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**WAYFINDING IN REAL AND VIRTUAL DOMAINS:
CONTINUITY AND EXPERIENCE**

by
Brent A. Welty, B.Arch.

**A Thesis submitted to
the Faculty of Graduate Studies and Research
in partial fulfillment of the requirements for the degree of
Masters of Architecture**

**Carleton University
Ottawa, Ontario**

July 2001

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**"Wayfinding in Real and Virtual Domains:
Continuity and Experience"**

submitted by Brent A. Welty, B.Arch.
in partial fulfillment of the requirements
for the Degree of Master of Architecture

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ABSTRACT

This thesis explores the relationship between wayfinding in physical (real) environments and electronic (virtual) environments. In particular, it looks at a class of websites that model the real world in order to introduce users to it and enhance their understanding of it through technology-mediated means. A theme is established for a waymaking (virtual) model that suggests that the virtual experience of a physical place need neither be a substitution to that space, but that the virtual model is an actual continuity of the experience of the physical environment. Continuity is established when both the real and virtual environments appeal to the same cognitive map, where the real and virtual experiences overlap in the user's memory and image of the environment. This is to benefit wayfinders by giving them "a priori" knowledge to develop a detailed decision plan, linking the delivery of the decision plan with the dynamic nature of web-based media, aiding in future design of spatial information systems in both real and virtual domains.

ACKNOWLEDGEMENTS

I would like to acknowledge the tremendous support and guidance of my advisor, Professor Ben Gianni, for his encouragement, opportunities and assistance through all phases of my graduate education. His intellectual stimulation has been invaluable in developing and focusing the ideas presented in this thesis.

Through the interdisciplinary nature of the Masters of Architecture program, I wish to thank the many instructors who contributed to my graduate education: Professor Greg Andonian for his discourse in architecture and technology; Lois Frankel for her exercises in human-computer interaction, and Brad Steele for his creative inspiration in multimedia design. Special thanks as well to Mike Getz for his support in the computer labs and patience in problem solving.

I would also like to acknowledge the contributions of Larry McCloskey and Dean Mellway of the Paul Menton Centre at Carleton University for providing the source material used to develop the virtual tour for Carleton University.

A special thanks to friends and fellow students who have been a link between my professional experience and my post-professional education: Dan Balas and Yardley McNeill, professional architects for ongoing debate; Jennifer Fraser, Vidya Shankamarayan and Katie Chau, M.Arch. Graduates for continued interest

in my research; and fellow M.Arch. students in the Design & Technology Program for new friendships. Special thanks also to Vicki Campbell who, as a friend and roommate, provided endless support during my years of study.

Last, and most gratefully, a very special thanks to my parents for their endless love, support and encouragement.

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CHAPTER 1: INTRODUCTION

"Eversion, as the name implies, is the turning inside-out of virtuality, so that it is no longer contained in the technologies that support it but is cast into our midst and projected onto our architecture and our cities."

- Marcos Novak

1.0 INTRODUCTION

1.1 Background

Communication and transportation technologies have radically altered both architecture and the function of architecture in the modern world. We find ourselves today embattled not only by the increasing complexity of the physical environment but by increasing numbers of virtual environments (accessible via personal computers, our office networks, and the World Wide Web) that both address and exacerbate the complexity of the physical world. We maneuver our way through cities, office buildings, museums, banks, bookstores and the like, while at the same time interacting with virtual versions, or counterparts of these entities on the web.

One aspect of the way we (successfully) experience our physical environments involves wayfinding. Wayfinding describes what people do as they move from one place to another. We rely on visual clues in the built environment not only to tell us where we are and how to get to where we want to be, but also to inform us when we have arrived. This navigation is based on common-sense knowledge of geographic space and memory-based knowledge of these spaces in relation to past experience.

Wayfinding design is not synonymous with simplicity; rather it is a dynamic affair. For example, the straight superhighways we use to travel from one city to the next are not necessarily the easiest or safest. Though expediency is one consideration, the total experience also involves reading and understanding traffic signs, directional signs, and the movement and patterns of the surrounding traffic. Thus, wayfinding not only involves movement through space but also a continuous involvement in reading, interpreting, and representing space. Environmental complexity stimulates interest, curiosity, and exploration.

Websites also involve wayfinding: reading, interpreting and conceptualizing space in virtual environments. But more often than not these virtual environments, and specifically websites, suffer from the same lack of structure and ordering systems that characterizes our physical environments. As the Web is considered to be primarily a tool for information discovery and retrieval, it is not always valued in proportion to the quality of our experience of it. An individual's experience of a website is often, if not by definition, characterized by a disjointed journey – jumping from one location to another through hyperlinks. As more of our daily life is conducted in virtual environments, the qualities of our experiences with websites in terms of their imageability and wayfinding emerge as important factors.

Where physical environments are concerned, architects face a unique challenge of integrating guideposts and visual cues with designs. Architects now have the opportunity to employ their skills not only in the development of real-world environments, but in the design of virtual environments. Many architects fear that virtuality will somehow replace reality, eating away at the built environment, at the profession, and at all held dear. While most architects see them as competing, however, I propose that there are cases where reality and virtuality have a mutually enhancing relationship, and that architects should address and design this relationship.

1.2 Context

This thesis will compare and contrast wayfinding and imageability in physical environments with wayfinding and imageability in virtual environments, specifically comparing pedestrian-scaled cities to websites.

To initiate this discussion, this thesis explores the notion of “disaggregation” of the built environment, and the role of virtual environments in addressing (or aggravating) it. Disaggregation stems from a personal observation that the definition of and the perceptual distance between cities has diminished in the wake of communication and transportation technologies. At the same time, print media, radio, television, computers and the World Wide Web, have enabled us to

learn and interact with environments around the world. We can explore distant cities, the institutions and activities within them, from the comfort and security of our own city or home. But these “connecting” technologies not only address but promote dispersion. While on one hand, technology has brought us closer together, it encourages us to live further apart. And while technology may be brought to bear on addressing the disconnectedness that it facilitates, the structure of most websites seems more to reflect our disconnected experience of the physical environment rather than improve on it.

Websites and virtual environments can be seen both as part of the problem and part of the solution to the disaggregation that technology facilitates. Either way, architects should be paying attention to them. Moreover, whatever the site or environment (physical or virtual), to the extent that it’s interactive and dimensionally rich, it will benefit from the application of wayfinding and organizational principles. Rather than treating all sites as equal however, this thesis will focus on a class of sites with a close relationship to specific places in the physical world. My goal is to explore how virtual and physical versions of a given environment might appeal to the same cognitive map and, in particular, the virtual version’s capacity to strengthen the cognitive map and enhance our understanding and appreciation of the built environment.

Cities are rarely designed from scratch, and the formal design principles used to “create” cities would not necessarily improve websites. Websites, like modern cities, are organic entities that undergo continuous evolution and redesign. The reflection of physical architecture in digital architecture, however, may help people to construct more useful mental models of how real-world spaces exist vis-à-vis digital information spaces, and hence enhance our understanding of both.

1.3 Organization

Following this introduction, Chapter 2 introduces the context for the thesis, proposing a classification system that describes real world institutions and their virtual versions on the web, including cases like Carleton University and the Menton Centre Virtual Tour where the overlap between the real and virtual worlds is explicit. Chapters 3 and 4 look comparatively at principles of wayfinding in architecture as presented by Kevin Lynch, Romedi Passini and William Mitchell, and navigation through information design principles as set out by Edward Tufte, Clement Mok and Louis Rosenfeld & Peter Morville, drawing parallels between the two in their approach to design and how they come to bear on establishing a real-world virtual-world continuity. Of particular interest is the cognitive map and its relationship to virtual versions of physical places. Chapter 5 looks at technology and precedent, examining the evolution of current

knowledge in the design of virtual environments. The case study is summarized in Chapter 6 (a detailed accounting can be found in Appendix B), taking forward the concepts presented in this thesis in the development of a Virtual Tour for Carleton University.

The conclusions in Chapter 7 attempt to demonstrate not only that the principles of the design of real environments can be applied to the design of virtual environments, but that virtual environments can be used to enhance our understanding of the environments with which we interact on a daily basis. In specific cases, virtual versions of complex physical environments can be used as tools to enhance the imageability and perceptual cohesion of those environments. In this sense both the real and virtual versions can appeal to the same cognitive map such that, at the cognitive level, the user's experience of both environments is the same. This uses the cognitive map to establish a unique class of relationship between real and virtual environments to the particular benefit of the built environment. As an architect, I am particularly interested in how virtual worlds can be used to support and enhance the built environment in this way; I am also interested in the role of the architect in designing both environments and the relationship between them.

1.4 Glossary of Terms

affordances	those things that an object, an assemblage of objects, or an environment enables one to do
cognitive map	conceptualization or model of space built upon a person's experience with their environment
landmark knowledge	information about the visual details of specific locations in the environment
procedural knowledge	information about the sequence of actions required to follow a particular route (also known as route knowledge)
real environment	the circumstances, objects, or conditions by which one is surrounded and the complex of physical factors that act upon a community and ultimately determine its form
route map	data about various features in the environment that occur in a particular sequence and aid a person navigating the environment through confirmation
schema	recurring mental patterns that help people to structure space in order to know what to do with or within it
space	a boundless three-dimensional extent in which objects occur and have relative position and direction
survey knowledge	configural or topological information, noting object locations and inter-object distances

place	a particular region or locality (recognizable as such) used for a special purpose
virtual environment	an artificial environment that is experienced through sensory stimuli (such as sights and sounds) provided by a computer and in which one's actions partially determine what happens in the environment
wayfinding	a form of spatial problem-solving and cognitive mapping using human activity, using behavioral patterns and abilities to direct the design of environments and to create environmental communication systems that take into account people's needs
waymaking	positioning representations of elements to form diagrams of spaces, where the resulting diagrams have a topological integrity and the relative placement of the elements can have more importance than the actual measurements or proportions of the space

CHAPTER 2: CONTEXT

2.0 CONTEXT

2.1 Introduction

Technology has contributed to globalization. It has brought us closer together through advancements in transportation and communication while, at the same time, facilitating dispersion and diminishing the importance of interaction at a geographically local level. Communities, which might once have been linked to some geographical area, are not necessarily seen that way now. Having managed to connect distant points in the real world using technologies, we now have the opportunity to connect real and virtual worlds – to explore how a website might be conceived of as an extension of architecture and our built environment. Note that I use the term “website” as synonymous with “virtual environment” because, at present, the web is the great portal to virtual worlds. It should be emphasized, however, that virtual environments are not limited to the web – we are also able to experience virtual environments through interactive kiosks, multimedia CDs, and gaming technologies such as PlayStation.

I find the connection between real worlds and virtual worlds of particular interest with respect to cities and their virtual counterparts. In particular, I look at the connection between a university campus (which I liken to a small city) and its

virtual counterpart on the web – where the overlap between the real environment and the virtual environment is important and significant.

2.2 Real World – Virtual World Relationships

All websites are not created equal; different sites have different degrees of relationships to the entities they “represent”. To that end, it may be important to distinguish sites into different classes. I have proposed six classes of sites, distinguished in order of the degree of overlap or relationship between physical and virtual experience.

This list is not meant to be exhaustive; the goal of this classification is to reinforce that the relationship between a physical entity and its virtual counterpart is more or less meaningful depending on the entity. This list however allows us to locate the unique relationship of a university to its website, where the university's existence as a physical place is key to its identity (likewise on the web), and where the real-world and virtual-world versions explicitly overlap.

Class 1: Galleries or Museums and their Virtual Tours on the Web
(e.g. National Gallery of Canada & <http://www.national.gallery.ca>)

As “one-of-a-kind” places, the identity of the institution is tied to a place and the particular characteristics of that place, and the virtual version must take into account these physical characteristics. There is, consequently, a large degree of (or potential for) overlap between the real and virtual worlds. The physical layout of the institution may need to be communicated through the structure and organization of the website in order to adequately promote or represent the institution. If this is so, the experience of the institution may be similar in both the real and virtual worlds – that is, wayfinding in the real environment and navigating on the web may be similarly structured.

In this class, the real and virtual environments are *recurrent*, and their relationship is *supportive*.

Class 2: Banks or Bookstores and their E-Commerce Sites on the Web
(e.g. Chapters Bookstore & <http://www.chapters.ca>)

In this second class – branches and franchises – the business image or idea of “brand” has to be consistent in both the real and virtual worlds, but the experience of shopping online need not be identical to shopping at a store. Consequently, there may be some degree of overlap between real and virtual worlds, although not as much as in Class 1. Similarly, the physical layout of the institution does not have to be communicated through the structure and organization of the website as in Class 1. Thus the experience of the institution is not similar in the real or virtual worlds (i.e. wayfinding in the real environment and navigating on the web need not be similarly structured).

In this class, the virtual environment is *referential* of the real environment, and their relationship is *parallel*.

Class 3: Businesses or Corporations and their Promotional Sites on the Web
(e.g. IBM Canada & <http://www.ibm.com/ibm/ca>)

A “corporation” is an abstract entity and not tied to a particular place with specific physical characteristics, so, in this regard, the entity in is to some degree already virtual. There is little or no overlap between real and virtual worlds, and the physical

characteristics of the entity have little bearing on the structure and organization of the website. To the extent that the corporation is already “virtual”, the experience of the institution may be, though need not be, similar in the real or virtual worlds (i.e. wayfinding in the real environment and navigating on the web are not similarly structured)

In this class, the virtual environment is *replicational* of the real environment, and their relationship is *non-continuous*.

Class 4: **Gaming Technology and Game Environments on the Web**
(e.g. Riven CD-ROM & <http://www.riven.com>)

Game environments are already virtual – worlds unto themselves, with no connection to a physical world. Game environments are abstract and not tied to any particular physical place, although actual places may be inspiration for the design of the environment. There is no overlap between the real and virtual worlds, to the extent that there is no particular connection between the game world and its physical referent. The experience of the game (i.e. navigating) is relative and dependant only to the game's design and structure, although as immersive three-dimensional environments,

the way we navigate through these worlds is often designed to replicate the way we move through a physical environment. Moreover, the point of the game may be to prevent the player from gaining a clear mental image of the environment he or she is navigating.

In this class, the virtual environment is a *simulation* of the real environment, and their relationship is *non-related*.

Class 5: **Travel/Tourism Industry and their Descriptive Sites on the Web**
(e.g. Lonely Planet & <http://www.lonelyplanet.com>)

This is a class of sites or environments which are designed to introduce us to physical places that we are not likely to go – whether far away (e.g. Tibet) or no longer existent (e.g. Ancient Rome). Here the virtual experience may need to re-create the actual experience precisely because we will never be able to actually visit it. There is overlap between the real and virtual worlds, to the extent that the latter duplicates the former. Wayfinding in the real environment and navigating on the web may be similarly structured: the way we navigate through these virtual

recreations is often designed to replicate the way we move through a physical environment.

In this class, the virtual environment is a *re-creation* of the real environment, and their relationship is *similar*.

Class 6: Universities and their Virtual Tours on the Web

(e.g. Waterloo University & <http://www.virtualltour.uwaterloo.ca>)

In this last class, similar to the first, the identity of the institution is tied to a place and the particular characteristics of that place, and the virtual version must take into account these physical characteristics. There is, consequently, a large degree (or potential for) overlap between the real and virtual worlds. The physical layout of the institution may need to be communicated through the structure and organization of the website in order to adequately promote or represent the institution. If this is so, then the experience of the institution is similar in both the real or virtual worlds – that is, wayfinding in the real environment and navigating on the web may be similarly structured.

In this class, the virtual environment is an *abstraction* of the physical environment, and their relationship is *complimentary*.

These six classes illustrate a possible degree of overlap or relationship between physical and virtual experience, however, these classes are not meant to be precise. There is some degree of overlap between each of the classes, noting that “real” with respect to virtual worlds indicates the degree to which they are immersive three-dimensional environments, and similarly “virtual” with respect to real worlds indicates the degree of (or lack of) physicality of the entity. I illustrate the spectrum of relationships between the six classes of real world – virtual world pairings in Figure 2.1 on the following page.

Figure 2.1 Physical World – Virtual World Relationship Spectrum

The first set of characteristics – recurrence, reference, replication and simulation, re-creation and abstraction – I use to describe each of the six classes also speak to the subject of a mental image that may (or may not) exist between them. At this point I simply introduce the aspect of mental image, or “cognitive map” that may also be a distinguishing factor in each of these relationships. For example, in Class 1 sites, the large degree of overlap between real and virtual worlds suggests a potential to share a common cognitive map. At the other end of the spectrum, Class 4 and 5 sites would evoke entirely separate and distinct cognitive maps from the real and virtual worlds. Exactly how the cognitive map fosters the relationship between real and virtual (specifically in Class 6 sites) is the subject of this thesis and is discussed in more detail in subsequent chapters.

Where the overlap is key (e.g. in Class 6 sites where the physical characteristics of a place that is meant to be visited first-hand are an integral part of its identity), I hope to demonstrate that the virtual-world space need neither be in competition with nor a substitution for the real-world space but in support of it.

CHAPTER 3: ARCHITECTURE & URBAN DESIGN

3.0 ARCHITECTURE & URBAN DESIGN

3.1 Introduction

This Chapter explores planning and design concepts common to architecture and urban planning. The writing of architects such as William Mitchell, Kevin Lynch, Romedi Passini and Christopher Alexander speak to generalized concepts and principles for the design of physical environments as they apply to wayfinding. Some also speak to the development of a clear mental image of an environment, be it real or virtual. These concepts and principles can also be applied to an understanding how one constructs a real world/virtual world continuity. Applying their ideas to notions of real world/virtual world pairs may help us to understand how we can enhance our experiences by experiencing both: whether it is to improve our appreciation of the physical world, to improve our ability to navigate through information spaces, or to use the latter to address the problems of the former.

This chapter begins by setting a brief historical context. It then discusses the principles of urban planning and the city, noting the city, one's experience of it, and the mental image one forms when navigating the city (and/or virtual versions of real-world cities). Also included are references to wayfinding and cognitive maps and their importance to urban design.

Amongst other goals, this chapter is intended to make explicit the role of the mental map in wayfinding. The following chapter will illustrate the connection between the experience of virtual-world environments and the mental image developed from them. Together, Chapters 3 & 4 set the ground for a discussion of the complimentary link between real world and virtual worlds via this mental image.

3.2 Context

Historically, the medieval city was self-contained, its boundaries defined by surrounding protective walls. Within, inhabitants moved about by way of laid out paths, using key elements such as churches as landmarks to locate and orient themselves. Cities grew simply and incrementally, and their inhabitants understood themselves in relationship to the city as a whole. Furthermore, the distinction and distance between medieval cities were clearly defined by their physical boundaries.

In a reaction to industrialization, modernism responded to the overburdened medieval urban fabric of European cities by conceptualizing and proposing planned cities. Modernism abstracted and standardized the structure of the city, breaking down boundaries and emphasizing space, light and the qualities of buildings themselves rather than imageable urban form. The modernist city

could only truly be understood from the plans that were used to create it; notions of paths and hierarchy (e.g. landmarks) were defined with respect to an extensive and extendable grid that replaced the organic medieval fabric.

In the 1960s and 70s, architects such as Kevin Lynch and Romedi Passini reacted to modernist notions of urban planning, extolling the medieval city for its legibility and organization in terms of paths, nodes, districts, edges and landmarks. They recognized cities as growing incrementally as opposed to being designed from “the top down” or built all at once. The absence of legible organizing principles such as hierarchy and symmetry that characterized planned cities made it apparent how crucial imageability and legibility were to the inhabitants’ understanding and appreciation of their environment.

Indeed the problems identified by Lynch and Passini have become even more exaggerated in recent years. The cities to which Lynch reacted are even less like their medieval predecessors where scale and boundaries are concerned. While Lynch and Passini’s ideas may be applied at a local (pedestrian) level, it’s unclear how they might be applied to an extended metropolis. Those, like Venturi, who have engaged the city from the perspective of an automobile have come to different conclusions about the concept of city image. Transportation technologies have encouraged cities to pull apart physically at the same time that communication technologies have pulled distant cities together. As a result, the

perceptual distance between modern cities has become inconsequential, and it is no longer important (or indeed possible) to know or to have an image of the city or the physical relationship between cities.

At this point, we look to technologically-mediated means to re-establish our city image and understanding of it. Los Angeles, for example, is a classic example of the extended metropolis – a city made up of many parts with no underlying structure, and a lack of imageable elements to relate the parts to something larger. As a physical city, is difficult if not impossible to understand as a whole. It is only through our representation of Los Angeles through technologically mediated means (e.g. magazines, television, film, Internet) that the city as a whole comes into being. This concept of technologically as a facilitator for developing a mental image and cognitive map of our cities is key to further discussions in this paper.

3.3 Architecture & Urban Design

3.3.1 Quality and Space

Durability, convenience, and beauty (more commonly known as firmness, commodity and delight) are the key qualities of architecture according to Vitruvius (27 BC) in the first of his Ten Books on Architecture. Vitruvius felt that firmness

is achieved when foundations are carried down to the solid ground and materials wisely selected; commodity, when the arrangement of the parts is harmonious and easy to use; and delight when the appearance of the work is pleasing, and when its parts are in proportion to the whole (Vitruvius, 27 BC).

These three words, though centuries old, also speak to the basis of a good relationship between humans and information. In his book City of Bits (1995), William Mitchell states:

“Architects of the twenty-first century will still shape, arrange and connect spaces (both real and virtual) to satisfy human needs. They will still care about the qualities of visual and ambient environments. They will still seek commodity, firmness, and delight. But commodity will be as much a matter of appropriate function and interface design as it is of floor plans and construction materials. Firmness will entail not only the physical integrity of structural systems, but also the logical integrity of computer systems. And delight? Delight will have unimagined new dimensions.” (Mitchell, 1995: 105).

Mitchell takes a broad survey of architecture and urban design as they relate to virtuality and the Internet. He discusses the relationship between real-world institutions (and their architecture), and the digital counterparts of these real-world institutions on the web, imagining architecture and urbanism in the context of new digital domains. In particular, Chapter 4 of his book examines “recombinant architecture”, where he compares architecture and urban design principles to principles of information design. His notions of decomposition and

recombination describe how the virtual realm will dissolve traditional building types and spatialized temporal patterns, resulting in new architectural re-combinations (Mitchell, 1995). Perhaps rethinking his principles of logic as they apply to the design of spaces, he suggests that the constituent elements in architecture and urban design, composed in their tightly packed compositions (such as those he describes in The Logic of Architecture), can begin to relocate and recombine according to the new logics of the virtual environment. He suggests that these parts must relate not only to their architectural and urban contexts, but also to their settings in virtual environments. I make reference to some of this in the categories I proposed in Chapter 2.

For Mitchell, the physical and virtual realms flow together and as such are both the concern of architects. This is not a widely held view. Many architects fear that virtuality will somehow undermine reality – that if the design and realization of virtual environments become more successful, we citizens may prefer to escape to virtuality rather than take responsibility for the structure and state of the built environment. So as architects, it is in our best interest that virtuality doesn't succeed in this way.

3.3.2 Spatial Knowledge

This section looks at generalized principles of spatial knowledge. It then looks at the principles of urban design, examining the relationship between the real environment (city) and one's immediate experience of it, one's memory of the city or the mental image that one forms to abstract and simplify the city in order to better navigate it. Later in this Chapter we will look at the relationship between the cognitive map and virtual versions of the city.

The subject of spatial knowledge has been studied by Thorndyke & Goldin (1983), who noted that general wayfinding tasks require that a person be able to conceptualize space as a whole. They summarized that wayfinding improves with increased spatial knowledge of the environment, and that this knowledge can be described by in terms of three hierarchical levels: landmark knowledge, procedural (or route) knowledge and survey (or topological) knowledge.

The specific information acquired along the route makes use of landmark knowledge, which is information about the details of a specific location, visual and static in nature. Procedural (or route) knowledge is the sequence of actions required to follow a particular route. Survey knowledge is topological information describing locations of objects and the space between them in a fixed frame of reference relative to the viewer. Prolonged exposure to navigating an

environment directly is more likely to result in survey knowledge. These three types of spatial knowledge serve as a measure of how one navigates (successfully or not) through a real or virtual environment.

It is worthwhile to point out that Lynch himself noted that survey knowledge is essential for skillful wayfinding (Lynch, 1960). He noted that with repeated experiences in wayfinding, procedural (or route) knowledge becomes survey knowledge, enabling inferences to be made from a geocentric (user-based) perspective.

3.3.3 Wayfinding

Kevin Lynch coined the term “wayfinding” in his book The Image of the City (1960). Lynch contended that all urban space could be described in terms of visual form: paths, edges, nodes, landmarks, and districts. It was this language of space that enabled later researchers to communicate with test subjects about what they saw, remembered, and used when trying to find their way.

Figure 3.1 illustrates an analysis of Old Boston using Lynch's urban elements. This diagram represents the city in terms of these five elements (nodes, edges, paths, districts and landmarks) – similar to the way a map abstracts a city plan down to basic elements of districts, roads, and key elements such as schools,

churches, and shopping malls. To Lynch, these types of diagrams are similar to the mental images of cities people carry around with them. The difference between Lynch's map and a real map is that it takes perception into account – adjusting the scale of various things to better represent their impact in the environment as we perceive it.

Lynch's map begins to approach a "cognitive map" where the measured, accurate relationship between things (and the measurements of things themselves) is less important than how these things appear to us. Lynch's map resembles the way the city appears in our memory.

We will look at this concept again with respect to the London Subway map in the next chapter. Important is the notion and function of abstraction to adjust between things as they are and things as they appear to us.

Figure 3.1 "The Visual Form of Boston as Seen in the Field"
 (from *The Image of the City* ©1960 by MIT. MIT Press, Cambridge, MA, p.19)

Lynch describes wayfinding as a consistent use and organization of definite sensory cues from the external environment (Lynch, 1960). In the process of wayfinding, the strategic link is the environmental image, the generalized mental picture of the exterior physical world that is held by an individual.

“This image is the product both of immediate sensation and of the memory of past experience, and it is used to interpret information and to guide action.” (Lynch, 1960: 5).

The work of Lynch and his language of urban space point to characteristics of the environment (real and virtual) that can aid wayfinding.

The environmental image can be further described. Lynch dealt with cities on a more local than universal scale. He likens Old Boston (see Figure 3.1) to a medieval city – indeed Old Boston’s fabric is pre-industrial. In his description of Old Boston, Lynch looked at ways of mediating between large and small scale – not only in two dimensions (such as the example of grid vs. pattern in Figure 3.4) but in the third as well. The third dimension was what allowed one to see and distinguish one scale (and place) from the next. Lynch’s example of “imageable” Boston used the third dimension (e.g. urban elements such as church steeples) as mediating elements.

In contrast to Lynch, the universal pretensions of the Modernists “privileged” the (city) plan as the overriding principle in large-scale urban design. In their cities everything was same height. Le Corbusier’s Plan Voisin for Paris (see Figure 3.2) is one such example. There is no third dimension in this universal space implied by the underlying universal grid; moreover the grid is the same in all directions. Le Corbusier’s Plan Voisin, exhibiting this lack of hierarchy, would not offer its inhabitants the affordances Lynch prescribes to make the city easily navigable.

Figure 3.2 Le Corbusier's Plan Voisin for Paris
(excerpted from "Le Corbusier's Plan Voisin")
<http://odin.let.rug.nl/~kastud/paris/n/20-2/txt.html>

In the 1980's, the work of Romedi Passini engaged many of the issues that graphic designers had been dealing with for years. His research findings, published in Wayfinding in Architecture (1984), proposed a structure for describing the design of wayfinding systems. The process of wayfinding, according to Passini, involves active engagement with the environment, and a continuous comparison and integration of existing knowledge with stimuli from the immediate environment. Such active engagement results in a more accurate and extensive understanding of the spatial relationships in the environment.

In his book, Passini advocates providing signage at decision points to help wayfinding decisions as part of his theory for wayfinding as spatial decision-making (Passini, 1984). According to this theory, a navigator begins with a goal and acquires information from the environment (and/or uses what he/she already knows about the space) to make his first move towards a top-level destination (see Figure 3.3). At decision points along the route, the navigator combines observation of local features with previous knowledge of the space to make the proper navigational move.

This principle speaks to developing a mental image when navigating or wayfinding. The information gathering a navigator undertakes can be (and should be) supported by information obtained in both the real-world environment, and as this thesis proposes, in the virtual-world environment as well. The ability

to draw from one or both would support a more successful wayfinding experience. Indeed, Passini's diagram resembles a site map for a website and recalls our patterns of decision-making when navigating the web.

Figure 3.3

Wayfinding Decision Plans

(from *Wayfinding in Architecture* ©1984 by Van Nostrand Reinhold, N.Y., NY, p.65)

A further idea of places “needing an identity” for wayfinding is discussed in Wayfinding: People, Signs and Architecture (Arthur and Passini, 1992). Here, the authors introduce the notions of identity and equivalence in speaking of the perceptions of places. Identity is what makes one part of a space distinguishable from another, and equivalence is what allows spaces to be grouped by their common attributes. They argue that identifiable places form the building blocks of our cognitive maps and the spatial anchors for the decisions made during wayfinding. This, in part, reflects Lynch’s city image and its elements (specifically landmarks), but also the notion that the development of a cognitive map (mental representation) is equally as important as the actual image.

3.3.4 Legibility and Imageability

Lynch also relates the physical characteristics of the city to the structure of the mental image. Lynch found that the city image, or mental model is built through experience. The extent to which the city elements can be organized into a coherent pattern describes the extent to which the city is legible, and that a legible city is a prerequisite for a clear mental image. City form that has a high degree of imageability assists occupants to navigate and cognitively comprehend their surrounds and, by doing so, also heightens the potential depth and intensity of human experience. Lynch refers to this visual quality as the “legibility” of the cityscape (Lynch, 1960).

This speaks to the idea that the mental image is perhaps already a virtual environment. It is the mental image we all carry around with us and what we recall when navigating the real-world or virtual-world spaces. Therefore, what we can draw from the legibility, imageability and intelligibility of real and virtual spaces can be used to help develop a clearer mental image to assist wayfinding. Again, this raises the question of the virtual world's relation not only to a physical space, but also to the mental map. We will look at this further in the section on cognitive mapping.

3.3.5 Design Patterns and Methodologies

Christopher Alexander initiated an approach to architectural thinking in which he stated that the same set of laws determines both the structure of parts and of the whole (e.g. a single room, a building or an entire city). His universal approach to design takes advantage of scientific reasoning, and opposes other unscientific approaches based on fashion, ideology, or personal preferences. Alexander offered solutions to the problems of urban architecture and design, abstracting the process by which organic and inorganic forms evolve. The incremental growth implied by organic forms is similar to the processes we observe in the growth of a city.

In A Pattern Language (1977), Alexander describes the nature of creating towns and buildings. He proposes the use of a language of patterns as a way to address human needs such as view, comfort and privacy. An architect would approach design by choosing a pattern, and if necessary add related patterns to fit design criteria. According to Alexander, his design solutions result in balanced patterns of natural and built spaces that enhance the quality of life (Alexander, 1977).

In The Logic of Architecture, Mitchell suggests that a mathematical approach as design generator can be used not only to describe existing architecture but also to generate form (Mitchell, 1990). In practice however, the existing conditions of the built environment and programmatic requirements make it difficult to apply such a strict organization. But while this may be true for physical spaces, a rule base may be applicable to the information (virtual) spaces that we experience online.

Alexander's pattern language and Mitchell's logic of architecture offer a framework for thinking about architecture, but are most often not design solutions on their own. The needs and activities of the user are a consideration for both architecture and interface design and are less likely to be solved using standards. However, Alexander and Mitchell's patterns may offer an initial basis for the design both of physical and virtual spaces. Similar to architecture, there

may be patterns that can be used to create meaningful, interactive digital environments. They represent a kind of crossover between the worlds of architecture and information design.

Mitchell and Alexander's design frameworks do however, speak to the problems of modernist space and relate directly to Lynch's critiques. Their concepts of logic and patterns suggest a reuse of technology and scientific reason to counteract the placelessness of modern space. In modern space, placelessness was a product of the universal Cartesian grid that many modernists adopted as an underlying design principle. The Cartesian space broke down boundaries in urbanism such as city walls and the distinction between urban and rural, and similarly broke down boundaries in architecture such as the distinction between inside and outside.

But the grid is only one kind of pattern; other patterns may be more conducive to our understanding and perception of space. Alexander used pattern to connect the part to the whole using an organic, rather than abstract (i.e. Cartesian) structure. We can compare the Cartesian grid of the Modernists to the natural patterns described by Alexander. I introduce examples of both – universal grid and fractal pattern – in Figure 3.4 on the next page. While both are patterns, they suggest different things.

Figure 3.4 Cartesian Grid and Fractal Pattern

The Cartesian system is absolute, while the fractal pattern is more dynamic suggesting a process. The fractal pattern has paths and nodes, with two directions of movement implied at any node. This suggests a hierarchy in terms of movement and decision-making at each node. In the Cartesian grid, the implied nodes are all identical, and at any node there are three directions of movement (four, if one chooses to retrace one's steps). The lack of hierarchy and differences in this system is more likely to cause confusion.

The two patterns are also different in terms of the third dimension implied by them. In Cartesian space, the third dimension is simply an extension, or extrusion, of the two-dimensional pattern along the z-axis. Thus, the grid is the same in all directions including vertical dimension. By comparison, the fractal pattern suggests variations in height implied by the variations of each individual node.

3.3.6 Cognitive Mapping

All knowledge is a form of representation – an act of comparing perceptual experiences to prior perceptual experiences they have been conceptualized in our memories. Knowledge is a constant process of comparison and adjustment. The cognitive versions of experiences change with each successive encounter –

and each perceptual encounter changes depending on the level of cognition we bring to it.

Cognitive mapping, as discussed in earlier sections of this Chapter, is the human process of developing mental representations of an environment. Such mental maps comprise not only spatial relationships (e.g. as seen in geographical maps), but auditory, sensory and emotional data. The spatial component of a cognitive map does not have the consistency of a printed map; rather it is layered, multifaceted, and fragmented. Individual differences in cognitive maps exist due to varied knowledge and experience of the environment.

In comparison, a route or road map contains data about various features in the environment that occur in a particular sequence and aid a person navigating the environment through confirmation. This occurs when items from the cognitive map are matched against corresponding features in the immediate environment. Route information in such cases can be used to confirm assumptions. Much of the information required to connect the disparate elements of incomplete cognitive maps is acquired through actively engaging in wayfinding activities, and print-based maps help to correct anomalies and bridge remaining gaps in knowledge.

3.4 Summary

Knowledge always has two components: direct, immediate experience and memory and mental abstraction. As such, we always carry around with us “virtual” versions of physical places. Indeed, one of the successes of a physical place is its ability to be conceptualized or virtualized.

The writings of Lynch, Passini, Alexander and Mitchell refer to generalized concepts and principles of urban design. The context for wayfinding suggests that somehow, in attempting to deal with the vast scale and spaces facilitated by technology, architecture has lost its way. With respect to cities, they speak of the importance of the connection between one's experience of the city and the mental image one forms to abstract and simplify the city in order to better navigate it. Lynch specifically refers to visual form: paths, edges, nodes, landmarks and districts as elements that help to articulate their understanding of a city and what they remembered, based on their immediate and past experiences. Passini is more proactive in his approach to navigating and wayfinding by suggesting certain design decisions be made in advance of creating a built environment. In either case, the “design” aspect of urban design is only part of, and perhaps arguably less important to one's understanding of a real (physical) environment.

In this respect the writings of Lynch and Passini refer to the importance of developing cognitive maps. Elements of physical space, the visual form and environmental image generated from it, and the qualities of imageability, legibility and visibility all need to be clear and effective. This is not only necessary to successfully navigate and wayfind in a physical environment, but necessary in order to evoke a clear cognitive map, which, along with the original physical elements, make wayfinding and navigation possible in a real-world environment.

This is the first important connection in describing a potentially complimentary relationship between real worlds (cities) and virtual worlds (websites). What is more important than the direct relationship between the two is the relationship that each has to a shared cognitive map. This chapter has described the nature of the relationship between the real-world environment and the cognitive map. Chapter 4 will attempt to describe the nature of the relationship between the virtual world (website) and the cognitive map.

In the next chapter we will also look at the idea of “imageability” with respect to virtual worlds. We will look specifically at the relationship between the virtual version of a physical place and the cognitive map that one might form of that place as one interacts and becomes familiar with it.

CHAPTER 4: INFORMATION DESIGN

4.0 INFORMATION DESIGN

4.1 Introduction

We have looked at a number of architects who have attempted to address and redress the complexity of the physical environment. This section introduces a more recent, parallel body of work dealing with complexity in the realm of information. While traditionally this has meant graphic design, the last decade has seen the emergence of immersive, interactive information environments – such as websites. As information delivery systems become more elaborate, dynamic and interactive, they increasingly approach built environments – thus the overlap between urban design and information design.

This Chapter introduces concepts of information design in the virtual realm. Little has been written about the structure of web-based environments in the way that authors like Lynch and Passini have written about physical environments. To this end, I have looked to authors like Edward Tufte, Clement Mok, and Louis Rosenfeld & Peter Morville, who have developed concepts and principles about the design of information. Their discussions span from graphic design to dimensionally rich, interactive environments like the World Wide Web. The authors discuss strategies of disseminating information in two-dimensional environments, and identify aspects of virtual environments that facilitate

understanding of the information they seek to disseminate. Their writings also parallel the writings of Lynch and Passini to the extent that their ideas draw upon metaphors from real-world environments.

4.2 Information Design

Richard Saul Wurman coined the term “Information Architecture” in his book Information Architects (Wurman, 1996). His discussion focused on the presentation of information on a two-dimensional page (e.g. graphics and layout of single pages of content), rather than on the structure and organization of information at a larger scale (e.g. a collection of pages, hierarchical structures and navigation through an entire site), which has since become synonymous with information architecture. The term “architecture” as applied to information design suggests an explicit relationship between the organization of information and the principles, processes and practices that have always been a part of architecture.

In the discussion that follows, we will consider Tufte to be concerned primarily with information arts (or graphic design), as compared to Mok who perceives information as a system, and Rosenfeld and Morville who address the structure of larger, interactive collections of information – such as those we find on the web.

Clement Mok distinguished “information arts”, “information design” and “information architecture”. In Designing Business, he relates these three concepts as shown in Figure 4.1.

Figure 4.1 Information Architecture Hierarchy
(from *Designing Business* ©1996 by Clement Mok and Clement Mok Designs.
Adobe Press, Indianapolis, IN, p.99)

As an introduction to the other examples presented in this Chapter, I present the London Underground map by Henry Beck as a noteworthy example of the relationship between real world environments and the dimensional reduction, or abstraction, of the real world through information design.

The initial London Transit Authority's Underground map (ca. 1932) was designed showing a direct and contextual relationship between the railway system and the area it covered. Distances on the map were in proportion to the actual distances between cities and towns, and it was believed that this type of map would provide riders with the closest understanding of their traveling environment. The opposite was unfortunately true; the transit maps became increasingly difficult to read as the Underground system grew.

In 1932 Henry Beck developed a new format for the Underground map, extracting only what he considered essential for riders to know and understand. He applied a level of functional abstraction to the map that emphasized the Underground's connections instead of its surrounding geography, compressing the outlying portions of the routes and enlarging the central district because of its complexity and density of interchanges and stations (see Figure 4.3).

Figure 4.2 London Transit Map
<http://www.ukguide.org/london/londonmap.html>

Figure 4.3 London Underground Diagram
 (from *Designing Business* ©1996 by Clement Mok and Clement Mok Designs.
 Adobe Press, Indianapolis, IN, p117)

This concept of abstracting reality to make it legible is a powerful notion – it is the idea that something might represent our “perception of reality” more so or perhaps better than reality itself. Like cities, reality is often complex and, as a result, it can be difficult to distinguish between what might or might not be relevant. Only in abstraction does reality come into focus. Decreasing dimensionality is one way of distilling and abstracting information.

The example of London’s underground map is not a “dimensional reduction”. While we often think of things as moving to a higher level as they move from two to three dimensions, this is not always true. The concept of abstraction (e.g. reducing three-dimensional information down to two) is a method of distorting information to make it clearer in one’s own mind. In other words, two-dimensionality can be a posterior abstraction of the three-dimensional experience.

4.2.1 Information Graphics

Tufte looks at the problem of graphically presenting large amounts of information. “Good design is clear thinking made visible” (Tufte, 1998). As a graphic artist, his bias is towards diagrams and print media. He mediates between large and small scale – the problem of big, complex ideas and processes that need to be “envisioned” in order to be understood. He advocates a consistent approach to

the display of graphics that enhances its dissemination, accuracy, and ease of comprehension. Tufte also emphasizes that displays of information support thinking and analytic tasks. Therefore, his principles of design, like those of Lynch and Passini, are derived from and applied to cognitive principles.

His series of three books: The Visual Display of Quantitative Information, Envisioning Information, and Visual Explanations focus on the presentation of content for maximum transmission of information. Tufte summarizes design as having to overcome two problems in communicating information: dimensionality-displaying multivariate data on the two-dimensional surface of paper or the computer screen, and resolution-displaying large amounts of data in a limited space – a task more difficult on computer screens than on paper.

Tufte describes the examples presented in Envisioning Information as “pictures of nouns” (Tufte, 1997: 10). He presents numerous examples of complex information, displayed as “maps of data and evidence” (Tufte, 1990: 10). Tufte uses these examples to show how to increase information depth on paper (and as could be applied to the computer screen) through his principle notions of: micro/macro readings; layering and separation; small multiples; color & typography and narratives of space and time. Though the diagrams may communicate dynamic concepts, these design strategies relate primarily to two-dimensional, static information (e.g. information graphics).

Tufte's discussion of micro/macro readings is particularly noteworthy when applied to the question of scale in urban environment. "Content chunking" as Tufte describes, is the process of breaking down information into smaller, more understandable pieces so that these smaller pieces can lead to a clearer and perhaps better understanding of the whole (Tufte, 1990: 37). This is the same strategy that Lynch advocates, suggesting that an overall understanding of city form can be achieved in terms of understanding its basic elements (e.g. path, edge, node, district and landmark). In both instances, reconstituting the whole from articulate parts facilitates the building of a clearer mental image.

Tufte might be considered the Lynch of the information age. His principles for the design of information parallel Lynch's principles for "legibility". With respect to information density, however Tufte's ideas oppose. The issue of visual form versus information density are different to the real and virtual environments. A city, for example, by virtue of its physical scale affords a broader view of environmental information. According to Tufte, a physically smaller and more restricted view (i.e. one presented by printed page or the computer screen) must be counteracted by an increased depth of information within the virtual space. Combining the two viewpoints could suggest that there is an inverse relationship between information density and the physicality or dimensionality of space.

In his subsequent book, Visual Explanations, Tufte expands and translates his notion of “pictures of nouns” to “pictures of verbs” (Tufte, 1997: 10). Here he discusses the “representation of mechanism and motion, of process and dynamics, of causes and effects, of explanation and narrative” (Tufte, 1997: 10). His ideas regarding information shift to a higher level of content and design integrity, suggesting that when information is more dynamic in nature information design should reflect this characteristic.

Tufte’s descriptions of these two books using “noun” (in Envisioning Information) and “verb” (in Visual Explanations), recognizes information as being both dynamic and static. Noun is a concept or a thing; verb is a process. And as verbs connect nouns, they are, by definition paths. Lynch suggests that path or process has an image, more specifically, that the experience of moving along the path facilitates developing a clearer mental image. The dynamic nature of information, for example on the World Wide Web, suggests that interactivity with information might lead to a better understanding of it and a clearer image of the message conveyed by the information.

In Visual Explanations, Tufte demonstrates the dynamic nature of information by introducing the term “confections” – an event or “intersection of a noun and a verb, of subject and action” (Tufte, 1997: 121). According to Tufte, a confection brings together multiple visual events on the two-dimensional surface (or

computer screen), suggesting these events “present and enforce visual comparisons, combine the real and the imagined, and tell us yet another story” (Tufte, 1997: 121).

Tufte uses the example of a two-part museum directory – a search screen and a search results screen as shown in Figures 4.4 and 4.5. The first screen deals with the complexity of the museum collection by creating a directory, or context, for the information. Rather than displaying the 45 directory listings page-by-page, the items are all presented on one (flat) screen, stating his preference for an organization based on spatial rather than temporal (e.g. the sequence of encountering) relationships. He also notes that the 45 listings themselves take prominence over superfluous graphics, icons or logos, so the information becomes the interface. (Tufte, 1997: 146) Thus, this first screen is the noun (or subject) of his “confection”.

MUSEUM GUIDE		MUSEUM GUIDE		
INFORMATION	FACILITIES	PERMANENT WORKS	SPECIAL EXHIBITIONS, NOVEMBER 1999	
art information	cascade espresso bar	American Painting	Architectural Design of Humphry Repton	Henri Matisse: <i>Les perriers</i> , 1919
bookstore	checkroom	British Painting		
calendar	concourse buffet	Dutch Painting		
copyrights	elevators	European Sculpture and Decorative Arts, 14th–19th century		
film programs	facility for disabled	Flemish Painting		
gallery talks	first aid	French Painting and Sculpture	Henri Rousseau: French Winged Confections	Susan Rothenberg: Recent Paintings
guides	garden cafe	German Painting		
hours	lost and found	Information Design		
photography	restrooms	Italian Painting and Sculpture		
security	stairways	Netherlandish Painting	The Great Age of Tedious British Water-colors: 1710 to 1830	Information Designs of Charles Joseph Minard
slide lectures	telephones	Spanish Painting		
special programs	terrace cafe	Twentieth-century Painting and Sculpture		
Sunday concerts				
tours				
wheelchairs/strollers				

Figure 4.4 Museum Guide – Screen 1
(from *Visual Explanations* ©1997 by Edward Rolf Tufte. Graphics Press, Cheshire, CN, p.146)

Figure 4.5 Museum Guide – Screen 2
(from *Visual Explanations* ©1997 by Edward Rolf Tufte. Graphics Press, Cheshire, CN, p.147)

The second screen – the verb (or action) – displays the results of the user's directory request. The emphasis is again on content – map, written directions, and video image of the user in the museum (all non-interactive), although as Tufte puts it, "... resembles a three-dimensional gesture made by someone giving directions." (Tufte, 1997: 147)

Tufte is then introducing the connection between reality of information and the virtual representation of information in a two-dimensional environment. He summarizes his discussion of "confections" – a combination of noun and verb – as follows:

"Confectionary designs are a (similar) gift to understanding. Like perspective, confections give the mind an eye. Confections place selected, diverse images into the narrative context of a coherent argument. And, by virtue of the architecture of their arguments, confections make reading and seeing and thinking identical" (Tufte, 1997: 151)

4.2.2 Information Systems

Many of the discussions Clement Mok presents in Designing Business relate to information design. While he recognizes the complexity of current media design, he, like Tufte, emphasizes effective presentation of information in two-dimensions. His organization of thought and structure of information is however

three-dimensional, similar to the three-dimensional environments in which we live.

Mok believes that “design is about creating communication” (Mok, 1996). In Designing Business, he examines the media revolution and computing technologies that change the way we do things. His main focus is on creating identity in virtual worlds (e.g. websites) using media hybrids. Design combined with technology is a system, and the combination of the two is called “interactivity design” (Mok, 1996: 128).

This is where Mok speaks specifically to the issue of “look” and “feel” with regard to the design of information systems. Though we tend to use these two terms as a pair when we describe both real and virtual environments, he makes a distinction, “there is no one-to-one relationship between feel in traditional media and in digital media” (Mok, 1996: 86). “Look” has more to do with the physical aspects of an entity. We understand the look of a book by holding it, feeling the paper quality and leafing through the pages and illustrations. It is how these physical parts of the book come together that conveys the sense of “feel”. Mok notes that because of the physicality of print media, a product such as a magazine is usually given a “look” first before the issue of “feel” is addressed.

But in virtual environments, “feel” becomes a more important factor. We can interact with books and magazines using our hands, but their virtual (on-line) counterparts must be engaged differently. Mok notes that in the transformation of real-world entities (e.g. books and magazines) to digital versions, much of the content is directly (and quickly) converted to digital format without consideration for the “feel” of the digital information and how it comes together. “Digital media isn’t just another way to say things that are in print” (Mok, 1996: 14).

To this end, Mok addresses the issue of “being explicit”. According to Mok, the lack of a direct translation between real world entities and their virtual counterparts suggests that the graphical interpretation of ideas is an important design consideration. Indeed, abstraction as part of the process of translation becomes an important notion.

Mok also refers to organizational models and solutions for the structure and presentation of graphical ideas in terms of patterns (e.g. linear, hierarchical, web, parallel, matrix, overlay and spatial zoom), and how these patterns can be used to decipher the form and function of data. These parallel Alexander and Mitchell's design patterns and methodologies in *Architecture and Urban Design*. As mentioned in Chapter 3, Alexander and Mitchell's approaches are perhaps more conducive to the design of information environments – the design criteria for a website could follow a pattern, with related patterns added as required and

as the design evolved. Like good architecture, the success of this design methodology would also have to be measured against the human response to the design.

Along with organization principles, Mok speaks to the media technologies (e.g. text, audio, music, images and motion pictures) noting that a truly integrated real world/virtual world system is based on a combination of one or more of the organizational models and one or more media types. This suggests that interactivity, characteristic of web-based environments, is an added (third, or fourth when including time) dimension to the two-dimensional computer screen, and that this interactivity is key to the imageability of information.

Mok also sets out a hierarchy in terms of how information is processed, which he calls "Information Processing", or how one navigates through information and builds knowledge from this activity. This is a "virtual" version of Passini's principles of wayfinding or "spatial decision-making", as shown in Table 4.1. Regardless of the process or the environment (real or virtual), the success of the spatial decision-making or information processing is measured by one being able to derive a clear mental image as a result of the activity.

"Information Processing" (Mok, 1996)	"Spatial Decision-Making" (Passini, 1984)
Decision-making and development of a plan of action to reach a destination	Establishment of a navigation goal
Perception and cognition (information processing), proving the necessary information to make and execute decisions	Acquisition of environmental information (local features) combined with previous knowledge
Decision-executing, transforming the plan into behavior at the appropriate place along the route	Making the proper navigational move

Table 4.1 Information Processing as Spatial Decision-Making

The example on the next page demonstrates the level of effort that must be put into an information system. It involves organizational principles, graphic and interface design, "look" and "feel", use of media hybrids, connecting with database information – all combined to create information as an interactive system. The complexity of the diagram emphasizes the complexity of constructing of a virtual environment, how the complex decision-making processes we experience in our physical environments are reflected in this model, and how the model, through the virtual interface, filters out (or abstracts) irrelevant information required to enhance our decision-making and understanding.

Figure 4.6 Pharmaceutical CD-ROM Profiling Diagram
 (from *Designing Business* ©1996 by Clement Mok and Clement Mok Designs.
 Adobe Press, Indianapolis, IN, p.89)

4.2.3 Information Architecture

In Information Architecture for the World Wide Web, Louis Rosenfeld and Peter Morville argue that shape and organization are necessary to counteract the modern condition of information overload, specifically as it relates to the design of websites (Rosenfeld & Morville, 1998). They characterize information overload on the World Wide Web as one's difficulty in finding information, the poor graphic design and layout, gratuitous use of technologies, communicating tone and language, designer-centeredness, lack of functionality and lack of attention to detail. Indeed, these problems parallel our experiences in the real world.

Similar to Mok, Rosenfeld & Morville define information architecture as a process, identifying three major phases of site development (note that "site" is not limited simply to the web) related our decision-making processes: gathering and synthesising information, conceptualizing and defining, and finally building, testing, and launching. This is achieved by utilizing organization systems that group content, labeling systems that describe the content groups, navigation systems that assists users in moving around and browsing through content, and searching systems as tools to help users formulate queries that can be matched with the relevant content. They also argue that information architecture, if successful, is transparent to the user.

According to Rosenfeld and Morville, an important underlying element to a successful website is its organizing system, consisting of an organizational scheme which defines content and the grouping of content, and an organizational structure which defines the relationships between content items and groups (Rosenfeld & Morville, 1998). They note that overall, content organization is closely tied navigation, labelling and indexing.

With respect to organization schemes, Rosenfeld and Morville introduce two categories – exact (e.g. alphanumeric, chronological and geographical) and ambiguous (e.g. topical, task-oriented, metaphor-driven). Examples of the ambiguous schemes group include the telephone yellow pages (topical), word processing software (task-oriented) and the Windows operating system “desktop” (metaphor-driven).

We can compare alphanumeric organization to the universal grid structure introduced in Chapter 3, and the concept of navigation based on this organizational scheme. Both the alphanumeric system and the grid are arbitrary in nature. While everything can be positioned in space according to these systems, the universal grid is self-same, and in a similar fashion any subdivision of an alphanumeric structure only yields the same structure again and one ultimately becomes lost in this system. As structure, both the alphanumeric and grid systems offer a solution to ordering space (e.g. subdividing information), but

do little to establish place. Ambiguous ordering systems (despite the connotation of lack of clarity) on the other hand, more closely resemble searching on the web, and, like the fractal pattern, are more like paths that we follow both in terms of decision-making and navigating in real and virtual environments.

Organizing structures reflect Rosenfeld & Morville's approach to the way in which information architecture is designed. This is based on the method or approach of designing information. The first, "top down" architecture, creates a basic top-level structure and navigation for large bodies of content, such as entire sites. Top-down architecture is concerned with determining effective questions to ask when designing a site. The second, bottom-up architecture, determines how content is organized at a much finer level (e.g. individual documents or pages). Bottom-up architecture deals with the specifics of how to organize the answers to top-down questions. As Rosenfeld & Morville note, all systems of information architecture combine both top-down and bottom-up design to some degree. This is also reflected in Mok's diagram in Figure 4.1.

Rosenfeld & Morville summarize that large-scale web sites should use three types of information organization: hierarchical, database, and hypertext. An example of this type of organization is shown in Figure 4.7. Compared to Passini's "Wayfinding Decision Plans" diagram (Figure 3.3), Rosenfeld & Morville's architecture blueprint can be considered a more accurate diagram of

how one navigates a website, indicating multi-directional movement and multiple ways to reach the same destination. The purpose of this mapping is to overcome the disjointed journeys and complexity that typically characterize navigation on the web.

Figure 4.7

High-Level Architecture Blueprint

(from *Information Architecture for the World Wide Web* ©1998 by O'Reilly & Associates. O'Reilly & Associates, Sebastopol, CA, p.155)

4.3 Summary

The complexity of our physical and information spaces and the technological systems that support both suggest that we seek a broadly-based set of theoretical concepts that can be applied to the design of real-world and virtual-world environments. What we experience in terms of difficulties with the complexity of wayfinding in real environments is paralleled by the complexity we encounter when navigating information environments.

The writings of Tufte, Mok and Rosenfeld & Morville refer to generalized concepts and principles of information design. Though biased toward two-dimensional media (e.g. print), Tufte presents strategies for increasing information depth on paper through layering and density, and displaying large amounts of information in a limited space. His notions of abstraction could be applied equally to an interactive three-dimensional model to a map or diagram. Mok sees information more dynamically than Tufte, and, with respect to websites, notes that a truly integrated real-world virtual-world system is a combination of one or more organizational models and one or more media types. Finally, Rosenfeld & Morville describe information as a system (similar to Mok), and propose a process for developing websites that facilitates the organization, navigation and comprehension of their content.

Elements and organizing principles in information design, the visual form of information, and the added dimensionality of interactivity are necessary elements for visibility and legibility in information environments. Indeed, many of the design concepts and solutions proposed by Tufte, Mok and Rosenfeld & Morville closely parallel the design concepts and solutions of Alexander, Lynch and Passini.

From the information design authors of this chapter, we gain a better understanding of two fundamental principles: the first is the notion of abstraction – what to include and what to leave out – and the second deals with structuring systems – the order to put things in.

As stated earlier, the concept of abstracting reality to make it more understandable and legible is a powerful notion – it is the idea that something might represent our “perception of reality” instead of aspiring to represent reality itself. Like cities, reality is complex and as a result it is often difficult to distinguish between what might be relevant or irrelevant to us. Only in abstraction does reality come into focus. Decreasing dimensionality is one form of distilling information in order to evoke a clear mental image (e.g. cognitive map) of the environment.

The concept of structural systems describes the way in which we are presented with information and the way we navigate through it. As summarized in the previous chapter, the ability to find one's path clearly through information supports the establishment of a clear mental image.

This is the second connection in describing the complimentary relationship between real worlds (cities) and virtual worlds (websites). The previous chapter has illustrated the importance of developing a clear cognitive map to enhance one's understanding of a physical environment. This chapter has described a similar relationship between information design and a clear cognitive map supported from the design of that information.

Chapter 5 examines precedent and the issues of navigating immersive three-dimensional virtual environments where the principles of wayfinding in real environments may also apply. The examples could also support the notion of the cognitive map as a key link between the experience of an environment and one's remembrance of it.

CHAPTER 5: ANALYSIS OF PRECEDENT

5.0 ANALYSIS OF PRECEDENT

5.1 Introduction

This Chapter looks at wayfinding in virtual domains, surveying the work of researchers and designers of virtual environments: Darken & Sibert, Satalich, Strong & Woodbury, and Strohecker, who have studied wayfinding issues as they relate to immersive three-dimensional environments such as one might find on the web or in computer games (e.g. Class 6 sites). These examples make reference to the writings of Lynch and Passini, applying principles of wayfinding and imageability based on real-world principles to their designs for virtual environments.

5.2 Virtual World Precedents

5.2.1 Wayfinding Strategies and Design Principles

Darken and Sibert conducted a study entitled “Wayfinding Strategies and Behaviors in Large Virtual Worlds” (Darken and Sibert, 1995) to demonstrate that much of what we know about wayfinding in the physical environment can be applied to the design of navigational aids in screen-based virtual environments.

They found that wayfinding strategies and behaviours were strongly influenced by the environmental cues (Darken and Sibert, 1995).

Their study sought wayfinding augmentations to virtual worlds that would enable users to navigate as if they had expert knowledge of that world. The underlying principle was that, through wayfinding, users would be able to conceptualize the virtual environment as a whole. Their experiment measured the performance of a searching task in a virtual environment, with different users being offered differing environmental cues. The cues were based on the concepts of spatial knowledge and the environmental design principles of Lynch and Passini. With respect to Lynch, they recognized his concept of dividing large-scale environments into smaller pieces using paths and landmarks, and that these pieces could be used to establish a hierarchy of knowledge. They added to this Passini's principle of adding an organizing principle (e.g. square or radial grid) to structure the environment, and making this structure evident to the navigator.

The users' wayfinding performance was tested under four conditions: in the first case, users were given no information about the environment they were asked to explore; in the second and third cases, users' explorations and views of the virtual environment were supplemented with an organizing grid and map (respectively); and in the final case users' explorations were supplemented with both the grid and map. A screen capture of this final case is shown in Figure 5.1.

Figure 5.1 Virtual World Interface - "The Map/Grid Treatment"
(from "Wayfinding Strategies and Behaviors in Large Virtual Worlds", Darken,
Rudolph and Sibert, John: 1996)
http://www.acm.org/sigchi/chi96/proceedings/papers/Darken/Rpd_txt.htm

The general results showed, not surprisingly, that users' wayfinding strategies and behaviours were strongly influenced by environmental cues. Darken and Sibert concluded that wayfinding methods were profoundly affected by the stimuli presented and that, as predicted, the coupling of a map with the grid was the most effective.

The authors made some interesting observations with respect to search effectiveness and the use of a grid. In the cases where users were offered a grid (either square or radial), they used the grid as a path – a way to traverse the virtual environment and learn from their travels. Notably, the square grid was found to be less effective than the radial grid. Using the square grid, users traversed the virtual environment in a “lawnmower-like” fashion, treating all space equally in their exploration, while noting the exceptions or landmarks along the way. Users who used the radial grid (e.g. radial lines and range rings), on the other hand recognized the hierarchical nature of the space they were exploring, and the landmarks were related not only to the path but also to the district. Darken and Sibert noted the users who used the radial grid had a greater directional accuracy, and were more comfortable with their navigating. The radial grid increased users performance and the ability to extract spatial information and survey knowledge.

Their study results showed that organizing principles provide the structure by which a user can mentally organize an environment into a spatial hierarchy that supports wayfinding tasks (Darken & Sibert, 1995). They described the following design principles as helpful in wayfinding:

- **divide the large world into distinct small parts, hierarchical in nature which preserves a sense of place**
- **organize the small parts under a simple organizational principle, such as a grid**
- **provide frequent directional cues in the form of directional landmarks**

Drawn from their work, they also concluded the following. Firstly, that when not given adequate directional cues, disorientation will inhibit both wayfinding performance and spatial knowledge acquisition. This was related to their observations that a large world with no explicit structure is difficult, if not impossible to search. As a result, a coordinate system or grid superimposed on the virtual world acts to divide the world into smaller, more understandable pieces. Further to the use of grids, they noted that path-following is a natural spatial behavior.

This superimposition addresses the difference between space and place and what happens to each when they are subdivided. Space is boundless – when an

organizing structure like a grid is subdivided, the subdivisions reflect the same boundlessness (a term called “self-same”). Subsets of place, on the other hand, reveal more of the characteristics that differentiate it from the place or space as a whole.

Darken and Sibert’s observations relate navigation of the virtual environment to the structure of virtual space based on urban planning or real world principles. A user’s ability to categorize space, which in turn reflects on searching strategies and behaviour, supports Lynch’s principles of urban design and the importance of developing a cognitive map. They remark:

“The importance of paths as described by Lynch indicates that in virtual and physical spaces alike, navigators need structured movement for effective navigation and spatial knowledge acquisition.” (Darken & Sibert, 1995).

They also observed that organization structure and restriction of movement are an essential part of navigation. They advocated that large virtual worlds be augmented with directional clues and a simple, well-defined structure that facilitates the construction of one’s own paths.

5.2.2 Navigation Behavior in Real and Virtual Worlds

In her paper “Navigation and Wayfinding in Virtual Reality – Finding Proper Tools and Clues to Enhance Navigation Awareness” (1995) Glenna Satalich postulated that the experience of a virtual environment would lead to similar behaviors a person would have in the real environment under similar circumstances.

Satalich examined the literature of human behavior in navigation and wayfinding in the real world and compared it with behaviors exhibited in virtual reality. Her research hypothesized that if the behaviors match, navigational tools that aid navigation awareness in real environments could be applied to virtual environments. To study this, she created a VR prototype and using a head-mounted display and had a group of users navigate a prescribed perspectival virtual environment (in this case a building interior) on three occasions. In the first instance, users were allowed to explore the environment freely, primarily to get familiarized with the display apparatus. In the second instance, she asked users to follow a path drawn on the floor of the virtual environment that directed them from one room to another in the building. A simultaneous view of a map of that environment (e.g. floor plan) supplemented this drawn path as shown in Figure 5.2. In the final instance, users were to navigate the same path from memory, without clues afforded by either the path or the map.

Figure 5.2 Virtual World Interface - "Guided Tour & Map During"
(from "Navigation and Wayfinding in Virtual Reality – Finding Proper Tools and Clues to Enhance Navigation Awareness", Satalich, Glenna: 1995)
<http://www.hitl.washington.edu/publications/satalich/ch3.html>

To her experiment, she introduced a second set of users as a control group, who were given a map of the same virtual environment but no pre-familiarity with or direct experience of the VR technology. Both groups were then asked to perform navigational tasks in the virtual environment.

Satalich's study provided surprising and counter-intuitive results. The control group with no pre-familiarity of the VR environment performed equivalently or better than users who were afforded the prior experience. This reinforces the effectiveness of a map in helping users create a cognitive map – i.e. that experience with an abstraction of the environment may be more effective than prior experience of the environment itself. As evidenced, the first set of users had direct experience of the VR environment, but couldn't translate that experience successfully into a cognitive map.

The observations of this experiment support my contention that sometimes abstraction is better than reality. The physical environment can benefit from an abstracted counterpart to help better understand the real. This experiment also points out that virtual versions of a given physical environment should not necessarily be immersive 3D models of that environment. Three-dimensional environments do not produce good cognitive maps – one is as confusing as the other. Where wayfinding is concerned, a virtual counterpart should abstract and clarify rather than trying to replicate reality.

Satalich's summary relates to two other aspects of navigational testing: the tool itself (e.g. VR prototype) and the information provided by the tool. To the former, she noted that virtual environment training was compromised by the intrusiveness of the VR interface. She states, "Any tool that attracts attention to itself may interfere with the learning that it is supposed to facilitate." Satalich's important conclusion to this is there are differences between virtual and real environments that affect performance in simple navigation and wayfinding tasks. These differences include the quality of the virtual interface and improving the virtual technologies to train real world tasks.

Satalich related her findings back to Thorndyke & Goldin's concepts for navigational awareness, noting that achieving complete navigational knowledge in a new environment, a person has to go through a constructive dynamic process (Satalich, 1995). Her research suggests that survey knowledge may be inhibited by encumbrances in obtaining landmark or procedural knowledge. In her case, the interface (e.g. headset) proved to be such an encumbrance.

Satalich proposes that one's ability to find one's way through a particular environment in an expedient manner, and to recognize the destination when reached, requires the following four steps:

- **orientation - determining where one is in respect to nearby objects and the target location**
- **route decision - choosing a route that will get one to their destination**
- **route monitoring - monitoring the route one has taken to confirm that one is on the correct route and is going in the right direction**
- **destination recognition - recognizing that one has reached the correct destination**

Satalich's research also speaks to the issue of content vs. technology. In an effort to produce more computationally-powerful computer-based tools, we may be interfering with the information delivered by these tools. If this is the case, a real world/virtual world continuity would suggest that the technology be transparent to the information it delivers, and that the virtual version not attempt to too closely replicate the environment it is designed to compliment.

5.2.3 Cognitive Map Generation

In their paper "Psyberdesign: Designing the Cognitive Spaces of Virtual Environments" Strong and Woodbury state that the cognitive maps people generate are important when considering complex virtual environments such as the World Wide Web (Strong & Woodbury, 1998). They defined a cognitive map as a record of the process of wayfinding, "which is an active and continuous process involving the integration of information from stimuli in the immediate environment with existing cognitive representations" (Strong & Woodbury, 1998).

Strong and Woodbury also spoke about the use of metaphor in the design of virtual environments. To that end, they design a wayfinding prototype called "WOMBAT" which navigates a virtual environment in the same way that its marsupial namesake follows paths in the Australian outback. The bush setting was chosen because of the degree of confusion and difficulty associated with the natural setting and the lack of a predefined order such as a grid which one might find in a man-made environment. The WOMBAT makes wayfinding information available to users by simulating movement down a path in the actual bush landscape through user-controlled video clips and interactive panoramas at nodes in the path. The interface is simply designed, indicating to the users which directional movement is possible and then displaying the appropriate media. An example of their interface is shown in Figure 5.3.

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Figure 5.3 The WOMBAT Interface
(from "Psyberdesign: Designing the Cognitive Spaces of Virtual Environments" in
Acadia '98 Conference Proceedings. Albuquerque, NM: The Association for
Computer-Aided Design in Architecture, 1998, p. 285)

The experiment was not designed to directly test Lynch and Passini's theory of wayfinding as it applied to virtual environments, but to use wayfinding theory to test cognitive map generation and wayfinding behaviour in a virtual environment. They attempted to understand how concepts of navigating in real environments translate to the virtual environment in terms of navigation, cognitive mapping and wayfinding devices.

Strong & Woodbury stated that their findings strengthened their conviction that cognitive mapping and wayfinding theory is applicable to the design of virtual environments at an abstract, not just visual level.

"Browsing the Web is becoming more disjointed. This is having an adverse impact on cognitive map generation, and consequently our appreciation of the Web, because transition and a sense of travel are especially important for the development of useful and coherent cognitive maps" (Strong & Woodbury, 1998: 288).

5.2.4 Participatory Design of Cognitive Maps

In "Toward A Developmental Image of the City: Design Through Visual, Spatial and Mathematical Reasoning" (1999), Strohecker examines Lynch's values of participatory design and how people think about the spaces they inhabit.

Strohecker presents the virtual world as a pre-existing condition, (i.e. as a world unto itself), where the virtual world is neither nor refers to any particular physical environment. To that end, each of her subjects constructed a virtual version of a real world environment they had each individually experienced. She asked subjects to find a pre-determined route through this virtual environment. Her focus was on people's construction of their own knowledge as a parallel to constructing their own maps in the physical world. Her experiment recalls the example of the subway map, where the relative placement of elements in virtual environments is more important than their actual position or proportions.

To study this condition, Strohecker developed a tool entitled "WayMaker" to permit users to position abstractions of Lynch's elements (e.g. paths, nodes, edges, districts and landmarks) in a computer screen environment to form diagrams of spaces of their cognitive maps. Each subject recalled his or her own personal place for the experiment. To this extent, the cities or places are irrelevant relative to the person's image or remembrance of it. The WayMaker

tool then transforms the user-constructed map to a series of ground level, two-dimensional scenes while at the same time displaying the original map that they were created from. As one navigates the virtual environment, WayMaker displays representation of Lynch's elements (e.g. nodes, edges and landmarks) according to their positions on the map. An example of this display is shown in Figure 5.4.

The WayMaker tool has a number of features. First, users were able to reposition and rescale elements as their perceptions of the space changed. Users were also able to save different versions of a map, recording change to their cognitive map as a result of repeated interaction with the virtual environment. Users were also able to go back and forth between a map and perspectival views to make adjustments, capturing their perceptions in greater depth and their understanding of spatial relationships. Finally, the WayMaker tool set maps into motion by illustrating views along the paths created in the virtual environment.

Figure 5.4 A WayMaker Composition Screen
 (from *"Toward A Developmental Image of the City: Design Through Visual, Spatial and Mathematical Reasoning"*, Strohecker, Carol: 1999)
<http://www.arch.usyd.edu.au/kcdc/books/VR99/Stroh.html>

Strohecker points to some important alternative thinking about wayfinding. Firstly, she notes that “WayMaker” is premised on an explicit version of Lynch’s assumption that wayfinding translates to a set of creative actions (Lynch, 1960), so people make their way literally as well as figuratively through the designed environment. Secondly, she notes that by creating their own maps, users reflect on memories of places they have been and on the design of places they might like to see, which is conducive to thinking and learning about spaces and spatial relationships. Thirdly she notes that the imaging process is enhanced with simultaneous displays of the aerial-view map and associated ground-level scenes. The ability to go back and forth between mapmaking and viewing modes helps generate a more refined image that reflects the “dynamic nature of perception” (Strohecker, 1999).

Strohecker’s important conclusion was that people who use tools such as WayMaker become engaged in their own processes of designing and of realizing their designs. To the extent that WayMaker is meant to be a version of a physical environment, WayMaker allows users to visually construct a mental map. Thus the virtual world becomes an externalization of the cognitive map and positions itself between actual experience and reflection on this experience. It’s an image model of the experience of a place.

Of all the four virtual environment precedents cited in this Chapter, this example comes closest to what I hope to achieve with the Virtual Tour prototype. The other three precedents of this Chapter sought to re-create or replicate a real environment in an immersive three-dimensional virtual environment. Their results have shown that this approach can be problematic – problems of understanding the real environment are simply transferred to the virtual environment and in the end both are confusing. As a (successful) counterpart to a physical environment, the virtual environment should abstract and clarify (using the power of the medium and technology) rather than replicate. By extension, the virtual environment becomes, like Strohecker's work, a tool for cognitive map-making.

5.3 Summary

The research examples cited in this chapter look specifically at how people navigate immersive three-dimensional environments. They all also speak to the importance of developing a clear cognitive map.

The issues, observations and conclusions of the researchers cited point to general design principles for making immersive virtual environments more effectively navigable. Navigability means one can successfully move in the information space from one location to another, even if the location of the destination is not known. Three criteria determine the navigability of a space: 1) whether the navigator can successfully locate and orient him/herself in an environment; 2) the ability to successfully perform wayfinding tasks, based on making correct navigation decisions that takes the navigator from a given location to a destination. This is what Arthur and Passini called “wayfinding spatial problem solving” (Arthur and Passini, 1992) in which the navigator finds a satisfactory solution to a larger task through navigation; and 3) how well the navigator can accumulate wayfinding experience in the space. This refers to Lynch’s notion of imageability and the ability of a navigator to form a coherent mental image or map of a space.

While presented for their advancement of wayfinding theory in virtual environments, the precedents cited in this Chapter differ from my proposed prototype in a number of areas. For example, the first two precedents do not relate a virtual environment directly to a given physical environment, so the comparison of real to virtual version is not made. Secondly, the same two precedents present the virtual world as an immersive three-dimensional environment. In the case of my prototype, it is not obvious that a virtual version of a physical place should be a three-dimensional environment. Thirdly, there is a difference between the virtual world as a representation of the physical world, and the virtual world as an abstraction of it (just as a cognitive map is a mental abstraction), and it is the latter that I wish to examine further.

While it may be an unusual experiment on its own, Strohecker's WayMaker suggests an interesting, if not subtle, principle. The will and ability for one to customize and change the virtual world to better correspond with their changing understanding of its physical counterpart is actually quite profound. It recognizes the dynamic nature of the cognitive map, and uses technology to respond and record the changes. This is also an instance where technology, at least on an abstract level, can help consolidate and coordinate the parts of the physical world it has disaggregated. As an interactive cognitive map, the virtual world becomes a personalized notebook about the physical world.

What has been observed from all the precedents in this chapter is that the success of developing a clear cognitive map is based on choosing an appropriate virtual model (and technology) – one that abstracts and clarifies the real environment rather than trying to replicate it.

In the next chapter I will expand on the issues and observations of these precedents looking specifically at a paired relationship between an actual and virtual environment.

CHAPTER 6: CASE STUDY: VIRTUAL TOUR PROTOTYPE

6.0 CASE STUDY: VIRTUAL TOUR PROTOTYPE

6.1 Introduction

Modern cities seldom benefit from the pedestrian-scaled localized elements (e.g. paths and landmarks) that characterized medieval cities. Imageability, as described by Lynch and Passini, may not be applicable. Their notions dealt with the relationship between the part (e.g. edges, districts and nodes) and the whole (e.g. overall city form and legibility). In the modern city, the inverse is more likely: the whole as an extension of the parts and the parts as a self-same subdivision of the whole. By this I mean that the city has been fragmented by communication and transportation technologies which, in turn, reconnect pieces in non-traditional ways and at scales that transcend architectural definition.

Campuses, however, still exist in a scale compatible with Lynch's pedestrian-based principles. In this Chapter, I look at the Carleton University Campus and the design of a virtual counterpart, the "Carleton University Virtual Tour" where a one-to-one correspondence exists between the real and virtual. This intensive correspondence between is especially interesting to me as an architect. It seemed an appropriate place to question the relationship between organizational principles and wayfinding in the real and virtual realms – especially as the function of the virtual tour is to help people better navigate the real campus.

As mentioned earlier, the Carleton Campus is particularly difficult to navigate, suggesting that an understanding of the problems that characterize it might lead to a discussion of how a virtual tour might help improve things. I also look at existing virtual tours of the Carleton University campus, and how they have attempted to portray the campus in a web-based environment. The concepts and discussions of previous chapters are then applied to the development of a prototype for a new virtual tour for Carleton. The prototype is itself a form of research, and, with respect to this thesis, particularly important in describing the relationship between virtual experience and the physical place (campus) it describes.

6.2 Carleton University Campus

Like most campuses, academic or corporate, the Carleton University Campus can be compared to a small city. It is relatively self-contained, geographically defined by the Rideau River and Rideau Canal which form two of its boundaries. But while the campus exhibits many of the elements that characterize a small city (e.g. Lynch's nodes, paths, edges, districts and landmarks), it possesses none of clarity and imageability that Lynch ascribes to good city form. The campus exhibits the problems of large-scale urban planning principles brought down to a local level.

Figure 6.1 Map of the Carleton University Campus
 (from the Carleton University website, accessed June 14, 2001
<http://www.carleton.ca/cu/campus>)

The Carleton University campus is organized into three districts – academic, residential and administration/athletic – each with its own underlying grid and orientation. Unfortunately, these grids do not resolve themselves successfully as they come together. This is the source of a variety of other problems.

Firstly, there are a number of paths through and about the campus that are implied by the district's grids and orientation. More often than not, these paths are discontinuous, terminating abruptly when they reach another district. The most notable example is the path from the Residence Quad to the Academic District which terminates suddenly at the Minto Centre (Engineering Building), rather than leading or directing students either up the hill towards the academic quad or east towards the athletic complex. In fact, it strands pedestrians in the middle of a road with no visual clues on how to proceed. Similar discontinuous paths can be observed at many other locations on campus. Without one path connecting to another, general movement about the campus is fragmented.

The absence of path structure also affects the relationship of key nodes on campus. There are no direct paths, for example, leading to the University (Academic) Quad, so the role of the quad as a node becomes less effective. There are no clear paths between sub nodes (e.g. the Residence Quad, the Science Quad, and Alumni Park).

There are notable elements on the campus. One - a railway line - bisects the campus. The visibility of the line as an orienting element and/or boundary is diminished by the landscaping that often conceals it; on the occasions where we encounter it, we usually pass underneath it. The other element, and perhaps more notable, is the underground tunnel system. Originally designed as a service infrastructure for the buildings on campus, the tunnels have been transformed into a path system for students to traverse the campus. The difficulty with the tunnels is that they have little or no relationship to the layout of the campus at grade. For example, the tunnel entrance to Dunton Tower is often missed when traveling the tunnel system, largely due to the fact that the tunnel passes tangentially to the tower rather than approaching it directly as one would expect with a tower. The problem is exacerbated by the fact that the tunnel is actually at grade at this location, one has no visual clues that the tower is immediately beside them. Like the paths at grade, the tunnel system evokes an extremely indistinct map which, to make matters worse, is incongruent with the paths and buildings above it.

Another key element at Carleton University is Dunton Tower, a landmark of the campus. While it is arguably the one clear element that students use to orient themselves as they move between buildings, its location suggests more prominence than it actually has. As the highest, most visible element on campus, and situated as it is on the main quad, one is surprised to discover that

it is a generic classroom building. The university administration is housed in a non-descript building at the far edge of the campus – disconnected from the path system and difficult to find. The physical hierarchies, such as they are, do not relate to or reinforce the academic and administrative hierarchies of the institution.

Although Carleton is a good example of a small city and has many positive physical attributes, the pieces (e.g. Lynch's elements) don't add up to the imageability and legibility Lynch advocates. This, in turn, makes it difficult for one to form a clear cognitive map of the campus. Furthermore the path system used to navigate the campus on-grade, and the tunnel system below grade evoke two different map images that compete with each other.

In Figure 6.2, I summarize these urban design problems of the Carleton University campus graphically, drawing by example from Lynch's diagrams in The Image of the City.

Figure 6.2 The Visual Form of Carleton University as Seen in the Field

If a virtual version of Carleton University (e.g. web-based Virtual Tour) is to help individuals to better understand the structure of the campus and the disposition of parts in relation to each other, it must help establish the feedback loop where the virtual environment informs the real environment, to the benefit of both. In the short term, the virtual environment should help compensate for the shortcomings of the real environment; in the long term the cognitive mapping that the virtual environment facilitates may improve the whole – by making it clear where paths and points of intervention are needed.

6.3 Early Carleton University Virtual Tours

To begin this discussion, I introduce two existing web-based tours of the campus. The first, commissioned by Undergraduate Admissions, offers a generalized view of the University, consisting of 14 panoramic photographs of various locations on campus. While the panoramas are titled, they are neither described in terms of their locations on campus, nor related back to a map to show their physical relationship to each other. The absence of detailed and contextual information (e.g. specifics about buildings or the routes between) prevents the user from understanding the whole in relation to its parts. As a result, this tour cannot contribute to the development of a clear cognitive map. A screen capture of this panoramic tour is shown in Figure 6.3.

Figure 6.3 Carleton University Undergraduate Admissions Virtual Tour
 (from the Carleton University website, accessed June 14, 2001
<http://www.admissions.carleton.ca/Tours/vtour>)

In contrast to the first tour, the second, developed for the Paul Menton Centre, is a highly detailed informational wayfinding tool. The tour combines an electronic database of digital images with related physical descriptions (e.g. accessible parking, tunnel access, elevators, washrooms, study areas, lounges and cafeterias) in an informational website for persons with disabilities on Carleton University's campus. The information is geared towards a different navigator – those who need specific information about how to travel from one location on campus to another. Route information is conveyed to the user by means of a step-by-step series of still images, and a corresponding plan of each route. Where the panoramic tour suffers from a lack of detailed information, this tour suffers from an overabundance. None of the detail is related to an overall plan or view of the campus, so like the first tour, it does not permit the user to develop a clear cognitive map. A screen capture of this second example is shown in Figure 6.4.

Figure 6.4 **Menton Centre Virtual Tour Prototype: Search Results Screen**
(from the Matrix Developments website, accessed February 15, 2000)
<http://www.matrix.ca/vtour>

In summary, the tours are positioned at opposite ends of the spectrum in terms of the information they convey, each with its own set of problems. Different kinds of information are being delivered to different target audiences – one an over-generalized view, and the other a detail-specific view – but the lack of context in both prevents either from imparting a holistic view of the campus.

As part of my research into virtual tours, I also compared the tours of Carleton University to virtual tours of other university campuses: Harvard University, MIT, the University of Washington, and the University of Waterloo. I selected these examples to show the broad range of tours available on the web.

Harvard University, MIT and the University of Waterloo organize their virtual tours as multiple simultaneous views of their campuses as a way of communicating wayfinding information. Specifically, they offer overall campus maps, detailed maps of a particular location, corresponding interactive images of those particular locations (referenced back to the maps), and textual information that offers a general description of the location and its relation to the campus as a whole. The tours exhibit an absence both of Tufte's principles for information design and Mok's principles for the design of information systems, where the multi-modal elements do not support each other in conveying the information they seek to deliver. The final example, the University of Washington tour, also parallels the Menton Centre Virtual Tour with respect to providing detailed wayfinding

information to persons with disabilities, and similarly neglects to relate this detail to the context of the university campus as a whole. A comparative summary, including detailed descriptions and screen captures of each of these university virtual tours can be found in Appendix A.

Using the examples of a point of departure, I revisited the notion of the Virtual Tour with respect to its potential and understanding and appreciation of the university campus. I use the term “re-present” here to mean that the virtual tour doesn’t simply recreate reality in another form, but uses the power of the technology and medium (e.g. the World Wide Web) to weave the whole into imageable elements, using the principles of Tufte and Mok to convey these elements, grouping content, and adding interactivity – information as a system. To that end, I developed a prototype for a new virtual tour at Carleton as a form of research, and summarize that research in the following sections.

6.4 Virtual Tour Prototype

6.4.1 Design Methodology

Using the Menton Centre Virtual Tour as a foundation, I attempted to apply principles of information architecture in the development of a new prototype.

These principles, described by Rosenfeld and Morville in Information Architecture for the World Wide Web as a process for building websites, involve a “top-down” approach of asking effective questions when designing a site, and a “bottom-up” approach that determines an organization of content that answers top-down questions. Underlying this process is the issue of identifying and addressing user needs and accessibility. The process, briefly described here is as follows:

- determining the goals and objectives for the site
- determining the target users for the site, the specific goals and tasks that bring those users to the site
- organizing the content (and where necessary, creating or acquiring new content) so that the target users have a clear understanding of how to navigate through the information on the site
- creating a structure to provide a means for navigating the site
- developing an alpha (text-only) prototype, then beta (graphical and interactive) prototype
- testing and evaluating the beta prototype by means of a formal user testing process

In reviewing the goals and objectives, it was projected that the new virtual tour would have a broader application than the specific users targeted by the Menton Centre, that is that the site would also offer wayfinding information to the general

university population (students, faculty and staff) and to the general public who would have occasion to visit the campus. Five groups of target users were profiled. Corresponding to the expanded scope, the organization of the site was also restructured and a new site architecture diagram drawn. Detailed information regarding the revised goals & objectives, new target users, profiles and use case scenarios, and restructured site architecture diagram can be found in Appendices B1 to B5.

6.4.2 Prototype Development

My analysis of the two existing Carleton University Virtual Tours – one an over-generalized view and the other a detail-specific view – indicated that both had problems with respect to context. To this end, I sought to introduce context in a variety of ways. Firstly, it was necessary to give the target users a sense of the whole (e.g. university campus context) by augmenting the types of information offered. This included providing historical as well as specific context for each of the buildings. Secondly, I determined that the target users should be allowed to position themselves in relation to this whole. This suggested a higher level of integration of the website content, and making the relationships between the constituent parts explicit. This integration involved the use of a variety of different windows and interfaces, incorporating a variety of technologies and levels of abstraction. Where the previous examples fell short, I sought to bring all

these parts together in an effort to facilitate the development of a clear cognitive map as a means of augmenting one's understanding of the physical campus through the experience and understanding of the abstraction of it online.

With respect to the particulars of the prototype, I incorporated new media types: an interactive QTVR model of the campus, interactive QTVR panoramas of the campus at grade, a map of the campus (showing the user's chosen route), still photographs as would be seen when traveling the route, and text descriptions offering both general and accessibility information. Assembling the information into the prototype I noted the importance of Lynch's city elements and Tufte's principles, emphasizing that every detail need not be re-created in the virtual site, but rather abstractions of the important elements. Tufte's principles were also particularly important in understanding how information might be communicated effectively within the fixed boundaries of the computer screen. Screen captures of the Virtual Tour beta prototype are shown in Figures 6.5 and 6.6 on the following pages, and a complete summary of the development process (alpha and beta prototypes) is included in Appendices B6 and B7.

Virtual Tour route search

Route Search:

From: Russell House

To: University Centre

Route: surface

Time: daytime

Method: barrier-free

Mode: wheelchair

Submit Clear

Figure 6.5 Beta Prototype: Search Input Screen

Figure 6.6 Beta Prototype: Search Results Screen

6.4.3 User Testing and Results

User testing was organized to evaluate not only the prototype and its relationship to the physical campus, but specific aspects of the interface itself. Test subjects were representative of the targeted users, and each was asked to select a specific route through the Carleton University Campus. They were then asked to describe the wayfinding information offered by the prototype in terms of helping them to understand the route. They were asked specific questions about the media types and representation of information – what was useful information to them in helping them understand their selected route and their selected route in the larger context of the campus. They were also asked to compare this information to the way they might navigate the same route on campus.

The results were positive, and supported the proposal that people were better able to understand their route using the virtual tool than if they had tried to navigate the campus without it. The complete User Testing Plan and Results are included in Appendices B8 and B9.

6.4.4 Future Work

Information architecture as a process affords the opportunity to design, test and redesign as needed before the website actually becomes “live”. Though the user

testing results were positive, there is an opportunity to incorporate additional features and functionalities into subsequent versions of the beta prototype.

The user testing, though designed to deal with the specifics of the beta prototype, asked some general questions about the kinds of (web-based) media users found personally useful in terms of understanding the university campus. The answers to this question were as varied as the users themselves. This made me reflect on Strohecker's research into the participatory design of cognitive maps. Her notion of constructing a mental image or cognitive map from a range of available information (e.g. media) sources was particularly interesting to me. Though her example was based entirely in the virtual realm, the principles I felt were also applicable to the particular case of the virtual tour prototype. To this end, a future iteration of the prototype would look at the ability for users to customize the virtual tour interface to include only those media types that serve as useful information sources to them. This could be accommodated by using a customized user-login at the start of the virtual tour which would bring up each user's version of the campus with elements adjusted (and adjustable) to fit their changing perceptions of the campus.

6.5 Summary

The development of the prototype as a form of research supports the proposal that, in the specific case of a university campus, the virtual tour can be a complimentary continuation of the real-world environment. A virtual tour represents an opportunity to interpret reality not to replace it. The virtual tour in this case can only be understood in terms of its relationship back to a physical place.

By aiding in the construction of cognitive maps, the virtual tour informs the real environment. It is not in competition with reality; one can learn from both the real and virtual environments in a way that enhances both.

Carleton University campus is a particularly good example of how the shortcomings of a physical environment can be addressed by the capabilities of a parallel version – the virtual tour of the campus. Moreover, the virtual does not exist simply to recreate the real, but rather facilitate the abstraction of the real. This, in turn, leads to the development of a clear cognitive map.

CHAPTER 7: SUMMARY AND CONCLUSIONS

7.0 SUMMARY AND CONCLUSIONS

This thesis has looked at the design and our experiences of real and virtual environments, and considered the problems that characterize each. Despite a view that suggests that technology is the cause of some of these problems, this thesis has looked to technology again as a solution.

7.1 Real World and Virtual World Issues

We are embattled by the increasingly complex nature of our physical environment, and at the same time by the increasing numbers of virtual environments that both address and exacerbate the complexity of the physical world. Communication and transportation technologies have been, in part, a source of this problem. Transportation and communication technologies have allowed cities to define themselves in relative rather than physical terms to each other. Cities have been able to expand geographically, influenced by factors of economics, population and technologies that support both. Present-day urban planning is unable to keep pace with this growth, taking a more reactive rather than proactive stance. The notion of recreating our cities to overcome some of the urban problems is impossible – we can only improve on them. We do so in terms of rebuilding infrastructures (e.g. roads and services) to keep pace with city growth and improve efficiency. While this facilitates continued growth, it does

little to contribute to understanding our cities in terms of navigability and imageability.

Our technologies do not always solve the problems they create. While they have expanded our range of communication options and decreased our sense of distance, technologies like the World Wide Web have introduced new problems. Websites attempt to recreate our physical world in the virtual world – in some instances this is a way to replace or compensate for the state of the physical environment. But the structure and organization of most websites seems to reflect our disconnected experience of the physical environment rather than improve on it. More often than not, websites also suffer from the same lack of structure and ordering systems that characterize our physical environments. As the Web is considered to be primarily a tool for information discovery and retrieval, it is not always valued in proportion to the quality of our experience of it.

7.2 Promoting a Complimentary Relationship

I have suggested that we not consider real and virtual worlds in terms of “either/or”, but to identify ways to dissolve their distinctions, overcome their problems, and to promote a complimentary relationship between the two. To facilitate this study, I have introduced six classes of relationships between physical entities and their virtual counterparts, noting the degree of overlap

between the physical and virtual experience in each case. I observed that there are particular instances or classes where there is a high degree of overlap between the two domains, a complimentary relationship between them, and where the virtual environment is in fact a continuity of the real.

This thesis has studied this overlap further by looking comparatively at principles of wayfinding in architecture and navigation through information, drawing parallels between the two in their approach to design and how they come to bear on establishing this real world/virtual world continuity.

The writings of Lynch, Passini and Alexander and Mitchell refer to generalized concepts and principles of urban design. With respect to cities, they offer us a foundation for recognizing elements in our built environment that enhance our understanding of that environment. Elements of physical space, the visual form and environmental image generated from it, and the qualities of imageability, legibility and visibility all need to be clear. They also speak of the importance of the connection between one's experience of an urban environment and the mental image one forms to abstract and simplify that environment in order to better navigate it. It is this mental image that we carry around with us and which relates our past experiences to the present and future.

The writings of Tufte, Mok and Rosenfeld & Morville refer to the elements and organizing principles in information design, the visual form of information, and the added dimensionality of interactivity that are necessary elements for visibility and legibility in information environments. Indeed, many of the design concepts and solutions proposed by these authors closely parallel the design concepts and solutions of Lynch, Passini, Alexander and Mitchell. The concepts and principles of information architecture also point to the concept of abstracting reality as something that might represent our “perception of reality” instead of aspiring to represent reality itself. Only in abstraction does reality come into focus. The ability to find one’s path clearly through information environments (or through built environments) supports the establishment of a clear mental image.

I have also observed from the study of virtual environment precedents that the success of developing a clear cognitive map is based on choosing an appropriate virtual model and technology that abstracts and clarifies the real environment rather than trying to replicate it. I have expanded this issue, looking specifically at Carleton University as an example both as a physical place (e.g. campus) and as a virtual experience (e.g. website). By applying the design methodologies and principles of architecture and information architecture, I have redesigned an existing virtual tour in a way that not only facilitates wayfinding, but also enables users to build better mental images of the real environment through technologically-mediated means. The development of the prototype as a form of

research supports the proposal that the virtual does not exist simply to recreate the real, but rather facilitate the abstraction of the real, and can be a complimentary continuation of the real-world environment. This, in turn, leads to the development of a clear cognitive map.

7.3 Conclusions

Whether physical or virtual, both environments are best understood with respect to context. The structure, organization and relationship between elements in a physical environment and a virtual environment are essential to the understanding of that space. Moreover, whatever the site or environment (physical or virtual) to the extent that it's interactive and dimensionally rich, it will benefit from the application of wayfinding and organizational principles. Furthermore, this relationship is non-hierarchical – the real does not necessarily precede the virtual nor does the virtual serve the real, but rather the continuity is one that enhances our understanding both environments.

The success of a real-world virtual-world continuity depends not only on the structure and organization, but also how successfully the environment (be it real or virtual) can be navigated. For particular classes of websites, wayfinding and navigation design issues are equally important in real environments as they are in digital information space; the concepts of navigation in virtual environments

and wayfinding in the built environment are closely related. This indicates that attention should not be exclusively concentrated on aspects of efficiency, but distributed between efficiency and promoting depth of experience, a sense of place, and creating efficient space.

I have attempted to demonstrate not only that the principles of the design of real environments can be applied to the design of virtual environments, but that virtual environments can be used to enhance our understanding of the environments with which we interact on a daily basis. In specific cases, virtual versions of complex physical environments can be used as tools to enhance the imageability and perceptual cohesion of those environments. In this sense both the real and virtual versions can appeal to the same cognitive map such that, at the cognitive level, the user's experience of both environments is the same. This uses the cognitive map to establish a unique class of relationship between real and virtual environments to the particular benefit of the built environment.

We have the potential to see virtual worlds not only as alternatives to, representations of, and/or simulations of the real world, but as complimentary environments, which in tandem with direct experience, contribute to our understanding of our cities and communities.

The cognitive map gives us a clue as to the nature of this truly complimentary relationship. Our reflection on our direct experience with our day-to-day environments fosters the development of a cognitive map. Likewise, our experiences on the web contribute to the building of cognitive maps. But more important is the nature of this relationship between the real and the virtual. Continuity between real and virtual environments does not imply mimesis, nor does wayfinding in the real environment directly parallel wayfinding in the virtual environment. There is an opportunity to connect these experiences through cognitive maps that are derived from each of them individually. It is the cognitive map that links our understanding, indeed our imageability, for both. Figure 7.1 illustrates this relationship.

Figure 7.1 Real World/Virtual World Continuity (Class 6 Sites)

In an online world where we build information spaces, we have so much to learn. We as architects and information architects cannot ignore the relevant knowledge currently partitioned in the fields of architecture, urban design and information design, nor the need for architects to participate in the design and fostering of relationship between the two.

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APPENDIX

APPENDIX A: SURVEY OF UNIVERSITY VIRTUAL TOUR WEBSITES

APPENDIX A: SURVEY OF UNIVERSITY VIRTUAL TOUR WEBSITES

To further my research, I surveyed what other universities have done in terms of virtual tours of their own campuses. Those I mention in this Appendix are: Harvard University, MIT, the University of Washington, and the University of Waterloo. As a group, they were selected to show the broad range of virtual tours that are available on the web, and the variety of information and construction of each.

Harvard University

The Harvard University Virtual Tour site provides two methods to explore the university campus: a guided tour (see Figure A1.1), or QTVR tour. The Virtual Tour site is rich in media technology. Graphical-based information includes small aerial-view maps of the campus, larger panoramic photos of the campus and accompanying descriptive text. Supplementary information is offered in the form of streaming media (movies and audio files) and virtual reality panoramic photographs (QTVR), identified by media type and image thumbnails on the left-hand side of the screen.

The presentation of information is balanced, maintained by using macro- and micro-scale levels of information, which dynamically respond with the visitor's progression through the tour. Graphic information is supported by text, particularly with respect to the descriptions accompanying the QTVR movies – the visitor has multiple readings in information. Some level of user-control in viewing is also afforded through the choice of media type.

Overall, the media is used not only to convey information about the campus, but also to convey the sense of place. Through the virtual tour, one has felt like they have actually been to and experienced Harvard.

Figure A.1 Screen capture from Harvard University Virtual Tour website
<http://www.news.harvard.edu/tour>

MIT

The MIT Virtual Tour introduces the visitor to the campus by means of a 3D axonometric drawing. Experiencing the campus as a whole (macro-scale) is however limited to this fixed viewpoint. The visitor has the option to select one of campus districts, and by clicking on it with a mouse proceed to an enlarged version of the section on a subsequent page (see Figure A1.2).

Information on the subsequent page is split horizontally on the screen using HTML frames into macro-scale (building exterior) information along the top and micro-scale information (building interior) information along the bottom. The top frame is used as the navigation: small yellow dots are hyperlinks to areas of more information (QTVRs) that will be displayed in the bottom frame. The use of QTVRs is extensive, and as a result requires that visitors to the MIT site have the prescribed browser plug-in. Unlike the Harvard site, the QTVRs are not supplemented with descriptive text describing the panorama.

Along with an emphasis on panoramas of building interiors, the MIT Virtual Tour affords a limited opportunity to gain knowledge through movement around the campus. The content, however, is not interactive in terms of visitor being able to specify his/her own customized criteria and route search.

Figure A.2 Screen capture from the MIT Virtual Tour website
<http://web.mit.edu/vrtour>

University of Washington

The University of Washington virtual tour consists of three main sections: campus maps (parking, buildings, computing labs, libraries), campus tours (photographic and historic tour), and facilities (accommodation, restaurants). The Campus Map section has two sections that deal with navigating the campus: "Access Guide for Persons with Disabilities" (see Figure A1.3) and "Directions to Various Campus Locations". These two sections ultimately end up delivering the same information to the visitor: a directional map, photographs of the principal building entrances, and a (text-based) building accessibility list.

Dealing with the macro-scale information, the map indicates major routes around the campus, and the principal building entrance(s), which, in turn, are described by photographs and text. Having viewed this information on the web before actually traveling to the campus, a visitor would know what to expect. Moreover, the information from the website would also provide, in advance, what they would see when they arrived at their destination (e.g. building entrance).

Where the site may not possess a high level of information graphics, it does provide direct and concise navigation information for the visitor.

Figure A.3 Screen capture from the University of Washington Virtual Tour website
<http://www.washington.edu/univrel/visitors>

University of Waterloo

As a direct contrast to the University of Washington site, the University of Waterloo's virtual tour places much emphasis on information graphics and technology. The site is technology-laden: from the first pages of the virtual tour the visitor is asked to choose between a java-enabled version of the site or using a proprietary panoramic image viewer (i.e. Live Picture Zoom Viewer). By default, the Zoom Viewer automatically starts rotating the panoramic image. Although the intent is to provide the visitor quick-start to viewing the image, to a visitor not familiar with the technology it may not be clear how this is working. As a result, it is necessary to provide instructions to the visitor on "how to tour" (see Figure A1.4).

On the other hand, the java-based navigation offers some unique opportunities to combine both the macro-scale navigation with the micro-scale navigation. Using an overall campus map, mousing over any particular building pops up a menu listing the key rooms within that building at which point a visitor can move down the list and select a particular room to explore. These sub-tours can place a room in any building within the generalized context of the rest of the campus. The java-based technology also makes extensive use of pop-up windows, and the layering of information on the screen. As a means of viewing density of information, they allow the visitor the opportunity to switch on and off the parts of the site that they feel is important to their exploration and information-gathering about the campus.

Figure A.4 Screen capture from the University of Waterloo Virtual Tour website
<http://www.virtualtour.uwaterloo.ca>

APPENDIX B: VIRTUAL TOUR PROTOTYPE DESIGN SUMMARY

APPENDIX B: VIRTUAL TOUR PROTOTYPE DESIGN SUMMARY

Information Architecture as described by Rosenfeld and Morville in Information Architecture for the World Wide Web is a process for building websites, involving a “top-down” approach of asking effective questions when designing a site, and a “bottom-up” approach that determines the organization of content that answers the top-down questions. Underlying this process is the issue of identifying and addressing user needs and accessibility. The process, briefly described here is as follows:

- determining the goals and objectives for the site
- determining the target users for the site, the specific goals and tasks that bring those users to the site
- organizing the content (and where necessary, creating or acquiring new content) so that the target users have a clear understanding of how to navigate through the information on the site
- creating a structure to provide a means for navigating the site
- developing an alpha (text-only) prototype, then beta (graphical and interactive) prototype
- testing and evaluating the beta prototype by means of a formal user testing process

This Appendix summarizes each of the processes above as they were undertaken in the development of the Paul Menton Centre Virtual Tour prototype for Carleton University.

APPENDIX B1: Goals and Objectives

The website was to provide more holistic information about the university (in addition to the specific and detailed information previously prepared for the Virtual Tour?) in a newly designed and newly-functioning website by:

- making the existing information more useable, by critically analyzing existing content in terms of usability and usefulness, and in supplementing it with other content made available over the past year and, where applicable, creating new content
- recognizing that the data gathered to date, and the new information to be added, are applicable not only to persons with disabilities but to the general university population as a whole
- incorporating new visualization and information technologies to the site design
- applying current accessibility standards to the site design
- looking at options for making the Virtual Tour material part of an applications information package available to prospective students
- designing the site such that it can be adapted and sold as a "Virtual Tour Program/Application" to other universities for their use

The following are proposed specifications for the new Virtual Tour site:

Design specifications:

- regrouping the previous site information into a new site consisting of approximately four main pages, each with two to four subpages
- develop and incorporate additional pages that provide a general level of information about the university (e.g. campus maps, images, photos, panoramas)
- broaden the overall scope for route searching, adding to the existing room-to-room search (within one building) with a building-to-building search and a room-in-one-building to room-in-another-building search
- add additional parameters to the route search criteria: route, time, method, mode
- add interactivity to the existing information
- add references (links) to general university information (e.g. Admissions)

Technical specifications:

- screen resolution of: 600 x 800 pixels, 96 dpi
- web-safe (216) color palette
- incorporate W3C accessibility standards into the design as much as possible
- limited use of browser plug-ins required to view QTVR panoramas
- route details linked to database information created in Microsoft Access
- ColdFusion used to access database information and post search results to the web

APPENDIX B2: Target Users

Visitors will be arriving to the Virtual Tour site with a variety of purposes in mind:

- prospective students: searching for an Ontario University, wanting to find out more about Carleton, looking for information prior to their first visit
- new or currently-enrolled students: wanting general information about getting around on campus, searching for specific route information to get from 'a' to 'b', inquiring about services available on campus and their locations
- students with physical disabilities: looking for campus accessibility information, looking for information on the accessible routes on campus (between buildings and/or within buildings themselves)
- school/faculty administrators, teachers & staff: providing information/directions for students who are looking for other destinations on campus, providing information to the general public regarding special events/activities on campus
- campus planning & development staff: looking for current information about the routes taken on campus for planning purposes, advising the general university population about new construction/temporary closures which will affect movement patterns on campus

APPENDIX B3: User Profiles and Use Case Scenarios

User Profile and Use Case Scenario 1: Prospective Student

Name: "Kumi"

Personality & Activities: As a new graduate from secondary school, Kumi is excited at the prospects of attending university in the fall. Her enthusiasm is heightened with the fact that she has a G.P.A. is good enough to get her into just about any university she wants. Kumi is also an avid badminton player, and hopes to join the university intramural team, wherever she ends up.

Web Savvy: Kumi is a frequent user of the web for her school-related work, and has her own computer at home. She is comfortable using the Internet for web browsing & searching, sending & receiving email, and listening to Backstreet Boys RealAudio files.

Scenario 1: Kumi wants to attend university in the Fall, and wants to see what information she can find about Ontario Universities on the Internet.

Scenario 2: After reviewing the application requirements for the University of Toronto, the University of Waterloo and Carleton University on their websites, Kumi decides to go back and take another look, this time to see what else each university has to offer.

Scenario 3: Kumi decides to visit Carleton University in person, and in planning her trip would like to know how to get to the Admissions Office in the Administration building.

Figure B3.1 User Profile and Use Case Scenario #1: Prospective Student

User Profile and Use Case Scenario 2: New or Currently Enrolled Student

Name: "Tarah"

Personalities & Activities: Deep into her second year of studies in Psychology, Tarah is happy with her choice of Carleton University. Living in residence has made her academic life a lot easier, and given her the opportunity to make all sorts of new friends on her floor. Other than her classes in the Loeb Building, life pretty much revolves around residence. However, Tarah has also been known to break away from her studies the occasional Wednesday nite to go the pub at Oliver's with the rest of her floor-mates.

Web Savvy: Tarah is a real whip when it comes to computers and the Internet. She is online 24 hours a day through the university's network, researching, writing and submitting her assignments, chatting with her friends back at home, and making the occasional purchase online.

Scenario 1: As winter approaches, Tarah remembers how much darker it gets earlier in the afternoon. Her evening class ends at 9:00 p.m., and without anyone else to accompany her in her walk back to residence, she needs to find a safe route back to residence.

Scenario 2: Tarah has been told by her professor that there is a short videotape on hold in the library which she is supposed to view before the next lecture. Tarah's no stranger to the library, but has never had any reason to visit the Instructional Media section before.

Scenario 3: Tarah met her next 'love interest', Steve, at Oliver's Pub last Wednesday. Steve has called Tarah and wants to meet her for coffee at Treats in the Science and Technology Centre.

Figure B3.2 User Profile and Use Case Scenario #1: Currently Enrolled Student

User Profile and Use Case Scenario 3: Student, Staff and/or Faculty with Disabilities

Name: "Mark"

Personalities & Activities: Mark is a goal-oriented individual - energetic, always busy, and keen to get his degree and get out into the 'working world'. Mark is also a member of the Computing Science Club on campus, and despite his pleasant-looking exterior, has been known to be ruthless when it comes to reviewing websites for the Club's online newsletter.

Web Savvy: Mark is very familiar with the Internet, web browsers and the laptop computer which he uses for school (and 'tweaks' himself for ultimate performance). Though his laptop has a small screen and slow modem connection, but Mark has been able to compensate for this by customizing his web browser to display fonts that are readable on his screen, and at the same time turn his screen resolution down to save processor speed.

Scenario 1: Mark opts to take the bus downtown instead of calling for his usual ride. He visits the university's Virtual Tour website, and searches for the most accessible route from his classroom to the nearest bus stop.

Scenario 2: The weather has turned for the worse, and because it's raining Mark now wants to take the tunnels to his first appointment with the dentist on campus.

Scenario 3: Through the Centre for Persons With Disabilities on campus, the Computer Science Club has been asked to assist in carrying out comparative evaluation of online accessibility information for selected Ontario Universities. Mark, known for his 'no holds barred' approach to writing, and for his own personal experiences, has been asked to carry out the evaluation.

Figure B3.3 User Profile and Use Case Scenario #1: Student, Staff and/or Faculty with Disabilities

User Profile and Use Case Scenario 4: School/Faculty Administrator, Teacher and/or Staff

Name: "Professor Jack Ford"

Personality & Activities: Aside from his regular teaching duties in Business Administration, Professor Ford takes an active role in Varsity Sports as an Assistant Coach for the Rugby Team. The extra time at school is rewarded with the satisfaction

Web Savvy: Though there is a computer in his office at the university, Professor Ford rarely uses it. He knows the fundamentals for surfing the 'net, and supports websites for the academic courses and sport that he teaches, however actually maintaining the sites (HTML editing) is relegated to more 'technically-minded' student volunteers.

Scenario 1: Professor Ford is organizing a Varsity Sports Fundraiser, and in addition to having the event posted online, would like to let patrons know how to get to the event on campus, and if they're driving, where they can park.

Scenario 2: Back in his office, Professor Ford has been talking with a student regarding academic scholarships available through the Dean of Engineering's Office. The student asks for directions to the Dean's Office which, embarrassingly, Professor Ford has never been to himself.

Figure B3.4 User Profile and Use Case Scenario #1: School/Faculty Administrator, Teacher and/or Staff

User Profile and Use Case Scenario 5: Campus Development Planner

Name: "Ms. Adair"

Personality & Activities: Ms Adair has worked with Campus Development for a number of years, and thanks to last year's Capital Fundraising Drive now co-ordinates a number of new construction projects on campus. She enjoys the breadth of experience her job offers, and likes to pride herself on a thorough approach taken to each and every project.

Web Savvy: Though she uses a computer in her daily work, Ms. Adair generally is more comfortable with the computer programs (drawing, spreadsheet, database) related to her own specific tasks. She recognizes the far-reaching capabilities of the Internet, but hasn't found a way to extract specific information that is useful to her and incorporate that information into her work.

Scenario 1: In updating the Campus Master Plan with proposed new construction, Ms. Adair would like to study up-to-date information about commonly-used routes on campus (vehicular, pedestrian, accessible) to help her determine suitable future building sites.

Scenario 2: A new multi-disciplinary building complex is starting construction next month, and Ms. Adair would like to co-ordinate with, inform the rest of the campus with route closures and detours information.

Figure B3.5 Campus Development Planner

APPENDIX B4: Site Content Inventory**01 - Splash Page***index.htm*

Item	Content	Format	No.	Status
01	introduction	animation (Flash)	1	
02	university crest	color graphic (GIF)	1	
03	campus motto	text	1	
04	general photographs of the campus	color images (JPEG)	6	
05	general photographs of students	color images (JPEG)	3	

02 - Home Page*index1.htm*

Item	Content	Format	No.	Status
06	university crest	color graphic (GIF)	1	
07	virtual tour logo	color graphic (GIF)	1	
08	navigation buttons	color graphics (GIF)	12	
09	general photographs of the campus	color images (JPEG)	3	
10	general photographs of students	color images (JPEG)	3	
11	welcome message	text	1	
12	links to general campus information	hyperlink (http://www.carleton.ca)	1	

03 - Introduction*index2a.htm*

Item	Content	Format	No.	Status
13	general photographs of the campus	color images (JPEG)	3	
14	general photographs of students	color images (JPEG)	3	
15	introduction to the tour	text (full page)	1	
16	navigation buttons	color graphics (GIF)	6	

04 - History*index2a1.htm*

Item	Content	Format	No.	Status
17	photographs of the Menton Centre Group	color images (JPEG)	2	
18	history of the virtual tour project	text (full page)	3	
19	links to Menton Centre	hyperlink (http://www.carleton.ca/pmc/)	1	

Table B4.1 Site Content Inventory – Pages 01-04

05 - Sponsors*index2a2.htm*

Item	Content	Format	No.	Status
20	general photographs of the Sponsors	color images (JPEG)	2	
21	acknowledgements	text (full page)	3	
22	links to sponsors' websites	hyperlink	2	

06 - Campus Info*index2b.htm*

Item	Content	Format	No.	Status
23	context map of Ottawa	color graphic (GIF)	1	
24	context map description & legend	color graphic (GIF)	1	
25	general photographs of the campus	color images (JPEG)	3	
26	general information about the campus	text (full page)	1	
27	descriptions of each of three subpages	text (paragraph each)	3	
28	navigation buttons	color graphics (GIF)	12	

07 - Campus Tour*index2b1.htm*

Item	Content	Format	No.	Status
29	3D map of the campus	color graphic (QTVR)	1	
30	3D map viewpoints of tour locations	color graphic (QTVR)	20	
31	Carleton's history (1 - 3 minute film)	movie (QuickTime MOV)	1	
32	large photographs for tour locations	color images (JPEG)	20	
33	small photographs for tour locations	color images (JPEG)	40	
34	enlarged map areas for tour locations	color graphics (GIF)	12	
35	panoramic photos for tour locations	color images (QTVR)	20	
36	text descriptions for tour locations	text (full page each)	20	
37	tour status bar	color graphic (GIF)	1	

Table B4.2 Site Content Inventory – Pages 05-07

08 - Facilities*index2b2.htm*

Item	Content	Format	No.	Status
38	descriptions of each facility/service	text (paragraph each)	5	
39	subpage image thumbnails	color images (JPEG)	5	
40	subpage map thumbnails	color graphics (GIF)	5	
41	links to separate campus maps	hyperlink	5	
42	student services description	text (full page)	1	
43	student services photos	color images (JPEG)	4	
44	student services links	hyperlink	12	
45	administrative services description	text (full page)	1	
46	administrative services photos	color images (JPEG)	2	
47	administrative services links	hyperlink	8	
48	student organizations description	text (full page)	1	
49	student organizations services photos	color images (JPEG)	3	
50	student organizations services links	hyperlink	10	
51	library description	text (full page)	1	
52	library photos	color images (JPEG)	2	
53	library link	hyperlink	5	
54	athletics description	text (full page)	1	
55	athletics photos	color images (JPEG)	3	
56	athletics link	hyperlink	1	

Table B4.3 Site Content Inventory – Page 08

09 - Maps & Photos*index2b3.htm*

Item	Content	Format	No.	Status
57	descriptions of each map	text (paragraph each)	7	
58	subpage image thumbnail	color images (JPEG)	7	
59	subpage map thumbnail	color graphics (GIF)	7	
60	links to separate campus maps	hyperlink	7	
61	building location and zone map	color graphics (GIF)	1	
62	building location and zone map - description & legend	text (full page)	1	
63	vehicle access and parking map	color graphics (GIF)	1	
64	vehicle access and parking map - description & legend	text (full page)	3	
65	walkways and cycle paths map	color graphics (GIF)	1	
66	walkways and cycle paths map - description & legend	text (full page)	1	
67	tunnel map	color graphics (GIF)	3	
68	tunnel map - description & legend	text (full page)	1	
69	academic services map	text (paragraph each)	3	
70	academic services map - description & legend	color graphics (GIF)	12	
71	food, leisure & entertainment map	text (paragraph each)	3	
72	tunnel map - description & legend	color graphics (GIF)	12	
73	general photographs of the campus	color images (JPEG)	3	
74	general information about the campus	text (full page)	1	
75	descriptions of each of three subpages	text (paragraph each)	3	
76	navigation buttons	color graphics (GIF)	12	

Table B4.4 Site Content Inventory – Page 09

10 - Route Search*index2c.htm*

Item	Content	Format	No.	Status
77	descriptions of each route search options	text (paragraph each)	2	
78	search options image thumbnails	color graphics (GIF)	2	
79	subpage map thumbnails	color graphics (GIF)	5	
80	navigation buttons	color graphics (GIF)	6	

11 - Macro Route Criteria*index2c1.htm*

Item	Content	Format	No.	Status
81	descriptions of macro route search	text (paragraph each)	2	
82	campus map	animation (Flash)	2	
83	origin and destination options (campus building list)	database (MS Access)	1	
84	route options	database (MS Access)	6	
85	time options	database (MS Access)	2	
86	method options	database (MS Access)	2	
87	mode options	database (MS Access)	5	
88	navigation button (inactive, rollover state)	color graphics (GIF)	2	

12 - Macro Route Results*index3c1.htm*

Item	Content	Format	No.	Status
89	3D map of the campus	color graphic (QTVR)	1	
90	campus map	color graphic (GIF)	2	
91	building name rollovers for campus map	color graphics (GIF)	28	
92	exterior photos of buildings/building entrances	color images (BMP converted to GIF)	200	
93	exterior panoramic photos	color images (QTVR)	2	(see item #35)
94	'next photo' navigation icons (inactive, rollover state)	color graphics (GIF)	2	
95	general description for buildings/building entrances	text (paragraph each)	200	
96	accessibility information for buildings/building entrances	text (paragraph each)	200	
97	general description/accessibility information icons (inactive, active & rollover state)	color graphics (GIF)	6	

Table B4.5 Site Content Inventory – Pages 10-12

13 - Micro Route Criteria*index2c2.htm*

Item	Content	Format	No.	Status
98	descriptions of micro route search	text (paragraph each)	2	
99	building floor plans	color graphics (GIF)	200	
100	origin and destination options (room list)	database (MS Access)	many	
101	route options	database (MS Access)	6	
102	time options	database (MS Access)	2	
103	method options	database (MS Access)	2	
104	mode options	database (MS Access)	5	
105	navigation button (inactive, rollover state)	color graphics (GIF)	2	

14 - Micro Route Results*index3c2.htm*

Item	Content	Format	No.	Status
106	3D floor plans of selected building	animation (Flash or GIF)	1	
107	interior photos of buildings/building circulation	color images (BMP converted 2000 to GIF)		
108	interior panoramic photos	color images (QTVR)	28	
109	'next photo' navigation icons (inactive, rollover state)	color graphics (GIF)	2	
110	accessibility information for buildings/building entrances	text (paragraph each)	2000	
111	general description/accessibility information icons (inactive, active & rollover state)	color graphics (GIF)	6	

15 - Contacting*index2d.htm*

Item	Content	Format	No.	Status
112	university crest	color graphic (GIF)	1	
113	general photographs of the campus	color images (JPEG)	3	
114	general photographs of students	color images (JPEG)	3	
115	contacting message	text	1	
116	links to general campus information	hyperlink	1	

Table B4.6 Site Content Inventory – Pages 13-15

APPENDIX B6: Alpha Prototype

The screenshot shows a web browser window titled "yorku.ca/department/virtualtour/Route Search - Microsoft Internet Explorer". The address bar displays "http://qedo.carleton.ca/vtour/proto3/index2c1.cfm". The main content area is titled "ROUTE SEARCH: BUILDING-TO-BUILDING" and contains the following text: "Introduction to the Building-to-Building Route Search (descriptive text)". Below this, it says "Please select your origin and destination from the lists below (or see map):". The form includes several dropdown menus: "From:" (set to "Architecture Building (AA)"), "To:" (set to "Architecture Building (AA)"), "Criteria:" (set to "Surface (outside)"), "Route:" (set to "Surface (outside)"), "Time:" (set to "Daytime"), and "Method:" (set to "Quickest"). A "Submit" button is located at the bottom left of the form. To the right of the form is a small, dark, 3D architectural rendering of a building complex. The browser's status bar at the bottom shows "Done" and "Internet".

ROUTE SEARCH: BUILDING-TO-BUILDING

"Introduction to the Building-to-Building Route Search (descriptive text)"

Please select your origin and destination from the lists below (or see map):

From:

To:

Criteria:

Route:

Time:

Method:

Figure B6.1 Alpha Prototype: Input Screen

Figure B6.2 Alpha Prototype: Search Results Screen

APPENDIX B7: Beta Prototype

Figure B7.1 Beta Prototype: Input Screen

Figure B7.2 Beta Prototype: Search Results Screen

APPENDIX B8: Formal User Test

Session Briefing

As part of a thesis project undertaken in the Masters of Architecture Program in Design and Technology in the School of Architecture at Carleton University, a prototype has been designed for a web-based Virtual Tour of the Carleton University Campus. The tour is intended to be used in conjunction with a larger-scale website about the University's programs and facilities.

The Virtual Tour site prototype has three major sections: an introduction, information about the campus (in two forms - a guided tour and a collection of searchable maps and photos), and a route search. What you will be looking at today is the portion of the Virtual Tour website that deals with the route search.

During the session you will be asked to perform several tasks relating to a specific journey on campus using the route search. Because this is a prototype, some parts of the interface may not be fully functional or be in their final form. We are interested in your impressions, so feel free to ask questions and make comments, both positive and negative, as we go through the various tasks. Also, in order to help understand your experience, please say out loud what you are thinking as you complete each task. At certain points during the evaluation, we will stop you and ask your opinion. Your comments will help in the evaluation of and improvements in the design of the Virtual Tour.

It is important to note that we are not testing you - we are evaluating the prototype. We are studying what works and what doesn't, so if you have difficulties we need to understand how and why so that we can make the appropriate adjustments.

The session should last less than one hour.

Thank you in advance for your participation. Do you have any questions?

Informed Consent Form – Virtual Tour

The purpose of an informed consent form is to ensure that you understand the reason for the study and the nature of your involvement. The Informed Consent must provide sufficient information such that you have the opportunity to determine whether you wish to participate in the study.

Research Personnel:

The following people are involved in the research project and may be contacted with any questions or queries:

Brent Welty, Thesis Student	tel. (613) 567-5653	email bwelty@chat.carleton.ca
Ben Gianni, Graduate Supervisor	tel. (613) 520-2862	email bgianni@ccs.carleton.ca

Purpose and Task Requirements:

The purpose of the study is to evaluate the usability of the Virtual Tour interface and compare it to how you would normally carry out the same task without the Virtual Tour/Route Search information. You will be asked to complete two short questionnaires and a set of tasks using a web-enabled computer (Mac or PC) and the Virtual Tour website. Data on how you complete the tasks, as well as your opinions about the prototype will be collected.

Duration:

The evaluation session should last less than one hour.

Anonymity and Right to Withdraw:

This session is confidential, and your name will not be associated with the data collected in any way. If, for whatever reason, you feel uncomfortable during the session, you may withdraw at any time.

I have read the description of the Virtual Tour study contained in this Informed Consent Form, understand the conditions of my participation, and agree to participate in the study.

Participant:

Name

Signature

Researcher:

Name

Signature

Date:

Pre-Session Questionnaire

Before starting the session, we need some information about from you and your familiarity with computers, the Internet and the Carleton University Campus:

1. How do you rate your computer experience?

novice	_____
intermediate	_____
expert	_____

2. How often do you use a computer?

almost never	_____
monthly	_____
weekly	_____
daily	_____

3. How often do you use the Internet for web browsing?

almost never	_____
monthly	_____
weekly	_____
daily	_____

4. What is your educational level?

secondary school	_____
some university or college	_____
university or college degree	_____
post-graduate studies	_____

5. How familiar are you with the Carleton University Campus?

never been	_____
occasional visits	_____
former student/faculty/staff	_____
current student/faculty/staff	_____

Virtual Tour Overview

As mentioned to you previously, a prototype has been designed for a web-based Virtual Tour of the Carleton University Campus. The tour is intended to be used in conjunction with a larger-scale website about the University's programs and facilities.

The Virtual Tour site prototype has three major sections: an introduction, information about the campus (in two forms - a guided tour and a collection of searchable maps and photos), and a route search. What you will be looking at today is the portion of the Virtual Tour website that deals with the route search, specifically the interface which presents you with the route information.

Because this is a prototype, some parts of the interface may not be fully functional or be in their final form, however the portions of the site that deal with the tasks asked of you today will be working.

Below is a picture of a typical Virtual Tour screen. One of the important aspects of the Virtual Tour screen is the delivery of pertinent information and details. Wherever possible, we have used content readily available from the university's resources, however there may be areas of the Virtual Tour site where either content is not available and a suitable alternate image or text has been put in its place.

You may navigate through the Virtual Tour in much the same manner as you would through any website: using hyperlinks, image hotspots, or by following the written descriptions (where available).

Task List – Preamble

You are going to use the Route Search section of the Virtual Tour website to demonstrate to you how to get from a residence building on campus (Russell House) to the University Centre (Unicentre).

For the purpose of this exercise, it is assumed that you have a computer, either at home or in your room at residence, that you are using access the Virtual Tour website. How you get to the starting point (Russell House) is not relevant. You will be using a wheelchair to get from Russell House to the Unicentre for a lunchtime presentation, and would like to minimize the time it takes you to get there using a barrier-free route. You have no other physical disabilities that will impair your journey.

We also assume that you have already logged onto the Internet via your PC, and have already logged onto the home page of the Carleton University Virtual Tour website.

Task List – Step 1

From the Virtual Tour homepage, you want to go to the Route Search section of the website.

Steps:

- Select the link for the Route Search.

Please indicate how easy or difficult this was to complete this task.

very difficult				neutral			very easy
1	2	3	4	5	6	7	

Do you have any comments or suggestions?

Errors or special actions:

Hint (yes/no):

Comments:

Task List – Step 2

You are presented with the first page of the Route Search section of the Virtual Tour website. Describe what you see on the screen.

Using this page, you will start your route search.

Steps:

- Enter your route information request using the route search page:
 - Origin: Russell House
 - Destination: Unicentre
 - Route: surface
 - Time: day
 - Method: barrier-free
 - Mode: wheelchair

Please indicate how easy or difficult this was to complete this task.

very difficult								neutral					very easy
1	2	3	4	5	6	7							

Do you have any comments or suggestions?

Errors or special actions:

Hint (yes/no):

Comments:

Task List – Step 3

You are now presented with the selected route information. Describe what you see on the screen.

Roll your mouse over the various information elements on the screen without clicking (or double-clicking) on any on them and describe what you see.

Describe what you think is the purpose for each of the following:

- 3D campus map
- 2D route map
- nodes on the route map
- white box at the bottom of the 2D route map
- general information
- accessibility information
- 'print route option

Do you have any comments or suggestions?

Errors or special actions:

Hint (yes/no):

Comments:

Task List – Step 4

You now want to proceed with exploring the route information and learning the selected route using the information provided on the screen.

Steps:

- enlarge the 3D campus map and move the map around so that the two buildings (your origin and destination) appear in an orientation that is useful (meaningful) to you.
- chose whether to keep the map open or close it.

Please indicate how easy or difficult this was to complete this task.

very difficult				neutral			very easy
1	2	3	4	5	6	7	

Do you have any comments or suggestions?

Errors or special actions:

Hint (yes/no):

Comments:

Task List – Step 5

You want to learn more about the accessibility information available for your point of origin.

Steps:

- select the accessibility information option and describe what you see
- close the accessibility information

Please indicate how easy or difficult this was to complete this task.

very difficult				neutral			very easy
1	2	3	4	5	6	7	

Do you have any comments or suggestions?

Errors or special actions:

Hint (yes/no):

Comments:

Task List – Step 6

Move to the next node along the route (node #2).

Steps:

- select the next node (second point) along the route and describe what you see.
- double click on the image of the Residence Quad and describe what you see.
- move the Residence Quad image around using the viewing tools provided.
- Close the Residence Quad image.

Please indicate how easy or difficult this was to complete this task.

very difficult				neutral			very easy
1	2	3	4	5	6	7	

Do you have any comments or suggestions?

Errors or special actions:

Hint (yes/no):

Comments:

Task List – Step 7

Continue along the route to the final node.

Steps:

- proceed with the remaining nodes along the route and describe what you see.

Please indicate how easy or difficult this was to complete this task.

very difficult			neutral			very easy
1	2	3	4	5	6	7

Do you have any comments or suggestions?

Errors or special actions:

Hint (yes/no):

Comments:

Task List – Step 8

For the purpose of this exercise, you chose to take a printed copy of the route results with you.

Steps:

- select the “print route” button and describe what you see.
- print the route information.

Please indicate how easy or difficult this was to complete this task.

very difficult				neutral			very easy
1	2	3	4	5	6	7	

Do you have any comments or suggestions?

Errors or special actions:

Hint (yes/no):

Comments:

Task List – Summary Questions

1. Overall, how easy or difficult did you find the Virtual Tour Route Search to use?

very difficult				neutral			very easy
1	2	3	4	5	6	7	

2. Please rate the following elements of the interface in terms of ease of use:

		difficult					easy
a) entering the route origin & destination	1	2	3	4	5	6	7
b) using the 3D campus map	1	2	3	4	5	6	7
c) using the 2D route map	1	2	3	4	5	6	7
d) using the QTVR images	1	2	3	4	5	6	7
e) using the still images & text	1	2	3	4	5	6	7
f) moving through the selected route	1	2	3	4	5	6	7
g) printing the selected route summary	1	2	3	4	5	6	7

3. Would more detail of the campus (e.g. secondary pathways, stairs) help in understanding the route?

4. Would the ability to resize any of the objects (like the 3D campus map) make them more useful?

5. Please rate the same elements of the interface in terms of usefulness to you in understanding the selected route:

		not useful					useful
a) route origin & destination lists	1	2	3	4	5	6	7
b) 3D campus map	1	2	3	4	5	6	7
c) 2D route map	1	2	3	4	5	6	7
d) QTVR images	1	2	3	4	5	6	7
e) still images & text	1	2	3	4	5	6	7
f) selected route summary (printout)	1	2	3	4	5	6	7

6. Are there any other objects that would help with route information?

7. Rate the following elements in order of most important to least important to you in understanding the route information.

3D campus map	1	2	3	4
2D route map	1	2	3	4
QTVR images	1	2	3	4
still images & text	1	2	3	4

8. Did the Virtual Tour help with locating the Unicentre?

no			neutral			yes
1	2	3	4	5	6	7

9. How satisfied are you with the Virtual Tour Route Search?

not satisfied			neutral			satisfied
1	2	3	4	5	6	7

10. Do you think enough information was provided through the Virtual Tour for you to eventually execute this route on campus?

11. What would be your preferred method of retaining the route information for your eventual trip onto campus?

- commit it to memory
- take it with me (e.g. printout)
- have an opportunity to view it again on a screen on campus
- have the each of the nodes confirmed to me as I execute the route on campus

12. How would you find this route (before coming to the campus) without using the Virtual Tour website?

13. How would you find this route (once on the campus) without using the Virtual Tour website?

14. What improvements, if any, could be made to the Virtual Tour?

15. Are there any other comments you would like to make about the Virtual Tour?

Debriefing

Thanks you for participating in this study. Your effort, input, comments and criticisms are greatly appreciated.

The user testing results will be available at the end of April. If you are interested in receiving them, please contact me by calling (613) 567-5843 or by email at bwelty@chat.carleton.ca

Any final questions and/or comments?

APPENDIX B9: User Testing Results

Participants

Target User	# of Participants
Prospective Student	1
New or Currently-Enrolled Student	1
Student, Staff and/or Faculty with Physical Disabilities	2
School/Faculty Administrator, Teachers and/or Staff	1
Campus Development Planner	1

Pre-Session Questionnaire

1. How do you rate your computer experience?

novice	0
intermediate	4
expert	2

2. How often do you use a computer?

almost never	
monthly	
weekly	1
daily	5

3. How often do you use the Internet for web browsing?

almost never	
monthly	
weekly	1
daily	5

4. What is your educational level?

secondary school	1
some university or college	3
university or college degree	1
post-graduate studies	1

5. How familiar are you with the Carleton University Campus?

never been	1
occasional visits	1
former student/faculty/staff	1
current student/faculty/staff	3

Task List – Step 1

From the Virtual Tour homepage, you want to go to the Route Search section of the website.

Steps: "Select the link for the Route Search"

able to do	5
hint required	1
unable to do	

Ease or difficulty to complete this task:

(1=very difficult, 7=very easy)	1	2	3	4	5	6	7
					1	3	2

Comments or suggestions:

<i>No comments.</i>

Task List – Step 2

You are presented with the first page of the Route Search section of the Virtual Tour website. Describe what you see on the screen.

Steps: "Enter your route information request using the route search page"

able to do	5
hint required	1
unable to do	

Ease or difficulty to complete this task:

(1=very difficult, 7=very easy)	1	2	3	4	5	6	7
				1	1	2	2

Comments or suggestions:

<i>Should search criteria be optional?</i>
--

Task List – Step 3

You are now presented with the selected route information. Describe what you see on the screen.

Steps: "Roll your mouse over the various information elements on the screen without clicking (or double-clicking) on any on them: describe what you see and what you think is the purpose is of each"

able to do	5
hint required	1
unable to do	

Ease or difficulty to complete this task:

(1=very difficult, 7=very easy)	1	2	3	4	5	6	7
					2	3	1

Comments or suggestions:

*Show the origin and destination points on the 3D Map.
Building name rollovers are helpful.*

Task List – Step 4

You now want to proceed with exploring the route information and learning the selected route using the information provided on the screen.

Steps: "Enlarge the 3D campus map and move the map around so that the two buildings (your origin and destination) appear in an orientation that is useful (meaningful) to you".

able to do	3
hint required	3
unable to do	

Ease or difficulty to complete this task:

(1=very difficult, 7=very easy)	1	2	3	4	5	6	7
				2	3	1	

Comments or suggestions:

*Show the origin and destination points on the 3D Map.
Orient 3D Map the same as the 2D Map.
Buildings should be more realistic-looking.*

Task List – Step 5

You want to learn more about the accessibility information available for your point of origin.

Steps: "Select the accessibility information option, describe what you see, and then close the accessibility information"

able to do	6
hint required	
unable to do	

Ease or difficulty to complete this task:

(1=very difficult, 7=very easy)	1	2	3	4	5	6	7
						2	4

Comments or suggestions:

No comments.

Task List – Step 6

Move to the next node along the route (node #2).

Steps: "Select the next node (second point); double click on the image of the Residence Quad; move the Residence Quad image around using the viewing tools provided; Close the Residence Quad image"

able to do	4
hint required	2
unable to do	

Ease or difficulty to complete this task:

(1=very difficult, 7=very easy)	1	2	3	4	5	6	7
				1	2	2	1

Comments or suggestions:

Clarity needed in distinguishing one node from the other.

Task List – Step 7

Continue along the route to the final node.

Steps: "Proceed with the remaining nodes along the route and describe what your see"

able to do	6
hint required	
unable to do	

Ease or difficulty to complete this task:

(1=very difficult, 7=very easy)	1	2	3	4	5	6	7
					1	2	3

Comments or suggestions:

<i>No comments.</i>

Task List – Step 8

For the purpose of this exercise, you chose to take a printed copy of the route results with you.

Steps: "Select the "print route" button and describe what your see, then print the route information"

able to do	6
hint required	
unable to do	

Ease or difficulty to complete this task:

(1=very difficult, 7=very easy)	1	2	3	4	5	6	7
						3	3

Comments or suggestions:

<i>Like the ability to add one's own notes to a printout.</i>

Task List – Summary Questions

1. Overall, how easy or difficult did you find the Virtual Tour Route Search to use?

(1=very difficult, 7=very easy)	1	2	3	4	5	6	7
			1		1	2	2

2. Please rate the following elements of the interface in terms of ease of use:

(1=very difficult, 7=very easy)	1	2	3	4	5	6	7
entering the route origin & destination					1	4	1
using the 3D campus map			1	1	3	1	
using the 2D route map			1		2	1	2
using the QTVR images			1	1	3	1	
using the still images & text						3	3
moving through the selected route			1			1	4
printing the selected route summary					1		5

3. Would more detail of the campus (e.g. secondary pathways, stairs) help in understanding the route?

Yes – 3 (for particular areas, if one was on foot)
No - 3

4. Would the ability to resize any of the objects (like the 3D campus map) make them more useful?

Yes - 3
No - 3

5. Please rate the same elements of the interface in terms of usefulness to you in understanding the selected route:

(1=not useful, 7=useful)	1	2	3	4	5	6	7
route origin & destination lists					1	2	3
3D campus map			1		1	3	1
2D route map		1			1	2	2
QTVR images			1	1	2	2	
still images & text					1	3	2
route summary (printout)				1		2	3

6. Are there any other objects that would help with route information?

Yes - 1 (voice instructions)
No - 5

7. Rate the following elements in order of most important to least important to you in understanding the route information.

	1	2	3	4
3D campus map	1	4	1	
2D route map	3		3	
QTVR images			1	5
still images & text	3	2	1	

8. Did the Virtual Tour help with locating the Unicentre?

(1=no, 4=neutral, 7=yes)	1	2	3	4	5	6	7
					2	1	3

9. How satisfied are you with the Virtual Tour Route Search?

(1=not satisfied, 7=satisfied)	1	2	3	4	5	6	7
					2	2	2

10. Do you think enough information was provided through the Virtual Tour for you to eventually execute this route on campus?

Yes - 6
No - 0

11. What would be your preferred method of retaining the route information for your eventual trip onto campus?

commit it to memory	
take it with me (e.g. printout)	2
have an opportunity to view it again on a screen on campus	2
have the each of the nodes confirmed to me as I execute the route on campus	2

12. How would you find this route (before coming to the campus) without using the Virtual Tour website?

*Use Carleton website
Phone InfoCarleton and have them fax over a map
Look at the back cover of a Carleton University Calendar
Ask someone for directions*

13. How would you find this route (once on the campus) without using the Virtual Tour website?

*Residence Information Desk
Ask someone else in residence
Look at one of the on-campus maps
Ask someone for instructions*

14. What improvements, if any, could be made to the Virtual Tour?

*More than adequate
Some more photographs of the campus would be helpful
Add titles to the photographs*

15. Are there any other comments you would like to make about the Virtual Tour?

No comments.