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Architecture + Hypermedia

**A didactic approach to exploring architecture as
both content and method in a hypermedia environment.**

Prototype Project

**An Interactive Multimedia CD-ROM on
Exploring Sacred Tibetan Architecture**

By Katie Chau

**A thesis submitted to
the Faculty of Graduate Studies
in partial fulfillment of
the requirements for the degree of
Master of Architecture
Design & Technology Stream**

**School of Architecture
Carleton University
Ottawa, Ontario, Canada
April 20, 2000**

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Architecture + Hypermedia

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both content and method in a hypermedia environment**

**submitted by Katie Chau,
B.E.S., B. Arch., O.A.A.**

**In partial fulfillment of the requirements for
The degree of Master of Architecture**

Chair

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12 MAY 2000

Carleton University

Abstract

This thesis is an inquiry into the ways in which architecture and hypermedia can become symbiotic disciplines through the confluence of shared concepts and principles of design.

In this information age, hypermedia offers us the ability to dynamically organize and access vast networks of data, information and sensory experiences. The added dimensions of space, time, movement and interactivity generate not only much greater data storage capacity, but also more ways for improving the experiential, cognitive and mnemonic qualities of our interaction with information. Architectural principles of spatial organization offer us a way of structuring information such that the navigation through it is as intuitive as through physical environments.

In return, dynamic and interactive hypermedia environments can be applied to enhance our knowledge, experience and understanding of architecture. In my prototype, architecture is used as both content, organizational metaphor, and navigational method. This reciprocal relationship between form and content serves to reinforce and enhance the didactic quality of the prototype project.

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Definitions

Ar /chi-tec-ture *n.* [L. architectura] 1. The science, art, or profession of designing and constructing buildings, bridges, etc. ... 4. Design and construction. 5. Any framework, system, etc. 6. The design and interaction of components of a computer or computer system.

Hy/per- *prefix* [Gr. hyper-] 1. Over, above, more than the normal, excessive. 2. Existing in a space of four or more dimensions.

me-di-a *n. pl. of medium.* 1. All the means of communication, as newspapers, radio and TV, that provide the public with news, entertainment, etc, usually along with advertising. ...5. Environment. 6. Any material or technique as used for expression or delineation in art.

Di-dac-tic *adj.* [Gr. didaktikos - apt at teaching] 1. used or intended for teaching or instruction.¹

Cy-ber-space *n.* [cyber(netics) + space.]

The electronic medium of computer networks, in which on-line communication takes place.

/si:'ber-spays/ 1. (Coined by William Gibson) Notional "information-space" loaded with visual cues and navigable with brain-computer interfaces called "cyberspace decks". In 1991 serious efforts to construct virtual reality interfaces modelled explicitly on Gibsonian cyberspace were already under way, using more conventional devices such as glove sensors and binocular TV headsets. Few hackers are prepared to deny outright the possibility of a cyberspace someday evolving out of the network.²

Cyberspace: A new universe, a parallel universe created and sustained by the world's computers and communication lines. A world in which the global traffic of knowledge, secrets, measurements, indicators, entertainments, and alter-human agency takes on form: sights, sounds, presences never seen on the surface of the earth blossoming in a vast electronic night.³

virtual reality *n. Abbr. VR*

A computer simulation of a real or imaginary system that enables a user to perform operations on the simulated system and shows the effects in real time.⁴

¹ Adapted from the Webster's New World Dictionary, 3rd College Edition. New York 1988

² Howe, Denis. The Free On-line Dictionary of Computing 1993-2000

³ Benedikt, Michael. Cyberspace: First Steps. MIT Press 1993

⁴ The American Heritage Dictionary of the English Language. 3rd Ed. Houghton Mifflin 1996

Section 1

Introduction

This thesis explores the intersection of two disciplines: one with traditions that go back as far as the beginning of human civilizations, and another that is so very new that it must be defined each time its name is evoked. Everybody seems to have an idea what 'Architecture' means, even if they don't always agree on the exact definition. But the term 'Hypermedia' raises more confused eyebrows than knowing nods. How can one area of knowledge enrich the experience of another? What concepts and ideas might Architecture and Hypermedia have in common? When a computer programmer and a builder both use the word 'architecture', do they mean completely different things? Or does the common technology imply that they go through similar thought processes in their work?

Over the last few decades, with the advent of the Information Age and widespread computerization, the popular notion of the word 'architecture' has come to include something other than the traditional 'bricks and mortar' of building construction. In fact, the dictionary definition of 'architecture' has broadened such that the word can now be applied to the disciplines of computer hardware design, systems design, and information networks (to name just a few).

Having been trained and having practiced as a 'bricks and mortar' type of architect, I feel quite at home with the concepts and principles of 'Information Architecture'. As information networks become increasingly complex, their interrelationships often demand to be displayed or perceived in three or more dimensions. These dimensionally rich 'Information Spaces' must be easily and effectively navigated by their users in order to access the contents within. It is with an architect's understanding of the structure of space that I approach the design of information spaces, which some call 'Cyberspace' – a term coined by a science fiction writer, William Gibson, to describe the computer-generated environments "where humans navigate in information-based space."⁵ (See definitions above)

With this in mind, I revisited my old first-year architecture textbooks by Francis Ching, Donis A. Dondis and Steen Eiler Rasmussen and identified design principles that apply to navigation in information space as well as in the physical environment. I then compared and contrasted design concepts in the two disciplines in order to extract the synergistic issues.

This interdisciplinary exchange is a two-way street. While information sources benefit from the application of architectural principles, the ability to integrate a variety of media using software programs such as Macromedia Director presents new opportunities for displaying and

⁵ Benedikt, Michael. *Cyberspace First Steps*. MIT Press 1993

communicating the ideas behind physical works of architecture. Within multimedia environments, one can combine text, photographs, graphics, 3D models, animations, QTVRs, videos, voice-over and music, etc. into a multi-sensory experience. This experiential mode of communication is far superior to the traditional ways in which architecture has been documented and represented, namely, drawings, slides, written and verbal descriptions. Moreover, through computer simulation and the interactive integration of a variety of media, the architect may be better able to visualize his own ideas – to work out ideas from the conceptual level to physical details in the design process.

By comparing and analyzing elements and principles of architecture with those that organize the data networks in hypermedia, I have identified significant overlaps. Chief among these are the time/space concepts of movement and perception. Among the goals of this thesis is the desire to explore some of the many ways to present information, taking advantage of the time/space capabilities of new media technologies. Using my training and experience as architect, I wish to provide users with an intuitive sense of familiarity when travelling through virtual spaces, similar to what they experience in their physical environments. I propose to combine concepts from both disciplines in order to identify principles for creating truly meaningful and intuitive interfaces. I will apply the appropriate architectural spatial concepts to fit the needs of digital media.

In this thesis, I explore the design and development of multimedia computer interfaces that engage the experiential memory of physical space in order to navigate multi-dimensional virtual information environments. Such environments can be used as educational tools to enrich the users experiences and enhance their ability to move through information. Traditional 2-D, static and print-based information cannot fully address the depth of information, interconnectivity, a sense of scale and spatial concepts of certain types of content such as architecture. Limited to looking at the pictorial and textual content, users cannot absorb the information as quickly and intuitively as experiencing it immersively, whether first hand or in a virtual sense. Combining the rich media of audio, video, photography, graphics and hyperlinked contents in an interactive virtual space can enhance and extend the learning experience in many ways. While not a substitute for direct experience, it can be more comprehensive in terms of its didactic potential.

Architecture is inherently multi-dimensional and can benefit most from the use of interactive multimedia for informal learning – especially where first hand experience is not possible.

Part of the process of exploring these ideas was the design of a prototype in the form of a multimedia CD-ROM. I used the prototype to explore the use of 3-D navigational systems for virtual spaces and to apply architectural concepts to help users experience interactively what they are learning. For example, in learning about Tibetan architecture (the subject

of the CD-ROM), the viewers move through virtual spaces that parallel the structure of traditional Tibetan buildings in order to access the information. This navigational structure could, for example, provide an overall architectural context for a museum exhibit on the topic. In this case, the prototype was designed to explore the issues around Sacred Tibetan Architecture to accompany the visit of Tibetan monks who will create a sand mandala as part of a Buddhist ceremony at the Museum of Civilization on May 20th, 2000. Such an interactive CD-ROM could be installed at one of the multimedia stations in the museum.

The goal of this project is not only to apply architectural principles to the design of a hypermedia environment, but also to test the effectiveness of a hypermedia environment to explore architecture. In so doing, I will focus on the issue of navigation, developing a series of navigational tools that are extensions of the architecture itself. As the prototype project deals with Tibetan architecture,

I have integrated the Tibetan temple and mandala form as navigational devices. I also explored the possibility of integrating a variety of related but distinct ways through the same information – all of which are thematically related to the information itself. This illustrates the symbiotic relationship between information and the way in which it is delivered.

Figure 1:**Table of Comparison showing the differences in elements of design between physical architecture and cyberarchitecture**

<i>Elements of Design</i>	<i>Physical architecture</i>	<i>Cyberarchitecture</i>
MEDIA	Atoms -- wood, bricks, stone, steel, etc. (Analog)	Bits -- pixels, 'machine language', equations, algorithm. RAM, hard drive, CD-ROM, DVD, etc. (Digital)
PARAMETERS	Laws of physics, climate, Building codes, zoning law.	Computer software programs, hardware, bandwidth, W3 Consortium, NCSA.
PURPOSE	Human shelter, cultural expression, power symbol.	Navigation through data, information and other contents.
ACCESS	Doors, windows, stairs, passageways, bridges.	User interface: menu, buttons, hyperlinks, scroll bars.
MOVEMENT	Human -- walking, running, climbing, sliding, rolling (wheelchair).	Cursor -- rollover, mouse down/up, scrolling. Object -- zoom, translation (slide), pan, rotation, tilt up/down.
COMMUNICATION	Abstract expressions using form and space, light and shade, rhythm and patterns, etc. Signs and symbols, directional graphics, color coding. Style, scale, sequence and hierarchy	Icons, menus, dialog boxes, status indicator, color, graphics and text messages. Voice prompts, narrative soundtracks. Help files, rollover descriptions, alerts devices, etc.

Section 2

Concepts in Architecture and Hypermedia Design

In order to identify concepts in common to architecture and hypermedia, I will examine the similarities and differences between them. To illustrate the differences, I compare the elements of design in both physical space and cyberspace in a table. (See Figure 1) This shows the different demands placed upon the designers of these two types of space. The fundamental difference between the two realms is the presence and limitations of gravity in the physical world, and a corresponding lack of tectonic requirements in the virtual world. As William J. Mitchell pointed out in *City of Bits*,

“The Net has a fundamentally different physical structure, and it operates under quite different rules from those that organize the action in the public places of traditional cities.” “The Net negates geometry... it is fundamentally and profoundly anti-spatial. You cannot say where it is or describe its memorable shape and proportions or tell a stranger how to get there. But you can find things in it without knowing where they are.”⁶

Where as “For millennia architects have been concerned with the skin-bounded body and its immediate sensory environment – with providing shelter, warmth, and safety...”⁷

Other issues such as permanence and materiality are slowly dissolving, as physical architecture gradually becomes more ephemeral (i.e. increasingly transparent, changeable), and cyberarchitecture takes on more immersive realism and sensory involvement. The laws of physics can be simulated in algorithmic movement, avatars can take on personalities and move correspondingly.¹

⁶ Mitchell, William J. City of Bits. Pg. 8

Figure 2:
Comparison of Design Factors:

⁷ ibid pg. 43

Figure 2 outlines some of the similarities between traditional architecture and interactive information design. By comparing the main design factors and identifying common challenges, this diagram explores the confluence between the two disciplines.

Based on these comparisons, I have identified ten points of overlap between navigation in information space and movement through the physical environment. These ten topics, as shown on the diagram in Figure 2, are discussed in greater detail below. Since the prototype project focuses on navigational methods in relation to the content, I have put a greater emphasis on issues relating to the design of navigational structures and the spatial organization. By comparing architecture and information design, I hope to facilitate the transfer of skills from one discipline to the other. Specifically, my goal is to investigate the potential of applying architectural concepts and skills to the design of hypermedia information systems.

2.1 Structural Framework:

Organizational patterns, relationships and hierarchies

The first point of overlap between architecture and Information Design is the structural framework. The tectonic requirements of architecture dictates that load bearing elements be of a certain shape and size. Structural principles and mathematical formulae help determine the placement and hierarchy of members. The structural framework becomes

the armature on which the other building elements are supported.

Similarly, the organizing structure of an information system can be ordered by the importance of its parts. Although there is no physical requirement to hold up formal elements in Cyberspace, a structural framework is almost always necessary to organize the data. This is particularly essential in larger networks or databases of information, such that each part will have a relationship to the whole. Identifying the hierarchy within the organization will sort out the layers of information for easier access.

In his book *Designing Business*, Clement Mok defines "Information Architecture" as "the integration of the structures underlying a system." He has identified seven organizational models of information design. (See Figure 3) Mok contends that these "seven universal data organization models underlay the structure and presentation of ideas in multimedia environments. In turn, they support five data types: text, audio, music, pictures and moving pictures. Rarely are the seven principles applied singly to any information structure; integrated systems in both the physical and digital worlds are based on a combination of several models."⁸

The organization models described above are essentially two-dimensional arrangements. As the computing medium involves the third and fourth dimension – 3D space and the element of time - the organization becomes more complex and blended, as shown in the

⁸ Mok, Clement. *Designing Business*. Adobe Press 1996 pg. 104

following two topics. In order to clarify the dimensional properties of information design, I have created a table in Figure 4.

Figure 4:

Levels of Navigation and Types of Information Display

Spatial Dimension	Information Display	Interactivity	Technical Requirements
Level 1	Text only, ASCII codes, in paragraphs, bar charts, tables, line diagrams, etc. (without pictorial illustrations).	Hypertext, tool-bars & menus. Annotations and indices.	Lowest in computer memory requirement, bandwidth, hardware and software sophistication
Level 2	Photographic images, 'cognitive art', drawings and other representations of a 3D world within a 2D page or screen.	Image maps, large icons and interactive graphics.	Memory and bandwidth depends on size of image, its color depth and degree of compression.
Level 3	3D and moving images: Digital models, video, 3D animation, QTVR.	Interactive 3D object-oriented displays. e.g. VRML	Higher demands on memory & bandwidth. Usually require plug-in browser or viewer.
Level 4	Immersive Virtual Reality using static and dynamic stereoscopy, polarized goggles, wrap-around projections, etc.	3D mouse, joysticks, data-gloves, motion sensors, etc.	Highest technological requirements in both hardware and software sophistication

This table lists four levels of spatial dimensions, and in relation to each level, I have shown the types of information display, their interactive potentials, and their comparative technical requirements. The Organization Models by Clement Mok (Figure 3) apply to the first two levels of information display, primarily the second level. In the following two sub-sections of 'Spatial definition', and 'Movement and Access in Time and Space', I shall describe design considerations for 3-dimensional and 4-dimensional information displays.

Figure 3:

Information Organization Models

From 'Designing Business' by Clement Mok

Linear **Matrix** **Hierarchical** **Overlay** **Web** **Spatial Zoom** **Parallel**

2.2. Spatial definition: qualities of space & form.

In his book, *Architecture: Form, Space & Order*, Francis Ching identifies five main categories of spatial organization. I believe that these categories can be applied equally well to organization of informational systems in virtual space. They closely parallel and can be used to build upon the seven models of information organization identified by Clement Mok in the previous section. In comparing the models of Ching and Mok, we see a difference in levels of information display and dimensionality, namely, the added spatial qualities in Ching's models. (See Figures 5 – 9)

2.2.1 Linear (see Figure 5) – sequential spaces like linked cars on a train, this concept is very similar to the Mok's linear model. "These spaces usually consists of repetitive spaces that are alike in size, form and function. It can also consist of a linear space that organizes along its length a series of spaces that differ in size, form, or function. Linear organizations are directional, and signify movement, extension, and growth. The form of a linear organization is inherently flexible and be straight, segmented, or curvilinear."⁹ In a three dimensional structure, and linear sequence can branch out in more than one direction and become a tree or root system (i.e. part of a hierarchy). Linear spaces can terminate in an axial focus, which acts as a 'spatial zoom' in a virtual space.

⁹ Ching, Francis. *Architecture: Form, Space & Order*. p214

Figure 5:

Spatial Organization: LINEAR

An Example of Linear Organization in Architecture:

BAKER HOUSE (Student Residence) MIT, Cambridge, MA.
1948 by Alvar Aalto

Examples of Linear Organization in Information Design:

Books, slideshow, film strips or video.

2.2.2 Central (see Figure 6) – a central dominant space about which a number of secondary spaces are grouped. It is a stable, concentrated composition with a unifying central space. Hierarchy is implied in the position of the subsidiary parts, vertically and horizontally. The most obvious example in 3D centralized form is the pyramid or ziggurat. Its centrality and bi-axial symmetry give this form its dimensional stability and inherent order. Centrally planned spaces are found all over the world – in Byzantine churches, mosques, Palladian villas, Roman temples, Tibetan monasteries, etc. The power of the center as reference point makes this arrangement the most easily understood and navigable of spaces. For this reason, I have chosen a central organizing structure (the mandala) for my prototype information design, which is described in a latter section of this paper.

Figure 6:

Spatial Organization: CENTRAL

Central Organization in Architecture:

St. Louis Des Invalides, Paris, France
1675-1706 by Jules Hardouin-Mansard

Illustration from *An Outline of European Architecture*
by Nikolaus Pevsner. Pelican Books 1981

Central Organization in Information Design:

Illustration from *Designing Business* by Clement Mok
Adobe Press 1996

The QTVR - Quick-Time Virtual Reality navigational environment is a perfect example of centrally organized information system. The viewpoint is at the center of a 360 degrees panoramic loop, with embedded hot-spots to hyperlinked documents. Everything is equidistant from the center, and equally accessible to the viewer.

2.2 Radial (see Figure 7) – a central space from which linear organizations of space extend in a radial pattern. Similar to the central, but less tightly organized and more likely to be asymmetrical, it “combines elements of centralized and linear organizations. Whereas a centralized organization is an introverted scheme that focuses inward on its central space, a radial organization is an extroverted scheme that reaches out to its context.”¹⁰

Spatial zoom acts in the same way as a linear ray that culminates in a focal point or object. By focusing on a single point or object, one is oriented until that focal point is reached. From there, the search continues for the next focal point, which may lead to a node of a web or network. This type of spatial web formed by linking radial nodes are exemplified in town-planning schemes such as Haussmann's Paris or L'Enfant's Washington. They represent a less formal hierarchical structure than the rigidly centralized organization. This is used typically in web-based information system, where one screen can be the node for a number of hyperlinks, leading to more nodes.

¹⁰ Ching, Francis. *Architecture: Form, Space & Order*. p224

Figure 7:

Spatial Organization: RADIAL

Examples of Radial Organization in Architecture:

Moabit Prison, Berlin. 1869-79 Hermann

Hotel-dieu (Hospital) 1774 by Antoine Petit

Illustrations from **ARCHITECTURE: Form, Space & Order**.
By Francis Chung. Litton Educational Publishing 1979

Examples of Radial Organization in Information Design:

Illustrations from www.Incight.com showing the Hyperbolic browser.

Illustrations from the SCAD Interactive Catalogue showing the secondary navigator dial.

2.2.3 Grid (see Figure 8) – spaces organized within the field of a structural or other three-dimensional grid. A rectilinear form of matrix, it can be repeated ad infinitum and is the least hierarchical of the organizations.

The square grid was much loved and used by architects and planners, particularly the so-called 'Rationalists' school (as opposed to those of the Romantic or Picturesque School) in vogue since the 1930's. Not surprisingly, grids are the most natural arrangement of data in computer space, since Cartesian coordinates have been used in mapping out positions in mathematical and geometrical spaces for centuries.

The beauty of the grid is the persistence of its geometric order as a regular framework, even as its content changes. It accommodates a great variety of contents within its structure.

Since "a three-dimensional grid consists of repetitive, modular units of space, it can be subtracted from, added to, or layered, and still maintain its identity as a grid with the ability to organize spaces."¹¹ Database tables are the most obvious example of the use of grids in information organization.

¹¹ ibid pg. 239

Figure 8:

Spatial Organization: GRID

Examples of Grid Organization in Architecture:

ERIC BOISSONAS HOUSE I
New Canaan, CT 1956
by Phillip Johnson

Illustration from **ARCHITECTURE: Form, Space & Order**. By Francis Ching
Liton Educational Publishing 1979

Examples of Grid Organization in Information Design:

This straightforward matrix showcases 100 Masterpieces of chair design from the 20th century. Clicking on any of the squares would lead to an enlarged view with details and descriptions of that particular chair, its history and its designer.

2.2.5 Cluster (see Figure 9) – spaces grouped by proximity or the sharing of a common visual trait or relationship. They may involve overlapping of shapes and forms, a three-dimensional type of overlay.

This is the least rigidly organized of spaces, its flexibility and informal arrangement can be refreshing and innovative. However, it is also easy to lose one's bearings in groups of clustered forms and spaces, as is frequently the case in haphazardly designed cyberspace. Lacking inherent geometric order or regular pattern, clustered organizations call for some kind of thread or repetitive element to tie the spaces together, otherwise its randomness makes it impossible to navigate with any purpose in mind. The disorienting properties of this type of space are used to advantage in computer games involving labyrinths, purposely making wayfinding in virtual space a challenge.

Figure 9:

Spatial Organization: CLUSTER

Examples of Cluster Organization in Architecture:

Hotel de Matignon, by Courtonne

This plan of clustered rooms seems to follow no apparent order at first. But it was devised as a neat solution to the problem of two unaligned axes: one towards the front court facing the street, the other towards the back garden. Both entrance halls are flanked by symmetrical rooms that nested into each other.

Illustration from *An Outline of European Architecture*
by Nikolaus Pevsner. Pelican Books 1981

Examples of Cluster Organization in Information Design:

This webpage for MetaDesign is a cheeky version of the traditional advent calendar. Each little window corresponding to the date before Christmas would open to reveal an animated scene, sometimes an interactive game. The ordering device is, of course, the days of the month, and the advent theme.

2.3 Movement and Access in Space and Time: approach, circulation, view and focus. (See Figure 10)

The third point of overlap between Architecture and Information Design is the issue of movement and access. While it is perhaps a function of spatial organization (the second point), it deserves to be discussed separately.

Architecture is form and space experienced through movement in time. "The circulation path can be conceived as the perceptual thread that links a series of spaces together. Since we move in time through a sequence of spaces, we experience a space in relation to where we've been, and where we anticipate going."¹²

In this section, we briefly re-examine the spatial organization categories from the last section, with the added dimension of time and movement. This is particularly important in level 4 spatial navigation in immersive virtual reality, where the human-computer interface approximates physical movement.

Linear spatial organization can be experienced as narrative sequence. The repetition of spaces can be varied with different scale and tempo. In fact, most arrangement of spaces in architecture can only be experienced as a linear sequence, as we can only go through one space at a time. But not so in computer space; the screen or hyperspace can include any number of 'windows' or boxes where different things can go on.

Circulation patterns within a centralized organizations may be radial, loop or spiral in form, terminating in the central space. A central spaces can

act as the terminus to a linear approach, or it can serve as an object-form within a defined field or volume of space. It can also be used as a pivot point or node for changing directions.

Radial organizations lead the user outwards from the core. They may be as regular as the spokes of a wheel, or as irregular as the arms of an octopus. The radiating pinwheel pattern gives the viewer a dynamic sense of rotation around the center.

Clustered spaces can be organized along a series of axes, usually intersecting or parallel with each other. Since there is no inherent hierarchy in clustered patterns, movement within clustered spaces can be disorienting unless the spaces are articulated by their size, form or orientation. Symmetry and axial conditions can be used to strengthen and unify portions of a clustered organization and help articulate the importance of a space or group of spaces within.

Movement through a spatial grid can be quite random in nature and yet still be perfectly oriented in reference to a regular coordinates system. The strength of the cartesian grid is its ability to accommodate variants and transformations without losing its cohesive order. A grid can also have irregularly spaced modules in one or more directions, like a Tartan grid. This could articulate circulation zones that create a hierarchy of different spaces and routes within the overall grid.

¹² *ibid.* pg 246

Figure 10:

Forms of Circulation

The degree of enclosure in the circulation space determines the amount of information accessible to the browsing viewer. Concealment adds to the suspense, gradually revealing what is behind and beyond the enclosure.

Movement through space and time

Navigational interface for 1997 Interactive Media Design Review
The International Design Magazine June 1997

2.4. Visualization of Abstract Concepts.

Visualization is the ability to form mental pictures. 'To see' has come to mean to understand. According to D. A. Dondis in his book 'A Primer of Visual Literacy'¹³, vision, pre-visualization, is intricately linked to the creative leap... as primary means of problem solving. And it is this very process of moving around in mental images in imagination that frequently takes us to the point of breakthrough and solution. The architect traditionally use sketches, bubble diagrams and working models to 'flesh out' her ideas. She moves fluidly from thinking in three dimensions to representations in two dimensions. As media technologies rapidly develop new tools for visualization, architects will have 3D design tools at their command from the conceptual design phase onwards.

"We think with space. Using our mind's ability to dimensionalize information, we reduce complexity to manageable units - objects - of information. The mind uses spatial thought to manage incoming information, reducing its complexity for our use. Spatial thought forms the foundation of our awareness. Anthropocentric cyberspace (an electronic environment designed to augment our innate use of space to think, communicate and navigate our world) links to a pre-linguistic knowledge of the world - a knowledge crucial to our navigation, operation, and communication. We understand spatial representation regardless of its cultural origin. Spatial thought - a shared, human trait - underlies the images of objects and spaces from all cultures."¹⁴

For the information designer, there are many techniques in manipulating visual elements in order to communicate a range of ideas from simple to complex. In laying out the conceptual framework for an information system, flowcharts and storyboards are the most commonly used. In visualizing 3D navigational space, the information designer could well employ the same

¹³ Dondis, Donis A. A Primer of Visual Literacy. The MIT Press 1973 p. 8

¹⁴ Paraphrased from: Anders, Peter. Envisioning Cyberspace. McGraw Hill 1999 p. 9, 10

modeling tools as the architect, tools such as cardboard models, or 3D modeling software. Whether the tool is digital or physical, it has an effect on the visualization process, and on the resulting design. The designer will have to decide which tool gives the most natural, transparent and intuitive path from mental image to tangible form.

According to Peter Anders, spatialization allows the translation of problems from cognitive to experiential modes. It helps us model and organize abstract concepts by presenting relationships in a palpable way. Abstract, numerical data can be modeled graphically for easier comprehension. Spatial presentation can also show multiple resolutions to a problem, in ways that defy verbal explanations. Anthropic cyberspace (see definition in the quote on previous page) could allow dynamic motion through information, letting us rely on our instincts rather than memorized rituals of interaction. It could assist us in the navigation of information using our innate, spatial literacy.¹⁵

2.5 Systems Integration:

making disparate elements work together

The fifth area of overlap is the parallel between Architecture and Information design with respect to Systems Integration.

An architect's job involves managing many different trades and professional input. Similarly, a multimedia project may involve input from graphic designers,

¹⁵ Paraphrased from: Anders, Peter. Envisioning Cyberspace. McGraw Hill 1999 p 11,12

writers, software programmers, interaction designers and many other disciplines. The synergy and, inevitably, friction between the many disciplines required to work together necessitates well-developed communication skills. A well orchestrated project is one in which the talents and potentials of each team member contribute toward a common goal.

An architect's ability to think in many different modes simultaneously is necessary in bringing together the diverse requirements in a building project. Being aware of the requirements of the physical location, zoning, building codes, structural and mechanical systems, economics, users and owners, as well as aesthetic and philosophical ideals, is often the greatest challenge to developing a coherent design. The same ability to synthesize information from all sources and directions is valuable in an interface designer, who must balance the requirements of hardware and computer software programs with the human factors.

2.6 Contextual environment: awareness of the larger context in which one is situated.

Information rarely exists in isolation. Architecture (even theoretical projects that were never intended to be built) exists in time and space. It is the context of time, ideology and its social and physical environment. In order to present a holistic view of this environment, architects need more than the traditional tools of drawings, photographs and maquettes to understand the

relationships between a building and its context. Hypermedia allows multiple viewpoints to be accessed simultaneously.

“Information space lets us create multi-modal environments that enrich our perception and cognition of the given information. Sometimes, the relationship between modes is more important than the information we receive. Space is the matrix that lets us experience the different modes of information simultaneously.”¹⁶

We use our environment to help us think. Our consciousness extends outside our bodies into the environment. Space and its objects mediate our externalized thought to ourselves and others. Our external memories are part of a shared experience. The realm of these information artifacts is a social space – the foundation of culture. Designers of cyberspaces can learn from this human use of space – space that is full, not empty. This familiar kind of space not only gives the users an intuitive sense on the process of accessing information but also encourages social interaction.¹⁷ The fast growing popularity of chat rooms and multi-use domains on the internet is evidence of the emerging social context in cyberspace. An excellent example of how environmental context affects information design is the notion of ‘Virtual Communities’. These are on-line interactive forums for information exchange and human support network. For more details on virtual communities, refer to the Masters Thesis by Vidya Shankar Narayan.

(<http://chat.carleton.ca/~vshankar/thesis/index.html>)

¹⁶ Anders, Peter. Envisioning Cyberspace. McGraw Hill 1999 p13

¹⁷ *ibid* p 21

2.7 Marketing and Economy

The realities of working within budget are common to any commercial venture. The need for an understanding of the market demands and other economic factors is fairly self-evident for any project designer or developer. Many tools are used to study and analyze the target market before design decisions can be finalized. They include surveys, demographics, focus groups, user scenarios, feasibility studies and prototype testing.

Both architectural and information design are governed by the economy. Economic forces are a part of the larger context in which artifacts appear. The differences between information design and architectural design, however, require different methods of responding to market conditions. For example, architects usually design a single product (i.e. a building) for a single client, or group of clients, whereas multimedia designers must respond to a variety of users in a market group. Hence, usability testing is more crucial to multimedia designers than to architects. Nevertheless, gauging user response is one area in which architects can learn from multimedia and product designers. Usability testing, which forms a large and important part of the iterative design process for interaction designers, is a little known skill in architecture. With few exceptions (Charles Moore being one, who incorporated design sessions with user groups), architects generally do not consult the users for their opinions on the proposed design. With improved design visualization tools, this important two-way communication can be more easily and effectively facilitated between target users and designers.

Another aspect of economy, which is more integral to design, is the economy of means. By that, I refer to that sometimes overused quote by Modernist architect, Mies Van der Rohe, "Less is More". Not that minimalism is suitable for every project, but it is well to remember that not every new high-tech tool is necessary to achieve a design goal. Sometimes the traditional hand-rendered image can bring out the poetic qualities that are hard to come by in computer-generated images. More often than not, low-tech solutions are more ingenious than those that depend on sophisticated technology because they are forced to do more with less.

In his book, *Envisioning Information*, Edward Tufte noted that "confusion and clutter are failures of design, not attributes of information."¹⁸

Architectural devices such as concealing and revealing through layering and transparency could be transposed to information as "design strategies for reducing noise and enriching the content of displays in information space." This is one example among many.

2.8 Human Factors and Anthropometrics: human memory and cognitive abilities.

Anthropometrics, both for architects and for human-computer interface designers, involves the study of human behavior and the perceptive and cognitive abilities of human beings. The ability to anticipate the physical and cognitive behavior of users is an important design skill that affects the ultimate

success (or usability) of the product, be it a house, or a computer desktop application. In designing a hypermedia environment, the study of human cognition is perhaps of more concern than in the physical counterpart. Many of our memories, however, are derived from physical actions (see procedural memory below) and there are numerous parallels between our ability to navigate through physical space and way-finding through information space in a computer hypermedia environment. For instance, in trying to provide directions to a new user navigating through a complex series of spatial experiences, one should be aware of the cognitive abilities and limitations of the human mind.

Cognitive psychologists have identified four different types of memory, organized under the two main groups of short term and long term memory.¹⁹ Briefly described, they are listed below:

Short-term memory lasts for 5 – 30 seconds.

- Working memory – the average number of 'chunks' of information an adult can hold in his/her head at one time is about seven. Emotion, alertness and other factors can influence the agility of one's working memory at a given moment.

Long-term memory forms only when information is actively processed.

- Procedural memory, also known as motor memory or body learning, involves using parts of our bodies in learning and remembering. Some physical skills, such as riding a bicycle, can only be learned by doing. Other

¹⁸ Tufte, Edward. *Envisioning Information*. Pg. 53

skills such as using a computer, can benefit greatly by 'hands-on' training. Tactile awareness, and the experience of walking through a building often help remember the quality and arrangement of a series of physical space.

- Reflexive memory is based on automatic, instant associations (such as using flash card to teach math facts). Frequently, this type of implicit, non-declarative memory is based on rote learning, and will not develop a reliable system for memory retrieval.
- Episodic memory is based on experiences, events and memories in context. It has unlimited capacity, forms quickly and requires no practice. It is enhanced by sensory input: sights, sounds, smells and movements. Recall is triggered by contextual cues such as location and emotions. This type of memory by association is by far the most powerful, immediate and lasting of all types of memories. Learning that can tap into this kind of memory system can be recalled in the most complete and meaningful way.

"Memory images must be labeled and organized within a propositional superstructure, perhaps a bit like hypermedia where graphics files are linked to attachment points within a large text or database."²⁰

"Experiencing information in more than one sensory mode can help us understand and remember more easily. Our ability to transfer cognitive artifacts into an experiential mode is a powerful tool for thought. Once expressed, they can be evaluated and critiqued."²¹

¹⁹ Partially derived from 'Cognitive Psychology' 5th edition by Robert Solso

²⁰ Pinker, Steven. How the Mind Works. W.W. Norton & Company 1997 p. 295

²¹ Anders, Peter. Envisioning Cyberspace. McGraw Hill 1999 p. 25

This type of experiential and multi-modal cognitive environment is further discussed in the section on Memory Palaces. The proper use of architectural metaphors can allow us to use our episodic, or associative memory to its full advantage.

2.9 Communication: perception and comprehension of signs, symbols, patterns and images

Studies in cognitive psychology indicate that humans' pattern recognition abilities can best be described as prototype matching. Repeated exposure to a number of similar patterns leads the mind to create some kind of abstraction of the patterns stored in our long-term memory. That abstraction then serves as a prototype to be used for later identification of the same type of pattern. For example, in learning the letters of the alphabet, we learn to recognize the individual letters in their many forms or fonts by repeated exposure to the letter and variations thereof. The prototype can be generated from the average, or mean, of a set of exemplars. It may also be the mode, or most frequently experienced combination of attributes. Thus, our past experiences and memories bring a unique meaning and perspective to our immediate present situation.

Formal perception is a three-dimensional, advanced form of pattern recognition. Gestalt psychologists have been trying to decipher how the human mind perceives form and space.

“The tactile awareness of our immediate environment since childhood is quickly augmented and superceded by the iconic – our ability to see, to recognize and understand environmental and emotional forces visually. ‘Visual literacy’ is the ability to make and receive visual messages. Although it varies according to each individual’s aptitude, culture and educational background, the visual input is usually considered the most direct, swift, dependable and comprehensive of all the senses.”²²

In developing a visual syntax, many of the guidelines for understanding meaning in visual form stem from the investigation of the process of human perception. Visual elements include: line, color, shape, direction, texture, scale, dimension, motion. The combination and variation of these elements are used to express and communicate ideas and information non-verbally. Architects, graphic designers and computer interface designers must be able to effectively manipulate these visual elements. “Solving a problem simply means representing it so as to make the solution transparent”²³

Christopher Alexander’s theories about Pattern Language in architecture, have been widely applied by computer scientists in the area of software design and object-oriented programming. His ideas, while still controversial, can surely spark a dialogue between designers of virtual, information space and architects of physical space.

2.10 Aesthetics and Style

From the studies of architecture throughout history, we can deduce that the best examples have certain common elements. Proportions, scale, rhythm

²² Dondis, Donis A. **A Primer of Visual Literacy.** The MIT Press 1973 p. 1,2

²³ Simon, Herbert. **The Sciences of the Artificial.** The MIT Press 1981 p. 153

and an overall sense of harmony or balance seem have characterized many of the best examples of architecture until the modern age of deconstructivism. The Modernist motto "Form follows Function" leaves out the element of aesthetics as being arbitrary, unnecessary and superficial (unless functionality itself can be developed into an aesthetic). In the Post-Modern age, decorative elements re-emerged as a response to years of austerity, until it, too, is satiated. And so swings the pendulum of aesthetic taste.

In the realm of information design, the interface designer, or the graphic artist usually handles the "look and feel" of the project. The graphic designer is trained to communicate effectively with visual elements, usually in two-dimensions, as the product is bound for the printing press. The use of color, typography and composition usually reflect the current style and trends. The graphic style should also reflect the identity of the client or product, which is behind the project. Whether the result is beautiful, or shocking, depends on the type of reaction to be elicited from the users.

Conclusion to Section 2

In summing up, these ten points of confluence between architecture and information design may have varying degrees of importance and levels of interchange. But they reveal that the two disciplines can learn much from each other, in a two-way exchange

The ideal balance may be expressed by Vitruvius's dictum: "Firmness, Commodity and Delight".²⁴ In other words, good design in architecture or information software must be well-built, user-friendly and beautiful.

The structural framework must first be established before further development. This is true whether one is building a website, or a house. And to have the structure firmly grounded in its context and environment is the first step towards having a well-built design.

To achieve "Commodity", the designer must consider all the factors of Anthropometrics, Communication, Market & Economy, Movement and Access. These factors inform the designer about the needs of the target user, so he/she can organize the content, or building elements, accordingly. Systems Integration and Spatial Definition are ways of orchestrating these elements, making the different components work together.

The aspect of providing "Delight" cannot be overlooked. In the highly competitive world of information design, what distinguishes great design from what merely works is frequently a highly tuned sense of aesthetic. Far from being decorative touches put on as an afterthought, a coherent visual design is the thread that ties together the whole project. After all, the first impression one receives from a visible product is its "look and feel".

To illustrate the transfer of these skills from architecture to information design, I have chosen the memory palace as an example of an appropriate architectural metaphor in information design.

²⁴ Marcus Vitruvius Pollio. *De Architectura*. Book I chapter 3

Section 3

Architecture + Hypermedia: memory palace as cognitive architecture.

In considering the above ten points of comparison between architecture and information design, it may be helpful to look at an example to illustrate how the confluence of these two disciplines can be made to work utilizing most of the design factors as discussed. As Peter Anders explained so eloquently in his book, *Envisioning Cyberspace*, three-dimensional objects can act as mnemonic devices. We can use mental artifacts as reference frameworks for detailed observation. We control our interaction with them by shifting our attention and focus. At the largest scale of attention we can see overall configurations; zooming in and scrutinizing an object reveals increasing detail. In this way a physical object potentially holds an infinite amount of information.²⁵

"Mnemonic structures have a tradition that reaches back to antiquity. In the classical Greek art form of rhetoric, the orator is required to memorize and recite great quantities of information. To aid his memory, he created complex and highly evolved mnemonic structures called memory palaces. These mental spaces were sometimes derived from the layout of an existing building or city, but they appear largely to have been fabrications suited to each individual. The memory palace was a non-linear storage system... a random access memory responsive to the user's situation in imagined space. It was ideal for spontaneous rhetoric since the speaker's narrative was mapped as a path through space. Alternate paths through the palace would produce a different recitation."²⁶

A repetitive, grid-like organization would not be suitable for a large memory palace since the palace's effectiveness depends on landmarks,

²⁵ *ibid* p. 29

orientation and recognizable spaces. Memory is scaled down to a level that can be readily grasped. The operation of such a palace involves a combination of cognitive and perceptual modes. The imagined sensory experience of the space helps the user recall and relate thoughts and memories. The virtual movement of the user through imaginary spaces reinforces the memories through the repetitive reconstruction of the spaces and their contents.²⁷

When considering the confluence of architecture, cognition and virtual environments, the memory palace could resurface as a model for Cyberspace. Such a structure would allow users to navigate and recall stored information in an intuitive, spatial manner. A truly cognitive memory structure must provide a stable frame of reference for information to be retrieved easily. Unlike traditional mnemonic devices, however, cyberspace models of memory would be visually verifiable. Moreover, the architecture of the structure could be more responsive to changes or reconfigurations for specific uses. The results would be a multidimensional construction of spaces, forms, symbols and relationships.

Hypermedia, as dynamic environments for interactive information access, can truly benefit from the skills of architects in applying models such as the memory palace to cognitive structuring of virtual environments. As evident in the sections comparing the elements and design processes of architecture and information design, the similarities in designing physical space and cyberspace are numerous. Like the memory palace, the use of the

²⁶ ibid p.31

principles of spatial organization, circulation systems, order, hierarchy, and other formal concepts would clearly distinguish a well-planned virtual space from a disorganized jumble.

Section 4

Hypermedia Applications in Architecture

Hypermedia is an extension of what is popularly known as 'multimedia' – an aggregation of information in the form of graphics, text, audio, video, animation, etc., usually in an interactive format. "What constitutes 'Hypermedia' is the capability to quickly access additional information related to the information currently under consideration. In terms of basic interactive processes, it is primarily a *skip and jump* approach to information acquisition that is made possible by hypermedia."²⁸ Related to, and including notions such as hypertext and hyperlinks, the term hypermedia was born of the ability of the computer to access huge databases of information accurately and categorically.

Properly designed, navigation through a hypermedia environment can be an intellectually stimulating and sensorially engaging experience, motivating users to do so for its own sake and on their own terms. The impact of such information-rich learning context, compared to the mainly book-based learning of just a generation ago, will greatly affect both how and how much this present

²⁷ *ibid.* p. 32

²⁸ Jonassen, David. *Designing Hypermedia for Learning*. Springer-Verlag, Berlin.

generation of students learns. For cultural institutions such as public museums, the appeal of interest-based, self-motivated learning is self-evident.

“The Canadian Museum of Civilization (CMC) is among the forefront of international museums using new technology to enhance the display of its collections within the Museum as well as in making electronic images and information accessible in keeping with its ‘Museum Without Walls’ mandate.”²⁹

“It is already clear from studies of the use of IMM (Interactive Multimedia) programs in museums that today’s audience is receptive to this technology of interpretation and that it can increase visitors’ understanding of exhibits.”³⁰

Whether within or outside of the museum context, hypermedia can benefit both the study and design of architecture. In the previous section, I explored the relationship between principles of architectural design and information design – to make a case for the application of architectural principles in the design of hypermedia. In this section, the emphasis is on exploring the didactic potential of hypermedia in the understanding and the experience of architecture. I have identified five major categories:

- 4.1 Analysis** – Hypermedia can be a powerful tool for analyzing and studying the various elements of architecture. For example, 3D models, when viewed from any angle in real time, with levels of detail down to the assembly of the smallest components, can explain the intricacies of the construction better than any verbal description, or even close-up photograph. Using widely available interactive 3D viewers such as Quick-Time movie player for QTVR and Cosmo Player for VRML (Virtual Reality Modeling Language), 3D study models can be

²⁹ MacDonald, G. and Corcoran, F. CMC’s 3D Virtual Reality Theatre. 1998

³⁰ MacDonald, G. and Alsford. Towards the Virtual Museum.

dissected, exploded and animated in many ways. The environmental effects of light, air movement, material decay, contextual views, etc. can be simulated in timed sequences. Historical changes such as additions and demolitions can be recorded in video for studies in building conservation.

4.2 Communication & Visualization – The abstract ideas behind architectonic concepts can be better understood visually by being demonstrated in three dimensions. The fourth dimension of time, in showing its effect on a building or in movement through space, can also be better demonstrated in hypermedia than in any traditional media. Although there is no substitute for the direct (actual physical) experience of architecture, there are limitations to this physical experience. For example, when visiting a building for the first time, our initial impression is colored by subjective factors – our mood, pre-occupations, and external factors - time of day, etc. We can only experience one space at a time, and at one scale. Unless presented with a floor plan, our sense of the overall spatial arrangement may be disjointed and incomplete. Many elements are usually hidden from view, such as the structural and mechanical systems, that are commonly represented in a building section drawing or exploded axonometric. In a hypermedia environment, one can access a number of different views at once. The scale and level of detail can be adjusted within the parameters set by the designer and the user.

The ability to upload this kind of information onto the Internet greatly adds to the power of communication between professional consultants, and between

client, user and designer, overcoming geographical boundaries and distance. The 3-D and 4-D representations of architecture has greatly eased the communication boundaries between architects and their client or user, replacing or augmenting the traditional 2D architectural representations, which are difficult for most lay-people to understand.

4.3 Design – Much has been written on the pros and cons of architectural design using digital tools such as CAAD and 3D computer modeling software. 'Digital Design Studios' was the main topic of discussion at the ACADIA conference of 1998. Its many presentations showed that software developers have been attempting to reconcile the traditional design methods of architects (pencil and paper, cardboard models, etc.) with the latest digital tools, bridging the gap between 2D representations and 3D spatial thinking.

As more designers adopt and adapt to these new digital tools, they are seen less as clumsy impediments to the creative flow of ideas (as earlier CAAD tools commonly were), and more as extensions to the creative imagination. The advantage in designing with digital tools lie in their visualization capabilities (design feedback in three or more dimensions), flexibility of viewpoints, levels of detail and ease of making changes. Since the use of virtual reality in the ideation of design is still in a developmental stage (see Digital Clay, The Grid Sketcher, and The Impact of Virtual Reality on the Design Process from the Acadia '98 Conference Proceedings), I will concentrate on the role of VR in communication and education in this paper.

4.4 Public education and information about architecture:

As architects do not generally devote a lot of time and resources to marketing and publicity in promoting their services and projects, there is a lack of public knowledge and understanding about what constitutes good architecture. An uncaring and indifferent public usually gets banal and uninspired buildings. Furthermore, bottom-line oriented clients without any vision of creating a better environment create the kind of faceless boxes that infest every modern city and (especially) suburb. On the other hand, it has been my experience that awareness of great architecture generally leads to a more discerning eye. I believe that public education, beginning at the primary school level and continuing through adulthood, is the answer to creating public demand for a better designed environment.

Since it is unlikely that architecture will ever be required on the public school curriculum, (given the current climate of basics-only, cost-cutting school board budget), learning about architecture must be made enticing and accessible enough to be interest-driven. Just as kids need no prompting to watch well-designed educational TV programs, or to learn to play computer games, they could be drawn into a thought-provoking and visually delightful program that teaches the concepts of architecture. Computer games (such as the popular 'Pandora's Box', with its sumptuous graphics and challenging puzzles), can also help develop our 3D visualization skills. If such ingenuity were directed into developing software for architectural education, the impact would be significant. Examples that demonstrate public demand for media-rich

information about architecture include:

Salamandre: Chateaux of the Loire. A laserdisc that uses the 'step' function (forward or back one frame at a time) so viewers can interactively review the historical process of additions, demolition, destruction and rebuilding of the castles in computer-generated massing models.

Inspired by Bach: I Carceri - the second of the series of six videos featuring Yo-Yo Ma playing the Cello Suites by J.S. Bach. A beautifully rendered digital model based on the etchings by Piranesi (an 18th century architect) provide the setting for Ma, performing with acoustical adjustments to simulate the sound effects in the virtual environment.

Though limited in interactivity, these examples show that architectural education for the public can take many forms (including entertainment), using any of the media commonly accessible. Well produced, this type of project can whet the public appetite and appreciation for good architecture.

Outside of the school system, cultural institutions such as museums and art galleries can bridge the educational void by creating and installing interactive programs to teach the public to understand and appreciate their built environment.

4.5 Preservation and restoration: In order to preserve what is remaining of architectural history, digital modeling and recording devices may soon replace or replicate historical buildings threatened by demolition, and/or damaged by

neglect. The development of photogrammetry, laser scanning, detailed digital models and QTVR are among the technologies that can help record these buildings for posterity. Immersive technologies increasingly add to the sensory realism, giving a virtual materiality to the VR interface. Rather than replicating the complete architectural experience, these digital simulations can supplement direct knowledge with detailed and accurate depictions of all aspects of the built environment. More complete than a set of measured drawings, photographs and videos, hypermedia can integrate all the information about a building into a holistic package. Moreover, it is interactive and caters to the user by providing relevant information and details on demand. It can be used to communicate both intangible qualities and the quantitative aspects of architecture.

Conclusion to Section 4

In this general overview of hypermedia applications in architecture, I have offered examples of how hypermedia can be used in the analysis, communication & visualization, design, public education, and the preservation of architecture. Given the current state of technological advances, I feel that the most valuable quality of hypermedia lies in its multi-modal flexibility – allowing the user a variety of ways to go through the content. The application of hypermedia to architecture can be grouped into two main categories: generative tools and descriptive tools. Analysis and design can be considered generative, formative processes dealing with the creation and articulation of ideas. The second group, including communication, education and

preservation (archival recording) involve describing and presenting to others fully formed ideas. Visualization is the thread that runs through both categories.

As many architects are still doubtful whether the latest technological tools will help create better architecture, the merits of hypermedia as generative tool are debatable. I have no doubt, however, about the descriptive potentials of hypermedia. Both in my research and in the design of my prototype, I have tried to examine the many ways in which hypermedia can have didactic applications in architecture. The following are a few examples of the use of hypermedia to explain and explore architecture. Unlike the videos mentioned above, these environments are delivered on such applications on CD-ROM and over the Web.

Section 5

Examples of hypermedia applications in architecture

On-Line

5.1 The Canadian Museum of Civilization - Mysteries of Egypt Virtual Tour

www.civilization.ca/membrs/civiliz/egypt/egqtv1e.html .(See plate 1)

This pilot project achieves the purpose of both providing contextual information for museum exhibits and using the navigation through a virtual space as an architectural experience. It is a fine example of the didactic possibilities of simulating the physical experience of moving through a series of spaces. It uses VRML to allow users to navigate through the tomb of Tutankhamun.

Through a representation of the landscape and pyramid form by simple 3-D modeling and texture mapping, it provides a virtual experience in exploring the famous Egyptian tomb. To improve on the physical experience, there are hyperlinks to full frontal views of murals if they are obscured by other objects in the perspectival view.

The drawbacks are common to most applications of VRML on the web. Given that the controls in a VRML browser are tricky to master, and the downloading time may be an impediment to those with low bandwidth, this application may still have to wait for full public acceptance in the future. The cross-platform

Plate 1:

Tomb of King Tut: Interactive VRML Journey From the Canadian Museum of Civilization website

Enter from outside the tomb

Hyperlink

The Burial Chamber

Elevation of the North Wall and
detail description.

issues have not been resolved by VRML developers, as VRML viewers are only available on SGI (Silicon Graphics) and PCs, not on Macintosh computers.

5.2 The Canadian Museum of Civilization – Canada Hall Virtual Tour

<http://www.civilization.ca/membrs/canhist/qtvr/cagtvr1e.html>

In this series of interlinked QuickTime VR movies, viewers are invited to “embark on a journey through time and see exhibits on aspects of Canada’s social and economic history.” Each movie module contains an interactive panoramic view of a separate space in the tour. Each module is connected to one or more module in the multi-nodal system, or they can be downloaded and viewed individually. The hotspots, or hyperlinks in the panoramic movie are embedded in doors or passageways to simulate physical passage through the spaces.

Navigation is simple and intuitive – clicking and dragging the mouse directs the view in any direction interactively. Zooming in or out is achieved by pushing either of two keys on the keyboard. The cursor changes into an icon when it rolls over a hotspot. Best of all, this technology is cross-platform, all you need is Apple’s QuickTime VR player which you can download for free.

This tour is much less demanding of the navigational skills of the user than the VRML tour, one does not ever crash into walls, or turn upside down, getting disoriented and confused about which button to push. This virtual experience of Canada Hall gives a good overall feel for having visited the place. But in order to view the exhibits within, another level of detail need to be inserted where the image resolution fails to be legible. Further improvements could

include a map or floor plan showing each node in context with the whole series of spaces. The next example met these two challenges simply and elegantly.

5.3 Philadelphia Museum of Art – Mademoiselle Pogany by C. Brancusi

www.narrativerooms.com/pogany/vr/index_a.html. (See plate 2)

This application of VRML, with the help of Java coding, managed to improve the non-intuitive interface of the usual VRML browsers and overcome the confusion and awkwardness of most VRML navigation. It borrowed some of the conventions of QTVR (see example above) in using the cursor to direct movement through the virtual space.

This is closest to the idea of the virtual museum experience, with its continuity of space, exhibit layout by 'rooms' and text/image panels suspended along the passage. The user enters by approaching the doorway, which opens to reveal a 'corridor' leading to panels of information and 3D models of Brancusi's sculptures. The architectural surroundings are pared down to the essentials for navigation and spatial context: Freestanding portals separate the different topics, there are no walls or ceilings, but movement by cursor is confined to the space intended for navigation (there is no falling off into a void of no return).

The user is gravity bound, and a patterned floor helps identify the route to follow. The content (text and images) are suspended in panels, similar to museum display panels. When a 3D model is approached, there is the option to click in order to circumnavigate the object without veering off to the side.

Other than this clickable box, which only appears when needed, there is no

toolbar to confuse novice users. The only tool is click and drag. (Movement: up=forward, down=backward, right and left)

Best of all, there is a floor plan that shows continuously the location of the user. A red arrow follows the movement of the viewer, indicating his position and the direction of view. This ensures that the user is never lost, and can always return to a previous position.

Unlike the King Tut VRML example, however, there are no clickable objects in the VRML world to take the users to a higher level of detail. As the user zooms in, objects appear more detailed; zooming out, farther objects disappear from view. This is the most intuitive and well-designed VRML interface that I have encountered.

Plate2:

5.4 Smithsonian Without Walls and the Hyperbolic Tree Grocery Shop

www.si.edu/revealingthings/

www.inxight.com/Demos/HT_Tour/First_Experience.html

The Smithsonian site uses the "thinkmap" applet designed by graduates of the MIT Media Lab to dynamically regenerate content relative to the current navigation position. Whereas the Inxight example utilizes a hyperbolic browser technology to generate representations of the data content, and to facilitate dynamic motion through the information. This technology offers controllability of the virtual environment: motion, color, aspect, ratio and size of the content. Both sites evoke space in an abstract sense; a branching 3D information structure approaches an organic architecture – ever growing, yet integrated with the whole. This concept is a brilliant multi-dimensional transformation of the common tree (or root) hierarchical organization of information. It allows visualization and manipulation of large hierarchies, all the while relating to the context of the whole system. Using a fisheye view (or hyperbolic lens), selective focus and freedom of movement, a huge amount of data can be accessed on a relatively small screen.

Interactive Kiosks

5.5 The Detroit Institute of the Arts interactive kiosk was the first and the best

experience I had with an interactive kiosk in a museum. Its touch-screen display provides an extremely intuitive interface for most people. The response is immediate and the navigation is well mapped and easy to understand. The interface starts on a broad scale with a world map, pinpointing the location

from where works of art originate. One can also search for artifacts by time period, or via an interactive scrolling time-line. (See plate 3)

'Explore the stories behind select works of art in the DIA collection' – one can explore the context in one of several ways: find out how the artwork is displayed, how it was made, the materials used, and its social/cultural context.

The display is engaging, informative, easy to use and to navigate. The only thing missing (and perhaps it will be added later) is three-dimensionality.

Some of the art objects would benefit from being shown as Quick-Time object movies, and interiors could easily be displayed as QTVRs. Nevertheless, this example shows how hypermedia can add contextual information to enrich the museum experience.

Plate 3:

Screen prints from the Detroit Institute of Arts
Interactive Touch-screen Kiosk on African Art.

5.6 The Tourist Information Centre at Metcalfe and Wellington St. in Ottawa

includes touch-screen interactive kiosks that provide information on sites of interest to visitors. From an interactive map of the city, the user can choose a part of town using buttons that highlight the locations of interest. One 'click' brings them to a brief description and graphic information about the location including QTVR panoramic views. Unfortunately, the QTVR views are not always well-chosen to describe a specific building, which may be hidden behind trees. The panorama is ideal for showing interior spaces, or outdoor 'rooms' such as an urban square, but it does not show more than one perspective view of a building. The designer of the display should avail himself of a greater variety of media (e.g. aerial views, QuickTime object movies, video clips, etc.) to appropriately show the building or site of interest to the user (in this case, probably a tourist visiting the city).

5.7 The Museum of Civilization includes a few interactive workstations installed amongst its current exhibits. The hardware interface is a fixed 'mouse' with a touch pad similar to that of a laptop computer. It takes a while to get used to the control, for those who do not work extensively with laptop touch pads. The content of these workstation provide little more than photographs and text descriptions of the associated exhibits. They do not seem to add much contextual information to the exhibits at hand.

CD-ROMs

5.8 Building for the Future – A web-based multimedia project commissioned by Publics Works and Government Services Canada to showcase its advanced research and development techniques. The VRML navigator developed by Robert Gascho of Abstract Solutions Inc. is the first truly interactive 3D virtual object I have encountered in a non-gaming CD-ROM. However, the navigator is too small and the user cannot see the images before they are chosen (by clicking on an image). Because the navigator is a series of abstract geometric solids, and does not relate formally to the content, one has to experiment to find out how to get to the information desired. Virtual Reality Modeling Language is also a potentially disorienting device; if one is not familiar with the viewer controls, it can be frustrating to navigate with them. Once accustomed to the device, however, the logic is clear –projects are arranged by years, and each year is represented by a sphere surrounded by image card that triggers the information displayed on the rest of the screen. This navigator is extremely compact and works well if browsing freely and aimlessly. But to remember where one has been and find out in advance where to go is not so easy. (See plate 4)

Plate 4:

An Example of Interactive 3D Navigator

By Abstract Solutions Inc.

Using VRML (Virtual Reality Modeling Language), a 3D Navigator is created to display interactive panels of projects, grouped according to the years in which they were active. The Navigator begins as a set of cones, which opens when clicked on, to reveal a column of spheres, each representing a year. When a sphere is clicked on, a set of panels surrounding it appears, each one hyperlinked to a project described on the rest of the screen.

As the VRML browser allows the objects to be manipulated all around, one can look at the navigator from any angle, zoom in or out, and rotate, pan, tilt, etc.

The only drawback is that the navigator is so small that it is nearly impossible to see what is on the panels. So the user does not know what the project is about, until it is clicked on, and the hyperlinked page is downloaded.

5.9 The SCAD (Savannah College of Art and Design) Interactive Catalogue of

1998-99 is a skillfully prepared guide to the campus and its programs. It uses a computer generated 3D mobile that users can rotate or slide up and down to browse through a hierarchy of choices. It is effective and fun to use. The campus tour starts with a downtown map of Savannah. The user can pan the map with a virtual magnifying glass and click on individual building. Each campus building has a floor plan with hot spots that launch Quick-time panoramic movies. Each QTVR node is linked to adjacent nodes using hot spots. (See plate 5)

5.10 Puppet Motel CD-ROM by Laurie Anderson, produced by Voyageur. This is

an example of the use of architectural metaphor to structure a set of narratives and events. In choosing to use a poetic and evocative look and feel, the author foregoes the usual 'safety net' of a control menu for the user. There is no back, help or skip buttons. It is not clear which part of the screen is interactive, and the user has no overview of the architecture anywhere in the process. As a result, the navigation can be disorienting and frustrating. Instead of being a memory palace, it is a labyrinth where one is lost and trapped. Presumably this was intentional and was meant to be part of the experience provided by the author.

Plate 5:

SCAD Interactive Catalogue: NavMobile

This well-designed and richly interactive CD-ROM uses nearly all of the Organization models as outlined by Clement Mok in his book, *Designing Business*. This includes:

Linear - video interviews, descriptive text and images with scroll bar.

Hierarchical - the NavMobile is a 3D form of the hierarchical structure.

Matrix - the map of the city

Spatial Zoom and Overlay - the magnifying glass

The QTVR interactive map is found below the campus tour icon.

The magnifying glass act as a device for spatial zoom. Whilst the map of Savannah act as a contextual matrix in which campus buildings are located.

Video interviews are found in various locations of the mobile.

The dial further directs the user towards another level of navigation. This is an example of central organization, not included in Moks list.

5.11 The Metropolitan Museum of Art's **Fun with Architecture**

- rubber-stamp set goes interactive!

"This Parents' Choice Gold Award-winning CD-ROM teaches your child the building blocks of architecture... while they play. Building upon the foundations of the inkspad and stamp game, this interactive *Fun with Architecture* features forty-five different shapes, twenty-four textures and colors, and dozens of building templates and colorful backgrounds. Your child can combine them in literally thousands of ways to design, create, and assemble an unlimited variety of buildings and vehicles - even entire towns and cities! Templates of temples, drawings of drawbridges, and marvels of marble are now all child's play. Plus an introduction to design by architect David Eisen. "

What this educational children's CD does not include in its 'architectural fun' is any experience of manipulating space and form in virtual 3D. Since architecture is all about the design of space and form, not about cutting and pasting colorful textures and shapes, I think the author has missed a great educational opportunity.

Conclusion to Section 5

In summary, the examples cited above show a great variety of navigational systems through virtual space. The museum examples obviously have a more didactic nature to their use of space, while others use architectural space as metaphor to their arrangement of information (e.g. Puppet Motel). Architecture is either the content, or the context, or the method of organizing the information. In my prototype project, I demonstrate how architecture as content and method can be integrated to provide context for a museum exhibit.

Section 6

Prototype project:

An Interactive Multimedia CD-ROM on Exploring Sacred Tibetan Architecture

As I have researched the principles and precedents to explore and demonstrate the interrelationship between architecture and hypermedia, I undertook the design of an interactive CD-ROM. It allowed me the opportunity to apply architectural principles to the design of a multimedia environment – to test whether my skills as an architect could be, as I contend, of use in the dynamic organization of information. Moreover, choosing architecture as the content of the project allowed me to explore the many ways in which hypermedia might be used to help explain abstract concepts in architecture. Finally, the prototype allowed me to explore the relationship between content and navigation. My goal in this endeavor was to design a navigational system that is both didactic and appropriate to the subject matter. This was both a conceptual and a technical challenge. Throughout the prototype, I have incorporated examples of the many types of information navigation systems discussed earlier in this paper. By applying and testing these systems, I hope to have gained additional insight into how well the different applications perform with different users and scenarios.

I chose to create a CD-ROM on the Sacred Architecture of Tibet for a variety of reasons. First of all, while little is known about Tibetan architecture

because of the remoteness of Tibet, it can immediately attract one's attention and engage the imagination because of its exotic and colourful nature. The plight of the Tibetan people and the precariousness of their cultural traditions (including their architecture) under Chinese occupation makes it a worthwhile subject to study and to promote. Moreover, traditional Tibetan architecture is in danger of disappearing completely, as most of the historical Tibetan architecture within the 'Tibet Autonomous Region' have been destroyed in the last fifty years. New constructions, however well-intentioned their builders, rarely preserve the rich cultural traditions in a comprehensive sense. Educational multimedia can help increase public awareness and generate support for the preservation of this unique culture.

Secondly, I was attracted by the extensive collection of photographs taken by William Semple, of Tibetan Architecture both inside Tibet and in the surrounding exiled Tibetan communities. Never having been to Tibet, Bill was kind enough to provide a tremendous resource of high quality images and information about Tibetan culture and architecture. I have incorporated Bill's writings and photographs as content in my project. Finally, I hope to display this CD-ROM in a museum exhibit of Tibetan artifact, or of a cultural event such as the Sand Mandala ceremony performed by visiting Tibetan Buddhist monks at various institutions around North America..

To demonstrate the freedom of choice and the simultaneity of experience made possible in hypermedia, the screen is divided into sections with different degrees of interactivity and dynamic viewpoints. For example, the

plan layout of the monastery complex at Samye is shown simultaneously in plan, aerial photograph, and in QTVR (Quick Time Virtual Reality). The user can see the geographic context of the surrounding landscape, the geometry of the plan design, and can manipulate the 3-dimensional model to view the complex from different angles. This interactive and multi-faceted experience helps strengthen the understanding and memory of the architectural organization of the building complex.

Moreover, applying architectural principles to structure and guide the interaction between the user and the digitized information adds another layer of meaning to the content organization. Just by exploring the information structure, the user experiences information in the same ways as he/she might experience the architecture, albeit on a very basic level. There is reciprocity between form and content. This simultaneity of different levels of meaning serves to reinforce the overall concepts of space and form, time and movement in Tibetan architecture.

I exploited the richness of the media to extend the experience of the content beyond still images and text. Two types of 3D digital models are used in the project: a massing model of a Tibetan monastery and an abstract model derived from a sand mandala drawing. The first is a representational model that serves to give the viewer a sense of spatial continuity, a contextual link for the photographs depicting views of different parts of a monastery. The second is a navigational model based on the spatial hierarchy of the mandala form. There are obvious parallels between the two models –both are based on the

concentric mandala form. The viewer is encouraged to go from the outside in, from general to specific, from bottom to the top, from the worldly to the sacred. A circumambulatory movement is emphasized repeatedly in the animation of the models. This is reminiscent of the circumambulation rituals performed by pilgrims around holy objects and sacred sites. In this manner, the user can virtually experience the basic approach to Tibetan sacred architecture without having to read the text or view every photograph.

The CD-ROM begins with:

- 1) A linear narrative – a journey into a part of the world that was so remote that little was known of its culture and architecture until the twentieth century. This photographic journey sets the context for the audience, from the geographic and historical perspectives to the social and cultural issues that shape the unique architecture of Tibet. This linear movie, or slideshow, is the least interactive portion of the program; its passivity is intended to allow the audience to enter, settle down and orient themselves to the context - much like a front porch to a house or an overture to an opera. (See Screens 1 & 2)

The main body of the CD-ROM is offers a variety of ways to experience the information.(See Screen 5) Using the visual metaphor of a three-dimensional mandala², the user has the choice of various levels and arrangements of information. Outlined below and organized relative to degree of interactivity are the four navigational modes employed in this project - with some allowing more freedom of choice and others following a structured path.

Plate 6:

Prototype Project - Exploring Sacred Tibetan Architecture Introduction

Screen 1: Zooming into the map sets Tibet within its geographical context. The image revealed behind the cutout gives the impression of flying over the Himalyan range into Tibet.

Screen 2: A multiple slideshow sets out the parti for the four thematic approach in the section to follow.

Plate 7:

Prototype Project - Exploring Sacred Tibetan Architecture Main Menu

Screen 3: This main navigational menu shows five types of informational access.

Screen 4: As the help menu, the same informational structure is laid out in a more traditional flow-diagram, showing the choices and the sub-topics at a glance.

Plate 8:

Prototype Project - Exploring Sacred Tibetan Architecture The Mandala Navigator

Screen 5: The 2D plan of a mandala is used as a navigational device. It acts as a directional matrix, combining the freedom of choice with a clear sense of directions and of the relationships between the parts.

Screen 6: As a mandala is intrinsically a 3D mental construct, I show the transformation of the 2D plan into a 3D model. It possess the same access to information, but now the vertical hierarchy is apparent.

Plate 9:

Prototype Project - Exploring Sacred Tibetan Architecture 3-D Animation and Navigation

Screen 7: QTVR interactive object model of Samye Monastery

Screen 8: Animated walk-through
of the Monastery cloisters.

Screen 9: Navigating through the interior of the 3D Mandala.

Screen 10: 'Circumambulating' the exterior of the 3D Mandala. The hierarchy of importance and sacredness suggested by the levels of opacity in the walls and their vertical relationship to each other..

- 2) The outer ring of the mandala takes you to the least structured way of navigation, a QTVR model. The user has maximum freedom of movement around the three-dimensional model of the monastery. He or she can manipulate the object by tilting, rotating and zooming, giving the virtual experience of an aerial flyover of the site. (See Screen 7)
 - 3) Next on the continuum between freedom and structured information is the inner circle (or ring of waves) of the mandala navigator. Clicking on this ring takes the viewer to a series of animated close-up renderings of the 3D model. This gravity-bound walk-through is a virtual experience of a circumambulation, still practiced by devout Tibetans around holy sites. Embedded in various locations on the quick-time movie are hot-spots that take viewers to corresponding parts of the building for more detailed information. (Screen 8)
- The information, or content, on the sacred architecture of Tibet, is grouped into four thematic approaches: Architectural, Social-cultural, Historical and Environmental. Although the information is categorized and presented in these themes, parts of the information are inevitably interconnected. This is where hypermedia is used to full advantage. The user can gain a much deeper understanding of the information if he/she can grasp the interrelationship between the items. (This is based on the cognitive theories on associative memory, as discussed in section 2.8 of this paper.) For example, an item from the Environmental Approach shows how the climate and geography of the region have strongly affected the vernacular design. The flat roofs, heavy masonry walls and careful use of wooden elements are all direct results of the

arid plateaus and scarcity of vegetation in most of Tibet. The user can then proceed to the Historical Approach, which explains how the thick masonry walls have been required as fortifications against attacks by neighbouring sects and tribes. The Social-Cultural Approach shows how the shape of the building and its elements are guided by traditional Tibetan principles of geomancy, a blend of practical and mystical wisdom. The Architectural Approach shows how they are all put together in a construction method characteristic of Tibetan architecture. (Screen 5)

- 4) Information pertaining to the site selection and preliminary planning of architecture can be accessed by entering one of the four gates, each one on a cardinal point, north, east, south, west, and color-coded for ease of memory and orientation. Entering a given gate takes the viewer on a sequential tour through photographic and textual information on that particular theme. At any point along the way, however, he/she can click on a different colored window on the portal frame to skip to the beginning of another approach. (Screen 3)
- 5) Even a two-dimensional interface can have an implied three dimensionality. Just as a sand mandala painting is a two-dimensional depiction of a three-dimensional mental construct; the concentricity of the layered mandala navigator implies a three dimensional ziggurat-like structure. To demonstrate this, an animated model transforms the mandala from plan view to 3D perspective views from all sides. Its form encourages the viewer to take a spiral pathway from the outside to the center. In doing so, the viewer encounters all four approaches to the subject of Tibetan Sacred Architecture, in each of four

different levels, from the contextual level to the specific, detailed level. (Screens 5, 6 & 10)

Figure 9: Form vs. Freedom in Navigation

Prototype Testing and User Feedback

In the nine months or more of working on this thesis prototype, I have validated some of my hypotheses, and overcome some misconceptions. First of all, hypermedia users respond widely differently to the use of 3D space in accessing information. More experienced computer users, especially veterans in computer games, are more comfortable navigating through image-based hyperlinks and 3D interfaces, such as QTVR and VRML. They are accustomed to clicking on all parts of the screen, not only on 'buttons' and underlined text. This category of users also has the hand-eye coordination needed to manipulate the controls, even controls as awkward as those in a standard VRML viewer. They enjoy innovative and sophisticated interfaces, are adventuresome and are curious to test the limits of the interface design.

But realistically, these types of users are still in the minority. In the context of a museum exhibit, visitors can range in age from toddlers to seniors; they come from all cultural and educational backgrounds and their experience with computer interfaces varies from expert to nil. It is therefore best to provide more than one way to access the content. Some duplication or redundancy is necessary to address such a diverse audience. As long as the choices are made clear, the frustration factor can be minimized even for the novice user.

There are certain problematic issues inherent in an immersive 3D navigational interface. The lack of physical constraints (such as gravity and mass) makes movement equally easy in any direction. Therefore, the experience of moving through space is undifferentiated except through artificial

means. Everything is contrived, and it is hard to escape the plastic-look in a digitally modeled environment without a great deal of detailed rendering, radiosity generated lighting and the massive computing power to run it. Without the full sensory experiences of sound, smell, touch and human interaction, Cyberspace can be an alienating and disorienting environment. Until these issues are resolved, many computer users will continue to prefer the safe, predictable interface of shiny buttons and text prompts.

Conclusions

As technology in this digital age grows at a furious pace, the boundaries between the initially distinct disciplines of hypermedia and architecture are blurring. The issues of permanence vs. ephemerality, solidity vs. immateriality, tectonic vs. virtual reality are becoming less evident as the disciplines seem to converge. The goal of this thesis is to explore this perceived convergence and to structure the comparison in order to open lines of dialogue between what we call 'architecture' in its various manifestations or practices.

Architecture, long seen as the paradigm of permanence in the arts, has become less permanent and less durable over the ages, due to a variety of social, economic, philosophical, and technological factors. The expected lifespan of most building materials used today is about thirty years. The

technologies that allow us to build more, faster, is focussed on change rather than durability. In most developing countries, centuries-old historical structures are bulldozed to make way for speedily-erected compounds to house the growing workforce of the new economy. By choosing the 'Sacred Tibetan Architecture' as the content of my prototype project, I address the challenge of presenting 'old wine in new skins'. It is an architecture rich in history, geographically isolated, but environmentally and culturally very integrated in its design evolution. All these aspects have made it appropriate for the exploration of the didactic potential of hypermedia in architecture, as well as for the application of architectural concepts in organizing the information systems in which the materials are presented. By expressing more than just the physical aspects of architecture, one can literally make the walls speak – of its history, its environmental context, its social and cultural significance.

With the level of sensory realism achievable by digital simulation technologies rapidly growing, it is tempting to try to push the representational aspect of didactic exploration in architecture to a high level of detail. With the development of dynamic stereoscopy (using polarized goggles and controlled by joysticks or datagloves) and fully immersive virtual reality simulators, one can almost replicate the experience of architecture without actually 'being there'. However, I think that my prototype project shows that the essential ideas behind architecture can be holistically expressed even with the relatively low-end equipment – the commonly available home PC. Even without the most

sophisticated, state-of-the-art equipment, there is still a rich variety of ways for the architect to express the information in a dynamic, spatial environment.

Looking into the future with rose-tinted lenses, the merging of hypermedia and architecture will be complete when the built environment is totally responsive to the control of its users (inhabitants) – including their need for continuity and permanence. The so-called "Smart buildings" with changeable surroundings controlled by human input or by automatic sensors are already being developed in Canada by the CMHC³ and the National Research Council. Less prosaic and function-oriented than digitally controlled mechanical systems, the 'Liquid Architecture' of the psychedelic sixties is still in the realm of experimental art.

Peter Anders's chapter on 'Augmented Reality' in his book *Envisioning Cyberspace*, and Marcos Novak's essay on Liquid Architecture in *Cyberspace* both explored the vision of combining virtual architecture within its physical counter-part.

"It is possible to envision architecture nested within architecture. Cyberspace itself is architecture, but it also contains architecture, but now without constraint as to phenomenal size." "Liquid architecture is an architecture whose form is contingent on the interests of the beholder... it is an architecture without doors and hallways, where the next room is always where I need it to be and what I need it to be. A liquid architecture in cyberspace is clearly a dematerialized architecture. It is an architecture that is no longer satisfied with only space and form and light and all the aspects of the real world"³¹

Well ahead of their time, a group of architects in England called Archigram saw the city as "an immense node of communications... a massive

³¹ Novak, Marcos. *Liquid Architecture in Cyberspace* pg. 250

education machine of its own complexity, involving equally all media, including buildings."

They dreamed of "a city that built itself unpredictably, cybernetically, and of inflatable buildings, buildings on rails, buildings like giant experimental theatres with video cameras gliding like sharks through a sea of information, buildings bedecked in neon, projections, lasers beams..."³²

More recently, the advanced application of hypermedia in architecture is demonstrated by Stephen Perrella's 'Hypersurfaces'. These artifacts are information surfaces that are respond to the actions of their inhabitants. They bridge the dichotomy between the physical and the virtual environment. "Hypersurface architecture is the simultaneous and incommensurate action of human agency over a material topology."³³

While the signs of the ephemeralization of architecture and its continuing capitulation to media are everywhere, the symbolic tradition of architecture persists. One cannot ignore the impact of the awe-inspiring temples of ancient civilizations and the gothic cathedrals filled with didactic stonework and stained glass windows. But their solidity and permanence gave credence to the lasting truths embodied by the architecture. In today's world, change is the norm, and architecture as medium of communication can become an ever changing palette of sensory interactions and real-time information.

³² Benedikt, Michael. Cyberspace First Steps. Pg. 16

³³ Perrella, Stephen. Hypersurface Theory: Architecture <X> Culture AD Magazine June 1997

Architects have an important role to play in the increasingly widespread use of dynamic information environments. In this paper, I have first identified and examined the complementary skill sets between architects and multimedia designers in Section 2. Next, a comparison of the two disciplines reveal a significant overlap in design concepts (see figure 2 and the corresponding sections). I have endeavored to apply the appropriate architectural concepts toward the design of a hypermedia environment in the prototype project (Section 6). To see the other side of the coin, the didactic potential of hypermedia in describing architecture is explored in the Section 4. The many examples of architecture as content or navigational method, discussed in Section 5, helped me clarify what works well and what is lacking and desirable in hypermedia. Finally, the results of my prototype project reinforced my notion that architecture can indeed work well as both content and method in a didactic hypermedia information system.

Endnotes

¹ Mitchell then showed in his book *City of Bits* how the two types of spaces are converging: "Increasingly the architectures of physical space and cyberspace – of the specifically situated body and of its fluid electronic extensions – are superimposed, inter-twined, and hybridized in complex ways. The classical unities of architectural space and experience have shattered – as the dramatic unities long ago fragmented on the stage – and architects now need to design for this new condition."

² The mandala is a potent universal symbol and a centering device used in meditation, particularly important in Tibetan Buddhism. It is used here as a navigator to orient the user toward the four approaches in exploring the content of *Sacred Tibetan Architecture*. I chose the mandala as a navigational device because of the depth of information it can carry - in its 3D form, it can be accessed from any of its six sides-- i.e. the four cardinal points, the zenith and the nadir. Its perfect symmetries and intricate geometry are, in their gestalt repetition, intrinsically a mental way-finding device. The richness of colors and symbols in the design of mandalas and their significance in many levels make them representational devices that reverberate in many cultures. A mandala painting has been described as 'architectural blueprints or aerial views of celestial palaces constructed of enlightened concepts.'

³ The Canada Mortgage and Housing Corporation – a federally funded body that, among other things, research various aspects of housing construction.

Bibliography

INTERFACE DESIGN and INFORMATION ARCHITECTURE

Anders, Peter. Envisioning Cyberspace: Designing 3D Electronic spaces. McGraw Hill 1999

Benedict, Michael ed. Cyberspace: First Steps. MIT Press 1993

Bertol, Daniela. Designing Digital Space: An Architects Guide to Virtual Reality. John Wiley & Sons, Inc., 1997.

Ching, Francis. Architecture: Form, Space & Order. Litton Educational Publishing Inc. Van Nostrand Reinhold Co. 1979

Dondis, Donis A. A Primer of Visual Literacy. MIT Press 1973

Janassen, David ed. et al. Designing Hypermedia for Learning. Springer-Verlag, Berlin

Mitchell, William J. City of Bits. MIT Press 1995

Mok, Clement. Design Business: Multiple Media, Multiple Disciplines. Adobe Press, San Jose, 1996.

Rasmussen, S. E. Experiencing Architecture. MIT Press 1959

Tufte, Edward. Envisioning Information. Graphics Press 1990

PROTOTYPE CONTENT: Tibetan Architecture

Booz, Elizabeth. Tibet: A Complete Guide. Passport Books 1986

Brauen, Martin. The Mandala: Sacred Circle in Tibetan Buddhism. Shambhala Publications Inc. Boston, 1998.

Farrer-Halls, Gill. The World of the Dalai Lama. Quest Books, Wheaton, 1998.

Fisher, Robert E. Art of Tibet. Thames & Hudson Ltd. London, 1997.

Mann, A.T. Sacred Architecture. Element Books Ltd. Dorset, 1993.

Nomachi, Kazuyoshi. Tibet. Shambhala Press 1998.

Semple, William. The Dolma Ling Nunnery - a Place of Liberation. University of Calgary. Calgary, 1992.

Semple, William. Tibetan Architecture - Exploring a Cultural Continuum. Proceedings January 6 - 10, 1995. Chandigarh, India.

Wong, How Man et al. Buddhist Monasteries of Ganzi Tibetan Autonomous Prefecture, Western Sichuan, China. CERS, 1992.

Yeung, Ka-Ming et al. The Art of the Tibetan Architecture in China. Szechuan People's Press, Szechuan, 1998.

Technical References

Allis, Lee et al. Inside Macromedia Director 6 with Lingo. New Riders Publishing 1997

Ames, A. and Nadeau, D., VRML 2.0 Sourcebook. John Wiley & Sons. Inc. 1997

On-Line Resources

www.vrml.org

An extensive list of sites using VRML or offering tools for developing VRML based programs.

www.chron.com/mandala

Chronicles of the Yamantaka Sand Mandala Ceremony taken place at the Houston Museum of Fine Arts in Texas, July 16-25, 1999. Performed by a group of Tibetan Buddhist monks from Gaden Shartse Monastery in southern India. It uses time-lapsed photography to record the process and displays the information by date and time.

www.washingtonpost.com/wp-srv/style/museums/phtoogallery/mandala/

Similar to the above site, it records a Mandala Ceremony taken place at the Sackler Gallery in Washington, D.C.

www.tibet.com

The official website of the Government of Tibet in Exile. It is an informative site on the current political situation of the Tibetans in and outside China.

www.asianart.com/cers/archrep.html

The China Exploration & Research Society is a U.S. based international organization who has done much research and restoration on the Tibetan monasteries in Eastern Tibet.