of visits (participation) to the virtual world.
		SI2	Amount of energy to spend on the virtual world.
Psychological ownership	Van Dyne and Pierce [80]	PO1	This is my virtual world.
		PO2	I feel a very high degree of personal ownership for this virtual world.
		PO3	I sense that I own this virtual world.
		PO4	It is hard for me to think about this virtual world as mine. (R)
Future use intention	Cyr [14], Palmer [56]	FUI1	I intend to revisit this virtual world when necessary.
		FUI2	I predict I would spend more time in this virtual world than other sites.
		FUI3	I expect I will interact with other visitors while visiting the virtual world.

Note: (R) indicates that the item was reverse-coded.

of fit for the model was confirmed following the cutoff value guideline [29]. The χ^2/df (degrees of freedom) (1,369.129/951) was 1.440, which is below the desired threshold of 3.0. The root mean square error of approximation (RMSEA) was 0.043, which is below the 0.08 cutoff, and the comparative fit index (CFI) (0.958) was above its corresponding cutoff value of 0.90.

Convergent validity was evaluated using three criteria suggested by Fornell and Larcker [21] and Hair et al. [29]: (1) all indicator factor loadings (λ) should be significant at $p < 0.05$ and exceed 0.7, (2) composite reliabilities should exceed 0.7, and (3) average variance extracted (AVE) by each construct should exceed the variance due to measurement error for that construct. Results show that all factor loadings in the CFA model exceeded 0.7 and were significant at $p < 0.001$. Composite reliabilities ranged between 0.871 and 0.953, and AVE values were well above the cutoff value of 0.50, which is greater than variance due to measurement error (see Table 4). Thus, all three conditions for convergent validity were met.

Discriminant validity was assessed by using interconstruct correlations (see Table 5). All the constructs were found to have a stronger correlation with their own measures than with the other constructs. All correlations between the constructs were less than the square root value of the AVE, representing appropriate discriminant validity. Finally, reliability was examined using Cronbach's alpha. All the constructs showed a value of more than 0.870, indicating a high reliability of items used for each construct.

Common Method Variance Test

Since measures of all constructs in the study were taken at the same point in time, the study examined the common method variance (CMV) following the marker variable technique of Malhotra et al. [50]. Specifically, we used fashion consciousness as a marker variable, which is theoretically unrelated to at least one variable in the study. Because the marker variable is presumed to have no relationship with one or more variables in the study, CMV can be assessed based on the correlation between the marker variable and the theoretically unrelated variable. Three items having a high reliability (Cronbach's $\alpha = 0.821$) were used to measure fashion consciousness. First we conducted a correlation analysis to find the value of a marker variable (MK), which was used as an indicator of common method bias, and found that to be 0.028. Then, by putting them into the formula provided by Malhotra et al. [50, p. 1868], we created adjusted correlation estimates and *t*-statistics. From our results (see Appendix B), we found that none of the original correlations except the correlation between variety–firmness, self-investment–mystery, and self-investment–classic visual aesthetics were significantly different from their CMV-adjusted counterparts, implying that the biases are not substantial.

Mediation Analysis

Since PO was modeled as a mediating variable, we conducted a mediating test to investigate its mediation effect. As described in Appendix C, we did a mediating test

Table 4. Results of Measurement Model Analysis

Construct	Items	λ	α	CR	AVE
Legibility	LEG1	0.787	0.889	0.891	0.672
	LEG2	0.881			
	LEG3	0.823			
	LEG4	0.785			
Coherence	COH1	0.831	0.910	0.912	0.721
	COH2	0.887			
	COH3	0.860			
	COH4	0.817			
Variety	VAR1	0.834	0.883	0.887	0.724
	VAR2	0.934			
	VAR3	0.778			
Mystery	MYS1	0.866	0.939	0.940	0.797
	MYS2	0.896			
	MYS3	0.929			
	MYS4	0.878			
Cognitive appraisals	COG1	0.897	0.954	0.953	0.802
	COG2	0.902			
	COG3	0.931			
	COG4	0.934			
	COG5	0.808			
Affective appraisals	AFF1	0.944	0.934	0.934	0.781
	AFF2	0.907			
	AFF3	0.848			
	AFF4	0.832			
Self-investment	EI1	0.928	0.937	0.938	0.883
	EI2	0.951			
Firmness	FIR1	0.784	0.870	0.871	0.693
	FIR2	0.887			
	FIR3	0.823			
Classic visual aesthetics	CLAS1	0.828	0.927	0.925	0.713
	CLAS2	0.805			
	CLAS3	0.858			
	CLAS4	0.858			
	CLAS5	0.872			
Expressive visual aesthetics	EXP1	0.853	0.880	0.881	0.713
	EXP2	0.876			
	EXP3	0.801			
Perceived control	PC1	0.909	0.921	0.925	0.805
	PC2	0.961			
	PC3	0.814			
Psychological ownership	PO1	0.830	0.925	0.926	0.758
	PO2	0.907			
	PO3	0.895			
	PO4	0.851			
Future use intention	FUI1	0.856	0.870	0.871	0.693
	FUI2	0.844			
	FUI3	0.857			

Notes: CR = composite reliability; AVE = average variance extracted. VAR1, PC3, and PO4 items are reverse-coded.

Table 5. Interconstruct Correlation Matrix

	Mean	SD	LEG	COH	VAR	MYS	FIR	CLAS	EXP	AFF	PC	COG	SI	PO	FUI
LEG	4.55	1.27	0.820												
COH	4.64	1.21	0.565	0.850											
VAR	4.00	1.32	0.279	0.249	0.852										
MYS	4.60	1.33	0.434	0.400	0.371	0.892									
FIR	4.54	1.28	0.330	0.434	0.128	0.209	0.832								
CLAS	4.83	1.26	0.329	0.337	0.365	0.329	0.236	0.844							
EXP	4.96	1.29	0.183	0.239	0.382	0.224	0.370	0.563	0.844						
AFF	4.66	1.35	0.425	0.353	0.517	0.427	0.230	0.560	0.504	0.884					
PC	4.64	1.34	0.373	0.381	0.185	0.261	0.298	0.241	0.335	0.392	0.897				
COG	4.45	1.28	0.583	0.561	0.296	0.410	0.430	0.264	0.280	0.486	0.364	0.897			
SI	3.54	1.39	0.262	0.309	0.285	0.141	0.187	0.152	0.237	0.441	0.285	0.317	0.940		
PO	3.91	1.47	0.299	0.273	0.296	0.101	0.202	0.218	0.257	0.512	0.385	0.398	0.616	0.871	
FUI	3.88	1.49	0.209	0.222	0.326	0.187	0.174	0.160	0.297	0.488	0.332	0.356	0.665	0.617	0.832

Notes: SD = standard deviation; LEG = legibility; COH = coherence; VAR = variety; MYS = mystery; FIR = firmness; CLAS = classic visual aesthetics; EXP = expressive visual aesthetics; COG = cognitive appraisals; PC = perceived control; AFF = affective appraisals; SI = self-investment; PO = psychological ownership; FUI = future use intention. The values in the diagonal of Table 5 represent the square root of AVE.

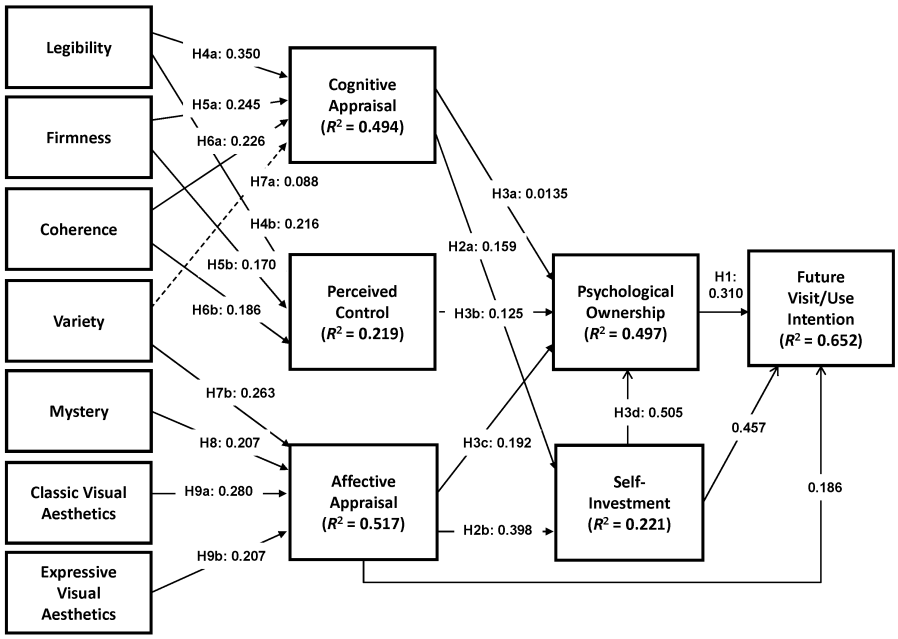

Figure 1. Results of the Structural Equation Model Analysis

using a pseudo *F*-test technique, which has often been used in previous IS studies [45, 49, 58]. Results showed that PO successfully mediated the relationships between antecedents of PO and future use intention. In particular, we found full mediation of PO for perceived control and cognitive appraisals and partial mediation for affective appraisals and self-investment. We further conducted model comparisons by observing chi-square differences between full models (augmented with additional nomological networks) and a nested model (i.e., original model). Results showed that adding additional networks between affective appraisals and future use intention and self-investment and future use intention increased the explanatory power of future use intention; thus these paths are included in the structural model described below.

Structural Model Analysis

The overall goodness of fit for the structural model was confirmed. The χ^2/df was 1.475 (1,462.846/992), which is below the desired threshold of 3.0. RMSEA was 0.045, which is below the 0.08 cutoff value, and CFI (0.952) was above its corresponding cutoff value of 0.90. The final results of the structural model analysis are shown in Figure 1.

Figure 1 illustrates the result of the structural model analysis, including the R^2 and path loadings for all hypothesized relationships. As shown in the figure, the model was found to successfully explain future use intention (R^2 = 0.652), PO (R^2 = 0.497), and self-investment (R^2 = 0.221), confirming that it is appropriate for usable virtual

world design. The path analysis showed that most hypothesized relationships were confirmed. Self-investment ($\lambda = 0.457$, $p < 0.001$), PO ($\lambda = 0.310$, $p < 0.001$), and affective appraisals ($\lambda = 0.186$, $p < 0.01$) significantly affected future use intention of a virtual world. Affective appraisals ($\lambda = 0.398$, $p < 0.001$) were the most influential factor on self-investment, followed by cognitive appraisals ($\lambda = 0.159$, $p < 0.05$). Self-investment ($\lambda = 0.505$, $p < 0.001$) was the strongest factor affecting an individual's PO toward virtual worlds. Cognitive appraisals ($\lambda = 0.135$, $p < 0.05$), affective appraisals ($\lambda = 0.192$, $p < 0.01$), and perceived control ($\lambda = 0.125$, $p < 0.05$) also had a significant influence on PO, explaining the large variance of PO ($R^2 = 0.497$). Furthermore, except for variety cognitive appraisals ($\lambda = 0.088$, $p = 0.112 > 0.05$), all other relationships between legibility ($\lambda = 0.350$, $p < 0.001$), firmness ($\lambda = 0.245$, $p < 0.001$), coherence ($\lambda = 0.226$, $p < 0.01$), and cognitive appraisals ($R^2 = 0.494$) were significant. All the nomological networks between legibility ($\lambda = 0.216$, $p < 0.05$), firmness ($\lambda = 0.170$, $p < 0.05$), coherence ($\lambda = 0.186$, $p < 0.05$), and perceived control ($R^2 = 0.219$) were confirmed. Finally, the large variance of affective appraisals ($R^2 = 0.517$) was explained by variety ($\lambda = 0.263$, $p < 0.001$), mystery ($\lambda = 0.207$, $p < 0.001$), classic visual aesthetics ($\lambda = 0.280$, $p < 0.001$), and expressive visual aesthetics ($\lambda = 0.207$, $p < 0.01$).

Discussion

BY ADOPTING AND INTEGRATING THE LANDSCAPE PREFERENCE MODEL, the architectural quality model, and PO, we proposed and validated a model of usable virtual world design that elicits users' PO and future use intention. We first showed how these usability factors (derived from the landscape preference and architectural quality models) influence affective and cognitive appraisals as well as perceived control. Subsequently, we investigated how these appraisals and control perception influence users' self-investment and PO. Finally, we examined how PO affects virtual world users' behavior.

Findings demonstrated that our model had strong psychometric properties and explained a large amount of variance in the attitudes and perceptions of virtual world users (cognitive appraisals: approximately 49 percent; perceived control: 22 percent; affective appraisals: 52 percent; self-investment: 22 percent; PO: 50 percent; and future use intention: 65 percent). This suggests that although further elaboration is warranted, the model can be used as a reasonable and valid means to assess the usability of virtual worlds. Many of the findings deserve further discussion below.

From a broader perspective, a part of this research may be viewed as an extension of applying the theories of usable "place" design to the context of virtual worlds; that is, usability factors that affect the design of preferable landscapes or artifacts may be considered as usability factors that contribute to designing a virtual world. Our findings are generally in line with previous theories, which maintain that usability factors influence users' attitude, perception, and behaviors [37]. Specifically, most of the usability factors from the landscape preference and architectural quality models were found to significantly affect cognitive and affective appraisals and perceived control in the context of a virtual world.

Usability Factors and Cognitive Appraisals

Legibility was found to be the most significant factor affecting cognitive appraisals. A virtual world such as Second Life provides a variety of navigation-supporting tools to minimize disorientation. But in a highly complex virtual environment with a stunning array of 3D environments, users have often reported great difficulty navigating virtual worlds. As a result, recently researchers in HCI and computer graphics have devised advanced navigation assistant tools to increase the legibility. For example, researchers in the UWISH (Usability of Web-Based Information Services for Hypermedia) project [78] proposed several personal agents for assisting nonprofessional users in finding their way in virtual environments.

In the present study, we observed participants having difficulty in piloting the virtual worlds due to a lack of experience with virtual worlds. Thus, during the debriefing interview, many novice users made the following comments: "I felt like there were a lot of fun and interesting things but I couldn't do anything with them"; "I did not know how to enter a building"; "I could not see myself where I was. Also, for some reason I couldn't fly"; "Is there any user instruction to what Warcraft provided for easily learning about navigation functions or keys?" Given this, continuing effort to enhance legibility through development of technical solutions and user training is recommended, and even seems to be necessary.

The significant relationship between firmness and cognitive appraisals suggests that reliability, responsiveness, and security features of virtual worlds were perceived as being useful and effective. A number of malicious cyberattacks have been reported in virtual worlds, such as Grey Goo and item duping, scammers that steal private data for fraud (e.g., phishing, sloppy scripting), virtual terrorist attacks, and virtual illness (e.g., [52, 68]). As a result of an act of cybervandalism, some virtual world sites (e.g., ABC's virtual site) have been devastated, and security concerns have prompted companies (e.g., IBM Innovative Quick [IQ] collaboration Metaverse) to develop their own internal virtual worlds [17]. In addition, system instability and high frequency of updates of virtual world applications that often cause system meltdown were examples of major concerns of current and potential virtual world users. However, most of the attacks occurred because of a lack of security awareness by users. By educating users on identity control or access management, setting strict punishment policies and regulations on vandalism and malicious attacks, and then disseminating the results of such to users, sites can promote a feeling of security and safety.

Coherence was also found to positively influence cognitive appraisals, indicating that when adequate numbers of design components of virtual artifacts and backgrounds are well developed and arranged to create the perception of close semantic and conceptual interrelatedness, users perceive less complexity and less cognitive load while visiting virtual worlds. This study confirmed the findings of HCI research (e.g., [13]), showing that visual and content coherence contributes significantly to the enhancement of users' perceptions of system effectiveness and efficiency. By using guidelines and coding techniques to enhance coherence, such as spatial grouping, brightness intensity coding,

location coding, preservation of white space, and progressive disclosure, designers can provide a more consistent and lucid virtual world environment.

The finding that the path between variety factor and cognitive appraisals was insignificant was interesting, implying that diverse 3D artifacts, information, and features in virtual environments are not sufficient to arouse high utilitarian value. One possible reason may be that in an earlier stage of virtual world development, designers concentrated on setting up reliably operational 3D environments rather than delivering a choice of system features to meet visitors' diverse needs and interests. A lack of rich and valuable content may be another contributor to the insignificance. Thus, it is recommended that developers not only create content themselves, but motivate other users to produce various contents using such incentives as sharing island ownership, acknowledgment of top contributors, and Second Life's Linden dollar (internal economy and internal currency) awards.

Usability Factors and Perceived Control

Perceived control was successfully predicted by legibility, firmness, and coherence; that is, visitors experienced a strong feeling of control when they could easily find locations or objects, perceive the site was reliable and secure, and easily grasp the whole site. In general, human beings have a desire to explore an external environment and control the environment in the man–environment interaction. For example, the critical role of control in virtual reality has been well recognized. Asatryan and Oh [4] found that easy navigation along with a comprehensive understanding of space directly affects the control perception of a pilot while practicing a flight using a flight simulator. Considering that a virtual world is an external environment, visitors would like to gain or exercise certain control on it. Our results support this conjecture, but showed that the explained variance ($R^2 = 0.219$) of "perceived control" is relatively smaller than the other exogenous variables in our model; therefore, future research to find reasons for this low R^2 or other factors contributing to perceived control is necessary.

Usability Factors and Affective Appraisals

As predicted, mystery, variety, and two virtual aesthetic variables significantly affected affective appraisals. As in previous studies (e.g., [35]), mystery significantly affected enjoyment from the site. Designers prefer to develop an interface that challenges users to explore cyberspace, assuming that they like to navigate further when they do not know what comes up next. More realistic mystery perceptions can be created in virtual world environments since, by nature, it is 3D. Moving to unseen places, walking around invisible side streets, entering buildings, and traveling to hidden islands are examples of mystery perceptions in virtual world environments. Therefore, continual effort to design interesting virtual world artifacts, avatars, and content that provoke users' curiosity and inquisitiveness is recommended.

Variety was also found to be closely linked to affective appraisals; that is, when designers or other users provide a choice of system features or artifacts, visitors report more enjoyment while visiting the virtual world. Similar results have been found in previous studies. For example, computer gamers are generally known to feel more playful when a computer game provides more choices or weapons. Similarly, online customers also have been known to perceive enjoyment from Web sites designed with diverse multimedia features [43]. Given its importance, continuously producing and providing a variety of artifacts or design tools for virtual world users are crucial ways to attract and please them. At the same time, it can be practical to implement incentive mechanisms to stimulate extrinsic (e.g., Linden dollars) and intrinsic motivation (e.g., fame recognition) for virtual world residents to actively participate in the creation of diverse artifacts.

The strong influence of visual aesthetics on affective appraisals confirms that the basic human enjoyment of beauty of appearance predominantly contributes to producing hedonic perceptions in virtual world environments. Recently, the importance of visual aesthetics in user interface design has drawn increased attention from HCI researchers (e.g., [54]), who have found that systems users like hedonic as well as utilitarian values while using a system. For example, Norman [54] noted three layers of visual appeal, including visceral, behavioral, and reflective. In the context of virtual world design, visceral appeal is associated with the initial visual stimulation of the look and feel of a virtual world, which often arouses unconscious gut reactions. The behavioral layer involves the pleasure derived from using the features provided by the site such as the playfulness of avatars. Finally, reflective design refers to the thoughtfulness of the virtual world design such as a sense of cleverness. Based on our results, facilitating both classic and expressive visual aesthetics (such as Norman's three layers of visual appeal) can strongly shape users' affective appraisal of a virtual world.

With the use of advanced computer graphic techniques, virtual worlds can deliver clean, clear, appealing, and vivid 3D artifacts that provide users with more pleasure. However, much improvement is needed to offer more visually appealing virtual environments. The limited number of avatars and their limited capacities of movement, as well as the limited number of nonverbal explanation mechanisms and decorations, are examples of features in need of improvement. In addition, beauty is highly context dependent. Thus, designers have to cautiously conduct user or site analyses before designing a visually appealing site in virtual environments.

Cognitive and Affective Appraisals, Self-Investment, and Psychological Ownership

Another part of our model further helps us examine the relationships between (1) usability perception and evaluations (perceived control, cognitive appraisals, and affective appraisals), and (2) perception of virtual worlds (self-investment and PO). First, our results indicated that affective appraisals had a stronger influence on self-investment than cognitive appraisals. This means that users' interaction with a virtual world that

utilizes multiple media and richer, graphical 3D interfaces is pleasurable and enjoyable, and, in turn, induces high self-investment (i.e., stronger intention to revisit, spending more time, and interacting with others) and PO of the virtual space. Compared to previous IS developed to deliver mainly functional values, contemporary information systems, including virtual worlds, have been challenged to incorporate hedonic features to meet users' need for perceiving enjoyment, fun, and arousal while using them [84].

Second, as hypothesized, PO was found to be explainable by its two well-known antecedents and two attitudinal appraisals. Self-investment was the strongest factor affecting PO. This finding suggests that the more energy people spend in virtual worlds, the higher they perceive that the virtual space is their own. Thus, virtual world designers and site owners should host a variety of activities, events, or develop artifacts to attract users to devote energy and time or to make them develop a stronger PO toward a virtual world.

Perceived control was also found to significantly affect PO, pointing to the fact that the more people feel that they have control over and can influence a virtual world and its artifacts, the greater possessive feelings they have toward it. Thus, virtual world designers should put extra effort into empowering users with enhanced controls (e.g., from virtual reality to simulated reality and augmented reality, using "immersive technology" and "immersive designs") by developing various ways of navigation, location awareness in 3-D environment, flexible interaction with others, and a consistent look.

Further, affective appraisals had a significant effect on PO both directly ($\lambda = 0.192$) and indirectly through self-investment (λ: $0.201 = 0.398 \times 0.505$), indicating that most virtual worlds users perceive stronger PO toward a virtual world that offers them enjoyment. Cognitive appraisals may also be an important factor affecting PO. Currently, the majority of virtual world sites are designed mainly for social networking and entertainment rather than business-oriented activities. Cognitive appraisals will be even more important as more and more sites are developed for business, education, or other knowledge-acquisition activities. It is recommended, therefore, that future research retest our proposed research model in a business-oriented virtual world environment.

Psychological Ownership, Affective Appraisals, Self-Investment, and Future Use Intention

As expected, people with strong PO showed high intention to revisit and use virtual worlds as well as interact with others in it. PO explains a large variance of future use intention (65 percent). This finding provides an economic rationale for virtual world managers and designers to facilitate artifacts that can be personally owned and made by users with a variety of embellishments. For example, currently virtual worlds force users to select one of the avatar names predefined by virtual worlds and the number of embellishments available for decorating objects also limited. To help users

perceive more PO, which triggers their territorial (future revisit and use) behaviors, virtual world owners and designers should allow users to freely name their avatars and provide a variety of artifacts for users to decorate their avatars, buildings, or islands in a virtual world.

The significant influence of self-investment on future use intention was found. It makes sense in that people who have visited a virtual world and spent considerable amount of time in it are more likely to visit there again in the future. However, we need to cautiously interpret the finding in that we conduct a cross-sectional study that measures self-investment (i.e., past use) and future use intention at the same time, which can cause CMV problems and a potential halo effect (e.g., [38]). Thus, the effect of self-investment needs to be reexamined by conducting replicate longitudinal studies. Finally, affective appraisals was found to have a direct influence on future use intention. This result implies that if people perceive fun, enjoyment, and excitement while visiting a virtual world, in particular, a hedonic virtual world, they are inclined to visit the sites again in the future. Given that more and more business-oriented sites are launched in virtual world environments, future studies to validate the direct influence of affective appraisals on future use intention are recommended.

Limitations

Despite its important findings, this study has several limitations. First, it has a potential low external validity with regard to the subjects and the research setting. Specifically, participants were college students, and although student subjects can represent the target population of virtual world users, future work that considers other types of users of a virtual world environment is necessary to test the generalizability of the findings. Second, the relatively small sample size is another limitation. Although virtual worlds are in the early adoption stage with only a limited population of experienced users, future replicated studies with a larger sample size are recommended. Having a large number of subjects allows researchers to conduct multigroup analyses to investigate the influence of personal (e.g., personality, experience), technical (e.g., avatars), and environmental characteristics (e.g., type of site) on users' perceptions and behaviors in virtual worlds. Third, we used two items for the self-investment construct, which only measure the past use of a virtual world. Considering that self-investment measures a broader concept of individuals' effort, time, and attention allocated to obtain an object, these items restrain our ability to fully capture the precise effect of self-investment. Additional items should be explored in future studies to operationalize self-investment in addition to past use items. Fourth, this was a cross-sectional study, which can cause CMV problems and prevent us from investigating time-variant relationships between variables (e.g., past use–future use network). Even though our test results indicate no significant CMV, it is recommended that a longitudinal study be conducted to avoid potential CMV problems and investigate time-variant relationships among variables. Finally, the study only investigated the relationship between PO and future use intention. However, as we found, other factors (e.g., affective appraisals, self-investment) may directly affect future use intention. Further investigation to augment our proposal

model or to compare competing models to precisely predict individuals' virtual world use is recommended.

Implications and Conclusions

THIS STUDY PROVIDES USEFUL INSIGHTS for researchers and practitioners based on a systematic investigation of the design of usable virtual worlds toward which users perceive PO. First, the study is important in that it represents a first attempt to propose and empirically validate a research model of usable virtual worlds design. As virtual worlds are becoming more pervasive and critical mass grows substantially, HCI researchers (e.g., [15]) have pointed to the need to pursue research in usable virtual world design, but to our knowledge, to date, no studies have been conducted in this area. Compared to traditional Web sites, virtual worlds are unique by offering a more realistic and vivid environment with depth, distance, and geographical boundaries and in-world representation by use of a variety of 3D navigation tools and a stunning array of 3D design components; therefore, separate attention to virtual world design is warranted. Our proposed model can be used as a reference for researchers to conduct future research in this area.

Second, this study contributes to expanding the theoretical boundaries of the architectural quality and landscape preference models by integrating these models based on an analogy of "place." Although both models have successfully predicted the design of attractive environments and artifacts in physical or Web space, to date, no attempt has been made to integrate them to facilitate a deeper understanding of the influence of usability factors on users' perceptions of a usable virtual place. It makes more sense to integrate the design theory for environments with that for artifacts, and we believe that our model can help advance these two models and expand their theoretical boundaries.

Third, this study contributes to the theoretical advancement of PO. Our results confirmed the significant relationships between two antecedents of PO, perceived control and self-investment, and PO in the virtual world context. In addition, a large amount of the variance of perceived ownership of artifacts, places, or avatars and subsequent behaviors was explained with our model; that is, our results showed that variables and nomological networks defined by PO theory can successfully be applied to virtual world environments. The study also examined the influence of affective and cognitive appraisals on self-investment and PO, which has not been investigated in previous studies of PO. The possible relationships between affective and cognitive appraisals and self-investment and PO have been predicted by the theory of PO and the theory of planned behavior. Nonetheless, researchers have not included affective and cognitive appraisals as determinants of PO and investigated their effect on self-investment.

Fourth, we also investigated PO as a mediating variable between usability factors and user behavior. By doing so, this study helps enrich researchers' understanding of virtual world users' usability perceptions and behavior as it examined both the antecedents and consequences of PO. One plausible future research direction is to expand the nomological networks by incorporating a variety of territorial behaviors

and examine the relationship between PO and those behaviors. In addition, the study expanded the PO literature by exploring the sources of perceived control. Compared to previous studies of PO, which did not examine how control perception was shaped but assumed that it was already stimulated, this study examined the three antecedents of perceived control to find their relative contributions to form perceived control.

Finally, the study developed and validated instruments for measuring usability factors in the context of virtual worlds using standard instrument development procedures. The validated instrument items, therefore, can be utilized in future studies, and accumulated findings can be directly compared.

From a practical perspective, this study provides a constructive guideline for designers to follow when developing virtual worlds that offer users a better experience. First, the study demonstrates that designing a usable virtual world that induces strong PO is crucial to attract visitors to spend more time, participate in more activities in it, and revisit the place. This is an important finding for forward-looking e-business managers looking to invest their limited resources in designing a better virtual world. Our findings also assist virtual world designers in persuading top managers to allocate more resources to designing virtual places that induce more PO. Second, by using our model and its instrument items, designers can benchmark the usability level of their own virtual worlds; that is, designers can evaluate the usability of their current virtual worlds, compare the results to the designs of competitors, and upgrade the offerings of virtual worlds, as needed, by allocating available resources to the most influential design factors. Finally, findings of different nomological networks and their different level of strengths of the relationships across different groups of users provide valuable insight to help designers develop customizable virtual worlds.

Notes

1. We included control and self-investment in our model but did not include "coming to intimately know the object." First, we believe that knowledge of the target object and self-investment conceptually highly overlap with each other in this study context (i.e., after spending time and effort, subjects will be more knowledgeable). Pierce et al. [60] indicated two sources for intimately knowing the target: more information about the target and intensity of association. In particular, for the latter, the authors insisted that number of interactions with the target is one of the factors affecting intimate knowledge about the target. The number of interactions the individual has with the target is also directly related to self-investment in the target. Second, as suggested by Pierce et al. [60], "coming to intimately know the target" should be both cognitive and affective in nature. We conjecture that measuring users' cognitive and affective appraisals of the target can also reflect "coming to intimately know the target." For these reasons, therefore, in this study we measured self-investment, cognitive appraisals, and affective appraisals but did not include "coming to intimately know the target."

2. It has been found that people are immersed very quickly, especially in a virtual world environment since it visualizes realistic space using stunning and vivid 3D visual components. For example, Pausch et al. [59] indicated that people are immersed in 3D virtual reality much faster than with 2D-based desktop interfaces. They found that virtual reality users performed 42 percent faster than 2D interface users. Similar results were found by Weibel et al. [82] in 3D virtual environments. They found that people were immediately immersed in 3D virtual environments, although the level of immersion is influenced by type of personality. The main goal of the scenario was to refresh subjects' memory of past use experience and site design features and content and thus assist participants in assessing the design quality of Second Life.

References

1. Agarwal, R., and Karahanna, E. Time flies when you're having fun: Cognitive absorption and beliefs about information technology usage. *MIS Quarterly, 24,* 4 (2000), 665–694.

2. Ajzen, I. From intentions to actions: A theory of planned behaviour. In J. Kuhl and J. Beckmann (ed.), *Action-Control: From Cognition to Behaviour.* Berlin: Springer, 1985, pp. 11–39.

3. Anderson, C.L., and Agarwal, R. Practicing safe computing: A multimethod empirical examination of home computer user security behavioral intentions. *MIS Quarterly, 34,* 3 (2010), 613–643.

4. Asatryan, V.S., and Oh, H. Psychological ownership theory: An exploratory application in the restaurant industry. *Journal of Hospitality & Tourism Research, 32,* 3 (2008), 363–386.

5. Barbatsis, G.; Fegan, M.; and Hansen, K. The performance of cyberspace: An exploration into computer-mediated reality. *Journal of Computer-Mediated Communication, 5,* 1 (1999).

6. Barki, H.; Paré, G.; and Sicotte, C. Linking IT implementation and acceptance via the construct of psychological ownership of information technology. *Journal of Information Technology, 23,* 4 (2008), 269–280.

7. Breckler, S.J. Empirical validation of affect, behavior, and cognition as distinct components of attitude. *Journal of Personality and Social Psychology, 47,* 6 (1984), 1191–1205.

8. Brown, G.; Lawrence, T.B.; and Robinson, S.L. Territoriality in organizations. *Academy of Management Review, 30,* 3 (2005), 577–594.

9. Byrne, B.M. *Structural Equation Modeling with Amos: Basic Concepts, Applications, and Programming.* Mahwah, NJ: Lawrence Erlbaum, 2009.

10. Campbell, J.; Fletcher, G.; and Greenhill, A. Sustainable virtual world ecosystems. *ACM SIGMIS Database, 38,* 4 (2007), 29–31.

11. Chen, X.; Siau, K.; and Nah, F. 3-D virtual worlds: Education and learning. In K. Saeed and H. Treiblmaier (eds.), *Proceedings of the Eighth Annual Workshop on HCI Research in MIS.* Phoenix, AZ, December 14, 2009.

12. Clemons, E.K. Business models for monetizing Internet applications and Web sites: Experience, theory, and predictions. *Journal of Management Information Systems, 26,* 2 (Fall 2009), 15–41.

13. Constantine, L.L. Visual coherence and usability: A cohesion metric for assessing the quality of dialogue and screen designs. In J. Grundy and M. Apperly (eds.), *Proceedings of the Sixth Australian Conference on Computer–Human Interaction.* Los Alamitos, CA: IEEE Computer Society Press, 1996, pp. 115–121.

14. Cyr, D. Modeling Web site design across cultures: Relationships to trust, satisfaction, and e-loyalty. *Journal of Management Information Systems, 24,* 4 (Spring 2008), 47–72.

15. Davis, A.; Murphy, J.; Owens, D.; Khazanchi, D.; and Zigurs, I. Avatars, people, and virtual worlds: Foundations for research in metaverses. *Journal of the Association for Information Systems, 10,* 2 (2009), 90–117.

16. D'Hertefelt, S. Trust and the perception of security. InteractionArchitect.com, 2000 (available at http://users.skynet.be/fa250900/research/report20000103shd.htm).

17. Dignan, L. IBM cooks up internal virtual world for confidentiality, security. December 18, 2007 (available at www.zdnet.com/blog/btl/ibm-cooks-up-internal-virtual-world-for-confidentiality-security/7382/).

18. Eben Saleh, M.A. The architectural form and landscape as a harmonic entity in the vernacular settlements of southwestern Saudi Arabia. *Habitat International, 24,* 4 (2000), 455–473.

19. Emergence of the 3-D Internet. IBM Research, Armonk, NY, 2008.

20. Fetscherin, M.; Lattemann, C.; and Lang, G. Virtual worlds research: A conceptual primer. *Journal of Electronic Commerce Research, 9,* 3 (2008), 192–194.

21. Fornell, C., and Larcker, D.F. Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research, 18,* 1 (1981), 39–50.

22. Fraine, G.; Smith, S.G.; Zinkiewicz, L.; Chapman, R.; and Sheehan, M. At home on the road? Can drivers' relationships with their cars be associated with territoriality? *Journal of Environmental Psychology, 27,* 3 (2007), 204–214.

23. Franceschi, K.; Lee, R. M.; Zanakis, S.H.; and Hinds, D. Engaging group e-learning in virtual worlds. *Journal of Management Information Systems, 26,* 1 (Summer 2009), 73–100.

24. Furby, L. Possession in humans: An exploratory study of its meaning and motivation. *Social Behavior and Personality, 6,* 1 (1978), 49–65.

25. Gartner says 80 percent of active Internet users will have a "Second Life" in the virtual world by the end of 2011. Gartner, Stamford, CT, 2007 (available at www.gartner.com/it/page.jsp?id=503861/).

26. Giedion, S. *Space, Time, and Architecture: The Growth of a New Tradition.* Cambridge: Harvard University Press, 1941.

27. Gimblett, H.R. Environmental cognition: The prediction of preference in rural Indiana. *Journal of Architectural and Planning Research, 7,* 3 (1990), 222–234.

28. Gonzales, M.; Fernandez, C.; and Cameselle, J. Empirical validation of a model of user satisfaction with buildings and their environments as workplaces. *Journal of Environmental Psychology, 17,* 1 (1997), 69–74.

29. Hair, J.F.; Anderson, R.E.; Tatham, R.L.; and Black, W.C. *Multivariate Data Analysis.* Englewood Cliffs, NJ: Prentice Hall, 1998.

30. Hendaoui, A., and Limayem, M. Understanding consumer virtual shopping behavior in 3D virtual worlds: A theoretical and empirical investigation. In D. Te'eni and F. Rowe (ed.), *Proceedings of the Twenty-Ninth International Conference on Information Systems.* Atlanta: Association for Information Systems, 2008.

31. Hong, S., and Kim, J. Architectural criteria for Website evaluation—Conceptual framework and empirical validation. *Behaviour & Information Technology, 23,* 5 (2004), 337–357.

32. Hubbard, H., and Kimball, T. *An Introduction to the Study of Landscape Design.* New York: Macmillan, 1917.

33. Kaplan, R., and Kaplan, S. *The Experience of Nature: A Psychological Perspective.* Cambridge: Cambridge University Press, 1989.

34. Kaplan, S. Aesthetics, affect, and cognition: Environmental preference from an evolutionary perspective. *Environment and Behavior, 19,* 1 (1987), 3–32.

35. Kaplan, S. Perception and landscape: Conceptions and misconceptions. In J.L. Nasar (ed.), *Environmental Aesthetics.* Cambridge: Cambridge University Press, 1988, pp. 241–248.

36. Kim, J.; Song, J.; and Jones, D.R. The cognitive selection framework of knowledge acquisition strategy in virtual communities. In R.H. Sprague Jr. (ed.), *Proceedings of the Forty-Third Hawaii International Conference on System Sciences,* Los Alamitos, CA: IEEE Computer Society Press, 2010.

37. Kim, J.; Lee, J.; Han, K.; and Lee, M. Business as buildings: Metrics for the architectural quality of internet businesses. *Information Systems Research, 13,* 3 (2002), 239–254.

38. Kim, S.S., and Malhotra, N.K. A longitudinal model of continued IS use: An integrative view of four mechanisms underlying postadoption phenomena. *Management Science, 51,* 5 (2005), 741–755.

39. Koufaris, M. Applying the technology acceptance model and flow theory to online consumer behavior. *Information Systems Research. 13,* 2 (2002), 205–223.

40. Kruft, H.W. *A History of Architectural Theory: From Vitruvius to the Present.* London: Zwemmer; Princeton: Princeton Architectural Press, 1994.

41. Kumar, S.; Chhugani, J.; Kim, C.; Kim, D.; Nguyen, A.; Dubey, P.; Bienia, C.; and Kim, Y. Second Life and the new generation of virtual worlds. *IEEE Computer, 41,* 9 (2008), 46–53.

42. Lavie, T., and Tractinsky, N. Assessing dimensions of perceived visual aesthetics of Web sites. *International Journal of Human–Computer Studies, 60,* 3 (2004), 269–298.

43. Lee, Y., and Kozar, K. Designing usable online stores: A landscape preference perspective. *Information & Management, 46,* 1 (2009), 31–41.

44. Lee, Y.; Ellis, M.; and Chen, A. Designing preferable virtual worlds. In R. Nicerson and R. Sharda (ed.), *Proceedings of the Fifteenth Americas Conference on Information Systems.* Atlanta: Association for Information Systems, 2009.

45. Liang, H.; Saraf, N.; Hu, Q.; and Xue, Y. Assimilation of enterprise systems: The effect of institutional pressures and the mediating role of top management. *MIS Quarterly, 31,* 1 (2007), 59–87.

46. Litman, J.A. Curiosity and the pleasures of learning: Wanting and liking new information. *Cognition and Emotion, 19,* 6 (2005), 793–814.

47. Loiacono, E.; Watson, R.; and Goodhue, D. WebQual: An instrument for consumer evaluation of Web sites. *International Journal of Electronic Commerce, 11,* 3 (2007), 51–87.

48. Machlis, S. Site redesigns keep it simple. *Computerworld, 32,* 43 (1998), 43–44.

49. Malhotra, A.; Gosain, S.; and El Sawy, O.A. Leveraging standard electronic business interfaces to enable adaptive supply chain partnerships. *Information Systems Research, 18,* 3 (2007), 260–279.

50. Malhotra, N.K.; Kim, S.S.; and Patil, A. Common method variance in is research: A comparison of alternative approaches and a reanalysis of past research. *Management Science, 52,* 12 (2006), 1865–1883.

51. Mennecke, B.E.; McNeill, D.; Ganis, M.; Roche, E.M.; Bray, D.A.; Konsynski, B.; Townsend, A.M.; and Lester, J. Second Life and other virtual worlds: A roadmap for research. *Communications of the Association for Information Systems, 22,* 20 (2008), 371–388.

52. Mills, E. Rising fraud threats in virtual worlds. Cnet.com, August 27, 2008 (available at http://news.cnet.com/8301-1009_3-10027609-83.html).

53. Moon, J., and Sanders, G.L. Customers' psychological ownership towards personalized spaces on e-commerce sites. In N. Romano et al. (ed.), *Proceedings of the Tenth Americas Conference on Information Systems.* Atlanta: Association for Information Systems, 2004.

54. Norman, D.A. Emotion and design: Attractive things work better. *Interactions, 9,* 4 (2002), 36–42.

55. Ozok, A.A., and Salvendy, G. How consistent is your Web design? *Behaviour & Information Technology, 20,* 6 (2001), 433–447.

56. Palmer, J.W. Web site usability, design, and performance metrics. *Information Systems Research, 13,* 2 (2002), 151–167.

57. Paré, G.; Sicotte, C.; and Jacques, H. The effects of creating psychological ownership on physicians' acceptance of clinical information systems. *Journal of American Medical Informatics Association, 13,* 2 (2006), 197–205.

58. Patnayakuni, R.; Rai, A.; and Seth, N. Relational antecedents of information flow integration for supply chain coordination. *Journal of Management Information Systems, 23,* 1 (Summer 2006), 13–49.

59. Pausch, R.; Proffitt, D.; and Williams, G. Quantifying immersion in virtual reality. In G.S. Owen, T. Whitted, and B. Mones-Hattal (ed.), *Proceedings of the Twenty-Fourth ACM SIGGRAPH.* New York: ACM Press, 1997.

60. Pierce, J.L.; Kostova, T.; and Dirks, K.T. Toward a theory of psychological ownership in organizations. *Academy of Management Review, 26,* 2 (2001), 298–310.

61. Pierce, J.L.; Kostova, T.; and Dirks, K.T. The state of psychological ownership: Integrating and extending a century of research. *Review of General Psychology, 7,* 1 (2003), 84–107.

62. Pierce, J.L.; O'Driscoll, M.P.; and Coghlan, A.-M. Work environment structure and psychological ownership: The mediating effects of control. *Journal of Social Psychology, 144,* 5 (2004), 507–534.

63. Preiser, W.; Rabinowitz, H.; and White, E. *Post-Occupancy Evaluation.* New York: Van Nostrand Reinhold, 1988.

64. Rasmussen, S. *Experiencing Architecture.* Cambridge: MIT Press, 1959.

65. Real, E.; Arce, C.; and Sabuced, J.M. Classification of landscapes using quantitative and categorical data, and prediction of their scenic beauty in north-western Spain. *Journal of Environmental Psychology, 20,* 4 (2000), 355–373.

66. Rochberg-Halton, E. Cultural signs and urban adaptation: The meaning of cherished household possessions. Ph.D. dissertation, University of Chicago, 1980.

67. Rosen, D.E., and Purinton, E. Website design: Viewing the Web as a cognitive landscape. *Journal of Business Research, 57,* 7 (2004), 787–794.

68. Sastry, A. Security in virtual worlds: Blurring the borders. TechNewsWorld, September 19, 2007 (available at www.technewsworld.com/story/59399.html?wlc=1273245352/).

69. Shumaker, S., and Reizenstein, J. Environmental factors affecting inpatient stress in acute care hospitals. In E.G. Evans (ed.), *Environmental Stress.* London: Cambridge University Press, 1982.

70. Singh, S.N.; Dalal, N.; and Spears, N. Understanding Web home page perception. *European Journal of Information Systems, 14,* 3 (2005), 288–302.

71. Straub, D. Validating instruments in MIS research. *MIS Quarterly, 13,* 2 (1989), 147–169.

72. Tavanti, M., and Lind, M. 2D vs. 3D, implications on spatial memory. In S. Feiner (ed.), *Proceedings of the IEEE Symposium on Information Visualization (InfoVis 2001).* Los Alamitos, CA: IEEE Computer Society, 2001.

73. Te'eni, D. A cognitive-affective model of organizational communication for designing IT. *MIS Quarterly, 25,* 2 (2001), 251–312.

74. Tikkanen, H.; Hietanen, J.; Henttonen, T.; and Rokka, J. Exploring virtual worlds: Success factors in virtual world marketing. *Management Decision, 47,* 8 (2009), 1357–1381.

75. Tractinsky, N. Toward the study of aesthetics in information technology. In R. Agarwal, L. Kirsch, and J.I. DeGross (ed.), *Proceedings of the Twenty-Fifth International Conference on Information Systems.* Atlanta: Association for Information Systems, 2004.

76. Trafimow, D., and Sheeran, P. Some tests of the distinction between cognitive and affective beliefs. *Journal of Experimental Social Psychology, 34,* 4 (1998), 378–397.

77. Turner, P., and Turner, S. Place, sense of place, and presence. *Presence-Teleoperators and Virtual Environments, 15,* 2 (2006), 204–217.

78. UWISH: Usability of Web-Based Information Services for Hypermedia. UWish Project (available at http://projects.cwi.nl/uwish/).

79. Van der Heijden, H. User acceptance of hedonic information systems. *MIS Quarterly, 28,* 4 (2004), 695–704.

80. Van Dyne, L., and Pierce, J.L. Psychological ownership and feelings of possession: Three field studies predicting employee attitudes and organizational citizenship behavior. *Journal of Organizational Behavior, 25,* 4 (2004), 439–459.

81. Vrechopoulos, A.P.; O'Keefe, R.M.; Doukidis, G.I.; and Siomkos, G.J. Virtual store layout: An experimental comparison in the context of grocery retail. *Journal of Retailing, 80,* 1 (2004), 13–22.

82. Weibel, D.; Wissmath, B.; and Mast, F.W. Immersion in mediated environments: The role of personality traits. *Cyberpsychology, Behavior and Social Networking, 13,* 3 (2010), 251–256.

83. Wood, C.M. The effects of creating psychological ownership among students in group projects. *Journal of Marketing Education, 25,* 3 (2003), 241–249.

84. Zhang, P., and Li, N. The importance of affective quality. *Communications of the ACM, 48,* 9 (2005), 105–108.

Appendix A: Scenarios for Second Life Experiment

LOG IN TO SECOND LIFE BY ENTERING THE FIRST AND LAST NAME you chose for your avatar and your password in the appropriate boxes.

Basic Avatar Movement

- For the purposes of this study you will be asked to move around a particular area in Second Life and look at the things that you find there (see Figure A1).
- Basic movement is accomplished using the arrow keys on the keyboard. They make the avatar move and turn.
- Your avatar can fly if you want to move to a different part of the site quickly. Press the Page Up button to rise and Page Down to fly lower. The direction in which you fly is determined using the arrow buttons just like walking. Continuing to press Page Down will stop your avatar from flying and return it to the ground.
- To interact with an object, click the left mouse button while pointing at it. You can also click the right mouse button to bring up a menu of options for the object.
- Sometimes it pays to stand still for a second or two while the program catches up. All aspects of the Second Life world are only rendered on the monitor as they are needed.

Figure A1. Navigation Tools in Second Life

- Visit the Second Life's Policies & Guidelines and read its online safety, privacy, and community standards ("big six").
- Take ten minutes to navigate the site, use some artifacts, or chat with others.

Visit Big Pond

- You will be asked to visit part of an area called "Big Pond," the most popular social area of Second Life. The goal of your time involved in this study will be to move around this area and observe the buildings, landscape, and other objects you find there.
- To move to the target area:
  - Enter "Pondfield" in the search field. You will find the search field in the upper-right corner of the screen.
  - Click on the "Region: Pondfield" link shown in the search results.
  - Choose the "Teleport" button on the next screen to go to that area.
- You will start in the marina. You will be given a note card and asked to read the terms of use. Click "Keep" in the window that says you are getting a note card and the text of it will pop up in another window. Select "Discard" to close the window.
- Use the arrows to move around the area for the time allowed. Look around the site about five minutes

Appendix B: Results of Common Method Variance Test

	LEG	COH	VAR	MYS	FIR	CLAS	EXP	AFF	PC	COG	SI	PO
Panel A: Interconstruct correlation matrix												
LEG												
COH	0.565											
VAR	0.279	0.249										
MYS	0.434	0.400	0.371									
FIR	0.330	0.434	0.128	0.209								
CLAS	0.329	0.337	0.365	0.329	0.236							
EXP	0.183	0.239	0.382	0.224	0.370	0.563						
AFF	0.425	0.353	0.517	0.427	0.230	0.560	0.504					
PC	0.373	0.381	0.185	0.261	0.298	0.241	0.335	0.392				
COG	0.583	0.561	0.296	0.410	0.430	0.264	0.280	0.486	0.364			
SI	0.262	0.309	0.285	0.141	0.187	0.152	0.237	0.441	0.285	0.317		
PO	0.299	0.273	0.296	0.101	0.202	0.218	0.257	0.512	0.385	0.398	0.616	
FUI	0.209	0.222	0.326	0.187	0.174	0.160	0.297	0.488	0.332	0.356	0.665	0.617

(continues)

	LEG	COH	VAR	MYS	FIR	CLAS	EXP	AFF	PC	COG	SI	PO
Panel B: Marker-adjusted interconstruct correlation matrix												
LEG												
COH	0.552											
VAR	0.258	0.228										
MYS	0.418	0.382	0.353									
FIR	0.310	0.418	0.103	0.187								
CLAS	0.309	0.318	0.347	0.310	0.214							
EXP	0.159	0.217	0.364	0.202	0.351	0.551						
AFF	0.408	0.335	0.503	0.410	0.207	0.548	0.489					
PC	0.355	0.364	0.162	0.239	0.277	0.219	0.316	0.375				
COG	0.571	0.549	0.275	0.393	0.413	0.243	0.259	0.471	0.345			
SI	0.240	0.289	0.265	0.116	0.164	0.128	0.215	0.425	0.264	0.297		
PO	0.279	0.252	0.276	0.075	0.179	0.195	0.235	0.498	0.367	0.381	0.605	
FUI	0.186	0.199	0.306	0.164	0.151	0.136	0.277	0.473	0.313	0.337	0.655	0.606
Panel C: *t*-test statistics of marker-adjusted correlation matrix												
LEG												
COH	9.776											
VAR	3.950	3.455										
MYS	6.793	6.110	5.573									
FIR	4.821	6.796	1.535	2.806								
CLAS	4.803	4.952	5.461	4.810	3.239							
EXP	2.378	3.289	5.776	3.041	5.542	9.743						
AFF	6.600	5.247	8.604	6.646	3.130	9.661	8.288					
PC	5.599	5.764	2.419	3.640	4.261	3.309	4.916	5.970				
COG	10.277	9.694	4.228	6.312	6.705	3.691	3.958	7.885	5.433			
SI	3.657	4.463	4.055	1.727	2.453	1.901	3.247	6.938	4.046	4.591		
PO	4.291	3.853	4.237	1.109	2.682	2.942	3.572	8.477	5.827	6.082	11.212	
FUI	2.796	3.004	4.754	2.450	2.250	2.030	4.254	7.930	4.861	5.289	12.806	11.258

Notes: LEG = legibility; COH = coherence; VAR = variety; MYS = mystery; FIR = firmness; CLAS = classic aesthetics; EXP = expressive aesthetics; AFF = affective appraisals; PC = perceived control; COG = cognitive appraisals; SI = self-investment; PO = psychological ownership; FUI = future use intention.

Appendix C: Mediation Tests

We first conducted a mediating test using a pseudo *F*-test technique, which has often been used in previous IS studies [45, 49, 58]. As a part of the pseudo *F*-test, we investigated the value of adding new nomological networks, including affective–FUI, cognitive–FUI, control–FUI, and self-investment–FUI, into the research model.

A pseudo *F*-test consists of two parts: (1) create full models and compare it with a nested model by observing the significant differences in R^2 statistics, and (2) calculate the *z*-test statistic by using the magnitude of the mediation between independent variable–mediator and that of mediator–dependent variable and standard errors of the mediated path. We calculated the pseudo *F*-test value based on the following formula:

$$\text{Pseudo } F = f^2 \times (n - k - 1)$$

with 1, (*n* – k) degrees of freedom, *n* = sample size, and *k* = number of constructs in the model.

We first calculated the f^2 value by adding additional cognitive appraisals–FUI, perceived control–FUI, affective appraisals–FUI, and self-investment–FUI networks into the original model and found f^2 values that are 0.001, –0.005, 0.037, and 0.202, respectively. The f^2 values were similar to those of previous studies (e.g., Patnayakuni et al.'s [58] study has f^2 values = 0.009, 0.008; Malhotra et al.'s [49] study has f^2 values = 0.06, 0.304).

Then, we calculated the pseudo *F* using the formula above and got 2.329 ($p > 0.05$), –1.143 ($p > 0.05$), 8.534 ($p < 0.05$), and 45.494 ($p < 0.001$), respectively. The results represent that adding additional networks between affective appraisals and future use intention and self-investment and future use intention increased the explanatory power of future use intention, whereas adding networks including cognitive appraisals–future use intention and perceived control–future use intention did not. We further conducted a mediating test by using (1) the path coefficients of antecedents of PO, PO, as well as PO and future use intention, and (2) their standard errors.

Using path coefficients and standard errors (S.E.) information (cognitive appraisals–PO [$\lambda = 0.116$, S.E. = 0.053], affective appraisals–PO [$\lambda = 0.202$, S.E. = 0.052], perceived control–PO [$\lambda = 0.136$, S.E. = 0.054], and self-investment–PO [$\lambda = 0.524$, S.E. = 0.066], and PO–FUI [$\lambda = 0.535$, S.E. = 0.071]), we calculated *z*-statistics for all the paths (cognitive appraisals–PO–FUI = 2.085; perceived control–PO–FUI = 2.452; affective appraisals–PO–FUI = 3.327; self-investment–PO–FUI = 5.404), which were all significant at the $p < 0.05$ level, indicating that the significant mediating role of PO between antecedents of PO and future use intention.