Virtual Architecture

An Analysis of Virtual Environments and the Development of a Virtual Architecture
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Undergraduate Architectural Thesis
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ARCHITECTURAL DESIGN THESIS COMMITTEE

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Table of Contents

Abstract 2

Thesis Topic: Issues and Position 3

The Thesis: Question and Objectives 4

Context: Virtual and Cultural 5

Phase I: Identification of Issues 6-7

Phase II: Design Decisions 8-11

Phase III: The Project 12-20

Conclusions and Recommendations 21

Acknowledgements and Bibliography 22

Appendix A: Thesis Journal 23
Abstract

The existence of cyberspace has, in recent years, presented architectural possibilities that have previously only existed in science fiction. The current state-of-the-art has advanced to a point at which cyberspace, a distinct, inhabitable and designable virtual world has come to fruition. This virtual world is vast and undefined and presents new and unfamiliar principles and issues that must be defined and explored. An architectural language must be developed that responds to the nature of this new world and the issues it represents. An architectural study of virtual environments will lead to the development of concepts that will serve as precedents for later virtual architectural designs and as starting points for further investigations.

A three dimensional, interactive, virtual gallery will be the vehicle through which the architectural design of virtual environments will be explored. This project will address the identified issues and principles of virtual space and present one of unlimited solutions. The gallery will be accessed via the Internet, and thus be available anywhere in the world where there is an Internet connection.

Architecture is usually considered to be the design and construction of physical buildings. Architecture in its purest form is the design of space for human habitation. The emergence of virtual reality technology and the popularity of the Internet has introduced a new arena for architectural design. Three-dimensional, inhabitable space exists on the miles of interconnected cables and computer chips called cyberspace. This environment is called virtual space and provides an opportunity for architects to develop a new vocabulary of architectural forms and a new set of architectural ordering principles that respond to this unique environment.

It is important that architects seize the opportunity to design this new environment from its conception. The basic concepts of architecture are present in this new media and therefore architects are the most qualified to undertake the designing of this new and exciting world.

The question that requires exploration is, How does architecture respond to a virtual environment? The exploration of this question involves a multifaceted process that will culminate in one possible solution. As with physical architecture, virtual architecture is not a definable entity and there are perhaps as many answers to this question as there are people in the world.

Virtual space imposes a set of characteristics and principles of its own, some are similar to those of physical space and some drastically different. The architecture developed to respond to this space should reflect these similarities and differences. The first phase in developing a virtual architecture is to identify and explore the important issues that will affect the design decisions and study and analyze the few precedents that currently exist. The issues identified will create a framework for the development of a virtual architecture.

The second phase involves interpreting the identified issues and proposing possible design responses. A list of responses must be compiled for each issue and then evaluated and tested. A design decision then must be made and a specific stance will be taken for each issue.

The third and final phase of the process involves creating a virtual environment using the specific design decisions established in phase two. There are an endless number of solutions at this phase as well and the specific design will depend on the designer.

As virtual reality and internet technology advance, new issues will emerge and new ideas and concepts will respond. Over time, virtual architecture could become an offshoot of the architectural profession with architects being specifically trained to respond to such an environment.

These first attempts to identify and respond to this new world will prove to be valuable steps in the process of building a new and comprehensive architectural language.
Thesis Topic

Why Cyberspace?

"Over the last twenty years, there has been a significant evolution of advanced industrial societies towards an increased production and consumption of information. As a result, the economic principles of material production and distribution in their classically understood forms - principles of property, wealth, markets, capital, and labor - are no longer sufficient to describe or guide the dynamics of our modern, complex, 'information society.' Our lives have been evolving on the experiential front as well. Ever more dependent upon channels of communication, ever more saturated by the media, ever more reliant on the vast traffic in invisible data and ever more connected to the computers that manage it, we are becoming each day divided into the entertainers and the entertained, the informationally adept and the informationally inept. Bombarded everywhere by images of opportunity and escape, the very circumstances of a free and meaningful human life have become kaleidoscopic, vertiginous. Under these conditions, the definition of reality itself has become uncertain. New forms of literacy and new means of orientation are called for." (Michael Benedikt)

Designing Cyberspace

Our information based society has created an entire, borderless, virtual world within which courses the very information that is the life blood of advanced industrial societies. Humans have been interacting with this world for the past ten years in a relatively superficial manner. Recently, an immersive technology has been developed that allows three-dimensional spaces to exist on the worldwide networks that comprise cyberspace. The design of these virtual environments is an architectural problem.

What would architecture look like without the constraints of the physical environment? What is it like to design without those constraints? Does cyberspace present designers with absolute freedom of expression? As with physical architectural design, does the architectural design of virtual environments come with certain responsibilities to the users? If so, what are those responsibilities? And to whom are designers responsible? What is it like to experience a virtual environment? How does it feel? Is it similar to experiencing physical architecture, or is it an entirely new experience?

In fact, cyberspace presents designers with unique design criteria. Cyberspace itself is a context to which virtual architecture must respond. The nature of cyberspace and the way architecture might begin to respond to it are both questions that demand investigation.

Design issues of physical architecture must be studied and redefined and new issues must be identified that are exclusive to virtual architecture. This investigation must also include an in-depth analysis of the experiential qualities of virtual environments including orientation, circulation, transition and scale.

The need for quality spaces is no less vital in virtual reality than it is in physical reality. For this reason, the identification of issues and design criteria facing designers of virtual environments must begin now, while the technology is still relatively new so that a standard of design integrity may be established.
The Thesis

The Question

How does architecture respond to a virtual environment?
Can an architectural vocabulary be established?
Are there organizational principles of a virtual environment?

Objectives

Establish a set of issues to be explored.
Develop a response to the issues through the study of precedent and design of conceptual models.
Design a virtual environment.
Context: Virtuality

What is cyberspace?

"By definition, cyberspace is a globally networked, computer sustained, computer accessed, and computer generated, multidimensional, artificial or 'virtual' reality." (Michael Benedikt)

"Cyber": from the Greek kybernan, meaning to steer or control

The Nature of Cyberspace

The dimensions, axes and coordinates of our physical environment do not exist as such in cyberspace. "In cyberspace, there is a mirroring of our expectations of natural spaces and places, they have dimensions impressed with informational value appropriate for optimal orientation and navigation in the data accessed. In cyberspace, information intensive institutions and businesses have a form, identity, and working reality - in a word and quite literally, an architecture - that is counterpart and different to the form, identity, and working reality they have in the physical world. The ordinary physical reality of these institutions, businesses, etc., are seen as surface phenomena, as husks, their true energy coursing in architectures only seen in cyberspace." (Michael Benedikt)

The principles of ordinary space and time, can, in principle, be violated. There is, however, a limit to how frequent and severe such transgressions can become before credibility, orientation, and narrative power begin to be lost. It is important to realize that myth and fiction do not contain violations of ordinary spatial logic, but description of such violations. In cyberspace, violations of spatial logic are actually performed in real time, routinely, and under our individual control. Cyberspace is not just a description or staging of an uncanny reality, but institutes a virtual reality as a functional, objective component of physical reality.

Cyberspace exists as a global virtual world independent of how it is accessed or navigated. There are several ways to enter cyberspace from mouse controlled video images to VR (virtual reality technology being directed to re-creating the human sensorium as fully as possible). There is also an unlimited number of ways to navigate cyberspace including walking, crawling, or even flying. In short, cyberspace is not a hardware system or a simulation or a software graphics program - it is a place and a mode of being.
Phase I: Identification of Issues

State-of-the-art, Internet, Virtual Reality, Precedent, Analysis

The first phase involved learning about the state of the technology and what was currently possible and also the identification of pertinent issues. The Internet was studied as a means to communicate ideas and space via VRML (Virtual Reality Modeling Language). This language had been recently developed and was in its infancy. However, there is a great opportunity for architects in the study of this language.

The identification of issues was accomplished through an extensive analysis of virtual space and a study of precedent. Contact was made with several other undergraduate and graduate architecture students who were currently or previously had explored similar projects. An organization entitled WAVE (World Architects of Virtual Environments) was formed to pool knowledge and propose ideas and solutions to identified problems. The projects and ideas of these other students were critically analyzed by experiencing the spaces over the Internet. This process allowed me to gain first hand knowledge of their projects and fully understand the implications of their individual design decisions. Several of the students also posted the jury's comments after evaluation. Through the study of precedent and my own analysis of virtual space, I identified a list of issues that would need to be explored in the development of virtual architecture.
Phase I: Identification of Issues

Architectural Issues

Orientation, Scale, Spatial Relationships, Lighting Qualities, Surface Qualities, Circulation Patterns

Environmental Issues

Absence of Gravity, Lack of Natural Environment, Self-Contained Space, No Codes Life Safety Issues, Absence of a "ground plane"

The analysis of precedent and of virtual space led to a list of issues that would require some form of response. There are two main categories of issues that have been identified. First, there is a set of issues that relate to the environment of virtual space. Second, there are issues that involve the way architecture can begin to respond to a virtual environment.

Virtual space is an environment devoid of gravity. It is also devoid of any sort of natural environment including sun and rain and sky and ground. The space is also created, being as large or small as the designer chooses and not physically connected with any other spaces. There is no up or down or ground plane of any sort. There is no risk involved with experiencing the space and therefore no life safety issues or codes.

These characteristics lead to the second set of issues. How does an architecture establish orientation without the typical elements of wall, ceiling and floor? How does an architecture establish scale with unfamiliar objects and spaces? How do spaces relate to one another and the user? What sort of lighting and surface qualities can be achieved that will augment the design and the experience of the space? How does the user move through the space?

These questions will be the framework of this exploration and guide Phases two and three. The issues identified are not the only ones, but are some broad ideas that will allow for some interpretation and evaluation of virtual space.
Phase II: Design Decisions

In Phase II, the issues identified through Phase I were further analyzed and an architectural response was determined. The responses identify ways in which architectural forms and spaces can be specifically designed to capture the characteristics and identity of virtual space. These responses offer one interpretation of responses to these issues and are by no means the only alternatives.

Environmental Issues:

Absence of Gravity
The absence of gravity poses some initial problems that require an adaptation in the way most designers think. There is no need for structural members of any kind. Architectural elements and forms can develop dynamic relationships that do not succumb to structural requirements. Horizontal forms that float at different heights create dynamic horizontal and vertical relationships while vertical forms rise from below and soar to unbelievable heights.

No Life Safety Issues
There is an opportunity to create effects such as a very narrow walk or a dangerously open bridge without the constraints of life safety issues. These effects can be utilized to increase the emotive qualities of the space as a whole.
Phase II: Design Decisions

Absence of Ground Plane
Virtual Architecture can exist on a variety of horizontal planes. There is no one plane that governs the positioning of the spaces. Dynamic views from one plane to another create a vertical relationship that is not possible in physical architecture. There is an opportunity to have forms floating above or below a horizontal plane creating a tension as forms do not intersect but just miss a plane.

Lack of natural Environment
Protection from the elements is not necessary in virtual space. There is an opportunity to create open or closed spaces based solely upon the design intent. Overhead planes and wall-like forms can still be used to create enclosure and scale and orientation, but should not exist because of convention. Open spaces provide for maximum views of other parts of the design and emphasize the magnitude of the project.

Self-Contained Space
Other virtual spaces exist, but are not directly adjacent to any other. There are no neighbors. Therefore there is a lack of context. The spaces exist in relation to each other, not to outside influences. A central focus emphasizes this fact.

Horizontal planes can give user a reference point without establishing a singular ground plane. The space is open because there is no need for protection from a natural environment.

The space is contained within itself as there is a lack of context in virtual space. There is no reference to any surrounding spaces.
Phase II: Design Decisions

Architectural Issues:

Scale
Scale can be achieved through the introduction of human scale objects. The human/object relationship must be initially established as the forms will be unfamiliar. Also overhead objects will provide a reference to other larger spaces.

Orientation
Vertical orientation is necessary for the space to be understandable and usable. This can be achieved through the use of "walks" or horizontal planes that allow the user to have a base reference. These planes may change throughout the space but will give the user enough to establish orientation. A general understanding of the layout of the spaces is also necessary for orientation.

Spatial Relationships
Spaces can exist separately and be linked by circulation patterns. The spaces can be both vertically and horizontally pulled apart to emphasize the depth of the space.

The user is made aware of scale by passing through and under objects and forms that allow for human scale to be achieved.

A main rhythmic element is used as a point of reference while in the other spaces. The spaces form around this central space.
Phase II: Design Decisions

Lighting Qualities
Simulated natural lighting as well as spot lighting can be used to augment the design forms. Lighting has the opportunity to lead the user through the spaces and provide points of arrival.

Circulation
Circulation becomes both horizontal and vertical and can be recommended by the designer but is ultimately the decision of the user. Should the user decide to stray from the recommended circulation patterns, so be it!

Surface Qualities
Computer simulated materials can be used as texture to provide visual qualities. Rough looking materials contrasted against smooth reflective materials creates a dynamic relationship. Color also becomes an important element.

Computer generated lighting qualities are similar to real life. They can be used to accentuate a form or create an arrival point in the sequence.

Rough surfaces intersected by a smooth, reflective surface creates a dynamic contrast.
Phase III: The Project

The project involved the design of a virtual exhibition space that was to realize the design decisions of phase II. The gallery was to be designed to exist solely in virtual space with the possibility of being accessed over the Internet from anywhere in the world. The gallery was to be designed to exhibit a variety of different images and objects ranging in size and scale.

The experience of the space was to be indicative of the type of experiences possible in virtual space. The ordering principles and forms were to be ideally virtual.

The program called for three main gallery spaces, each with unique and special characteristics. The main gallery space was to exhibit mostly two-dimensional images of varying sizes, including life size images. One gallery space was to exhibit full scale computer models that could be entered and experienced. The third gallery was to be a fully three-dimensional space in which specific orientation became ambiguous.

The spaces were to be interconnected with a series of circulation "walks." An entry point was to be designed from which any of the galleries could be accessed.
Phase III: The Project

The three galleries are designed in a radial form around a central circulation hub. This radial form creates a focus inward and makes reference to the fact that virtual space is self-contained. The horizontal planes direct the user in different directions and give points of reference to aid in orientation. There is a rhythm established with forms that move from the central hub out to each of the galleries and then are seen in different places throughout the complex. Images and objects can be placed throughout the complex including within the circulation patterns. The main gallery is designed to show two-dimensional images and small objects. The other galleries allow for the display of extremely large objects.

Overview of gallery spaces. Central circulation hub in middle with access to each of the three galleries.
Phase III: The Project

View from main gallery into other areas. Central hub is in middle giving access to other spaces.
Phase III: The Project

Elements to establish rhythm.

View down corridor leading into main gallery. Rhythm of elements leads user to gallery. Horizontal planes float inside other forms, defying gravity.
Phase III: The Project

View into one of the galleries. Work is exhibited at a very large scale and lighted from above to accentuate the images.
Phase III: The Project

View from top level of main gallery into "atrium" space.
Phase III: The Project

Images on all surfaces

3-D Mov't.

View of three-dimensional gallery. Images and objects can be displayed all around these elements.
Phase III: The Project

Aerial view of main gallery. The vertical is exaggerated for effect. There are no railings on the levels to create a feeling of danger.

Rhythmic elements pull user toward main gallery. Horizontal planes float above the surface defying any notion of gravity.
Phase III: The Project

Main gallery space is four levels on which images may be displayed. A vertical slit in the curved element provides framed views of the rest of the complex.

The overlook gallery allows for the display of large three-dimensional objects. The curved elements focus attention to the display area while frame views of the rest of the complex.
Conclusions and Recommendations

The design of virtual environments is a newly emerging field of architecture that could prove to be a viable realm of practice for architects in the future. This thesis made some assumptions and offered many theories as to how this space could be designed. However, there are unlimited possibilities as far as how to deal with certain issues. As with physical architecture, different architects will make different decisions and identify different issues to study. The architecture of cyberspace will very likely be more diverse than physical architecture.

I encourage architects to actively pursue this arena so that from the beginning, people turn to architects to design virtual spaces. There is a threat of computer programmers and engineers becoming the creators of these spaces and that would be an injustice. Architects are trained specifically in spatial design, whether virtual or physical. The skills and abilities of architects make them the most qualified to design virtual spaces and I hope to see virtual architects seizing this opportunity.
Acknowledgements & Bibliography

The most current studies of the design of virtual environments can be found published on the Internet. An organization entitled WAVE (World Architects of Virtual Environments) was established for the exchange of ideas and theories on the subject and includes undergraduate and graduate students from around the world. The organization allows for research and discoveries to be shared in a networked body of information that proves vital to any research taking place in this area. Because of the infancy of this technology, much of the information previously published in books is speculation. It is only as the technology has become more advanced that research can take place on the actual design of virtual environments.

Members of WAVE
Allison Stamides, MIT
George Paschalis, NJI
Ken Hillis, University of Wisconsin
Dace Campbell, University of Washington
Torbjoern Casperson, UNIT

Patrick George
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Clay Graham
Silicon Graphics

Terence Chang
Student, UCLA

Michael Benedikt
Cyberspace: First Steps (1991)

John Frazer
An Evolutionary Architecture (1995)

William Gibson
Burning Chrome, short stories (1986)
Neumancer (1984)
Count Zero (1988)
Mona Lisa Overdrive (1988)

Vitruvius
Ten Books on Architecture

Gottfried Semper
The Four Elements of Architecture

William Mitchel
Digital Design Media (1990)
The Reconfigured Eye (1992)
The City of Bits (1995)

Marcos Novak
Pantopicon

Taylor and Saarinen
Imagologies (1991)

Christian W. Thomsen
Visionary Architecture
Appendix A: Thesis Journal

August 1995:

Beginning of thesis year.
Goals:
- Investigate virtual environments
- Establish design criteria for the design of virtual environments
- Study the relaying of information in a 3D format
- Become more familiar with internet and HTML
- Re-contact Dace and look for more precedents of virtual environment design
- Narrow focus to a "thesis project"
- Buy computer to facilitate investigations

Ordered Gateway P5 100

Re-established contact with Dace Campbell at University of Washington. His work in virtual environments is extremely interesting. He is dealing with many of the same issues I have thought about....we should be able to pool our resources and work together... he will be a good resource throughout the duration of the project.

Received computer... have decided to run Windows 95 and am loading Microstation, AutoCad, and 3D Studio. I'm not sure which I will end up using and exactly what its purpose will be...time will tell.

September 1995:

Have decided as a first step to learn how to design Web pages... I've heard that the new architecture history professor knows HTML....will meet with him to see if he is interested. Designing Web pages will allow me to learn about the internet and how information wants to be conveyed...this will transfer later to the virtual environment design.

Met Patrick George, new history professor...he seems to be very knowledgeable on HTML...he has agreed to teach me. I will try to establish working relationship with him...he might prove to be a good resource for later investigations as well.
Appendix A: Thesis Journal

I will look for a copy of Netscape 1.1 to load on my computer to facilitate the design of my Web pages. I have heard of a helper application to Word 6 called Internet Assistant...am going to send for it and see how it is.

Received Internet Assistant...have begun to try it out. Patrick has given me the basics on HTML.

Web page is coming along slowly. Internet Assistant seems to be quite limiting. I will look into other possibilities.

I can’t get Netscape to load on my computer...it might be because of the lack of a network connection...although it should be able to run locally...I’ll have to work with it some more over the next couple of weeks. I have started to use Word and just write the HTML code manually...it’s much easier than I thought...Internet Assistant was a complete waste of time. Netscape 1.1 allows for backgrounds and different types of formatting...things that Internet Assistant did not even address.

Been spending more time navigating the internet...trying to find precedents into virtual environment design...there seems to be a couple of other architecture students looking into it...Dace, myself and a guy in the Netherlands...his work seems to be more conceptual. Have come across VRML...Virtual Reality Modeling Language...it appears to be a real time 3D modeling language that is accessible over the internet...I will definitely look into this...I am going to ask Dace what he knows about it...how it works...how you create VRML. This could be the vehicle for my exploration of virtual environments.

VRML requires a

October 1995:

Talked to Dace about VRML...he is using it in his investigations...he says the conversion from a dxf file to VRML is complicated...might need to use 3D Studio and some other applications in a many step process...seems a little overwhelming right now.

Web pages are coming along...still a pain not having Netscape on my machine...will try again to get it loaded...a network connection would really be nice!!
Appendix A: Thesis Journal

October 30, 1995
Have asked Don Harris of LAS Architecture to be non-faculty advisor. He has done some work with Georgia Tech dealing with Virtual Reality...should prove to be a good resource.

November 1, 1995
Began writing proposal for ARCH 490 - Independent Project - that will focus on Representation and deal with issues of digital imaging. Will work in nicely with thesis exploration handling some more technical issues. Patrick George will be the faculty advisor for the project.

November 6, 1995
Have started thesis proposal. That needs to be completed by the end of the week. I have identified issues of transition, circulation, orientation and form as initial exploration...more will come later. Have begun to come up with ideas for dealing with these issues in cyberspace...after I have some solid ideas, will begin to explore them 3-dimensionally. This needs to take place before Thanksgiving...so they can be presented the week after at the completion of the semester.

November 8, 1995
Further defined the project that is going to test my thesis...I have decided to design a gallery space that relays information on VRML and research being done in that field. I want to have actual virtual environments that can be accessed and experienced. I am going to ask the members of WAVE to show me to show their conceptual models in the gallery...devoting a wing to each one of them. The gallery will contain a lobby that contains general information on VRML and the history and purpose of WAVE. The gallery will contain links to spaces and will use multimedia (video, audio, still images) to augment the design. The members of WAVE will serve as my clients...each will have an individually designed wing.

November 13, 1995
Presented to the class on Wednesday...went well. fielded some questions. Spent some time using AutoCAD...trying to generate 3D shapes, take them into 3D Studio and convert them into VRML - something isn’t working quite right, I think it has to do with the shading. Will try and meet with Patrick tomorrow to figure it out...then develop the concepts...Also...finished proposal today...will talk with Sonny about the program.

November 14, 1995
Have begun to do test with AutoCAD - 3D Studio - VRML. Have made several successful conversions...have to remember to render in 3DS format before converting. Materials do not show very detailed and lights seem to get darker upon conversion...have tried several different materials and light intensities...there will be certain materials that show up better than others. Have to figure out how to set the home view in WEOspace so that the user will enter the model at the correct point.
Appendix A: Thesis Journal

Have been unsuccessful so far. Need to buy a manual for AutoCAD v.12 so I can come up to speed on 3D. For now I am just using 3D primitives.

November 16, 1995
Met with Sonny Palmer today to discuss the thesis proposal... it went well, he liked my approach and thought my process was well defined and that it was the exploration and discovery that was the most important, not the final product of a gallery space. We talked about the program and how that might adapt to the non-traditional nature of my thesis. He suggested to program the process in a comprehensive and complete manner.... although certain aspects of the process will be defined by the earlier discoveries and explorations. We talked about the issues that I have identified and how I might a published and widely accepted set of architectural elements. I spoke with Patrick about this and he suggested Vitruvius’ Ten Books of Architecture and the four elements identified by Guy Semper (Presented in a lecture at the ACSA Conference)... I will get the video of the lecture next week. The issues to be explored will be chosen from a comprised listing. Establishing these essential elements of architecture will give me a solid foundation to base my investigations. My program will identify and concisely define how I will explore these issues. I will attempt to create a conceptual exploration of each of these identified issues before the end of the semester.

November 27, 1995
Will be putting together a final presentation of everything today. The end of the semester is rapidly approaching. I have not been able to get everything done that I wanted to. I am going to try to use boards, handouts and on screen interactive displays for the presentation.

January 9, 1996
Beginning of Spring semester. Will be jumping right in after a meeting with Patrick.