Introduction

This dissertation articulates an opportunity presented to architecture by computation, specifically its digital simulation of space known as Virtual Reality (VR) and its networked, social variant cyberspace. I will argue that VR/cyberspace poses a unique challenge to both materialist and idealist practices. In an effort to address this challenge I will offer a procedural model for how VR and cyberspace may be integrated within the processes and products of architectural design.

VR and cyberspace have yet to significantly affect the professional/materialist practice of architecture. Reasons for the impact's delay include 1) technologies' cost and unreliability 2) lack of client demand and 3) uncertainty about client acceptance. There are also unsettled questions of the nature of the architectural product, whether it is space, service or building. As a result there is a gap that separates the practitioner's materialism from the theorist's idealism. How to bridge this gap and thereby extend the practice of architecture is the subject of this thesis. Such an extension could lead to the development of cyberspaces and their integration within the architectural product. The results, herein called *cybrids*, could incorporate virtual realities, telepresence, and spatialized databases within hybrid structures, that are simultaneously physical and emulated. With these possibilities at hand, the present thesis proposes both a practical and theoretical model for a richer practice that integrates cyberspace and materiality within the architectural product.

Structure of the Dissertation

Below is provided a chapter summary of the dissertation that lays out the topics under discussion.

1) Architecture's Adoption of Information Technologies

Architecture's adoption of information technologies has had considerable effect on architectural production but less so on its products. Computation was reluctantly adopted in architectural practice owing in part to initial expense and still immature technology. The use of computers to further the construction of buildings has characterized professional practices to date. In the 1990's a more idealist model of architecture emerged that challenged the practice's service to construction. This model asserted that virtual reality (VR) and cyberspace provide a fertile domain for architectural action.

This chapter discusses four strands of architectural computing 1) Virtual Reality, 2) CAD, 3) Networked Computing, 4) and Responsive Environments. While these have each found application in the profession, their reception by architecture's practitioners differs from that of its theorists. According to theorists, these technologies have the potential to construct spatial products that could significantly change orthodox practice, i.e. the creation of a virtual, cyberspace architecture.

2) Transformative Possibilities for Architecture

Virtual reality offers – and embodies – many of the qualities other forms of architectural computation. Like CAD, the objects seen in VR are evanescent representations of data. Like networked computing VR challenges conventional notions of architectural space. Finally, VR offers a unique form of responsive environment, one whose technology is so sophisticated as to follow and respond to subtle movements of the observer. These issues raise the possibility of a virtual architecture that could vie with the conventional products of architecture. Whether such consequences are possible or desirable is critically discussed in light of the *Library Paradox*, a thought experiment that presents an idealist model of architectural practice.

3) The Unmet Challenge of VR/Cyberspace in Architecture

Owing to its emulation of actual construction and the threat – or promise – of a virtual architecture, VR poses a unique challenge to architecture. This challenge is illustrated by the changing conceptions of architectural inscription and simulation, i.e. the possible autonomy of representation in VR. The chapter describes the historical impact of virtual reality and cyberspace on architectural academia and practice since the early 1990's. It distinguishes *information architecture* from *virtual architecture* and outlines the varied success of each. The difficulties encountered by virtual architecture owed in part to differing values held by those in theoretical and professional practices. This raises questions as to whether one could reconcile the values of an idealist, virtual architecture within the conventional, materialist practices of architecture.

4) Cybrids: Accepting Virtuality within Architectural Practice

The divide between materialist and idealist approaches may be resolved by examining frames of reference used in architectural computation, symbols and agencies in practice, and matters of product vs. process orientation within the discipline. This suggests that an expansion of architecture's definition is possible. Fundamental to this proposition is that 1) computers themselves offer a dualistic model (material and informational) for architectural products and that 2) architecture can be defined by its symbolic processes as well as its end products. Theoretically, the architectural end product could be a hybrid of material and symbolic phenomena. Such compositions are herein called *cybrids*.

5) Hybrids: Precursors of Cybrid Technology

If such cybrids are possible it is useful to review current, sympathetic technologies that may lead to their realization. Three prominent forms of architectural/technological hybrids have emerged since the introduction of computers to architecture. These are *Display Space* (computer-driven screens used functionally and ornamentally in buildings), *Computer Augmented Environments* (built spaces made interactive through networked, distributed, or environmental computing), and *Augmented* or *Mixed Reality*, called AR and MR respectively (techniques for situating virtual presences within a physical setting). These are not mutually exclusive technologies, and each bears attributes that may be employed in the creation of cybrids.

6) Integrating Hybrid Technologies within Cybrid Compositions

Cybrids could employ hybrid technologies to merge physical space and cyberspaces within the minds of their observers. Whereas Display Space and Computer Augmented Environments are largely material in nature, Augmented or Mixed Reality depends for its effect upon the observer's perception and ability to reconcile actual and simulated realities. AR and Mixed Reality are based on a cognitive/psychological model of the user that assumes the user can integrate the two types of environments. This model puts these technologies at odds with materialist, professional practice whose model of the user is physical by comparison. AR, then, proves to be a key technology for cybrids in that it reconciles material and simulated entities by recognizing that the user may empirically integrate both.

7. Developing Design Principles for Cybrids

Architecture has traditionally met societal needs by providing a context for communal social reality and a framework for the coherence of culture. Contemporary society has similar needs, but now they have extended beyond the physical domain of conventional architectural practice. In order for cybrids to meet the needs posed by contemporary society, it is necessary to outline principles for their application. We propose that 1) the need for context be met with material and simulated environments, that 2) the need for coherence be met with cybrids' static and dynamic behaviors, and that 3) the need for modal corroboration to be met by reconciling the user's direct and extended experience. Upon these premises we can develop seven principles that would govern the composition of cybrids: 1) Comprehensive Space, 2) Composition, 3) Corroboration, 4) Reciprocity, 5) Extension, 6) Social Context, and 7) Anthropic Design. They are articulated as principles to be applied in the following case study.

8. A Case Study Application of Cybrid Principles

We pose an architectural design program as a test bed for the seven cybrid principles. The project for the design of a decentralized research institution – the Planetary Collegium – calls for physical campuses dispersed about the globe which are in continual communication. The program is developed in a series of studies to determine which of its parts must be material and which may remain virtual. The analytical methods employed are based on those of conventional practice, but diverge from them by assuming virtual spaces to be valid parts of the design. A schematic design for the cybrid ensues.

9. A Design for the Planetary Collegium

The design is articulated in text descriptions, illustrations, and interactive graphics provided in the attached CD-ROM. The proposal is for a hybrid of physical and cyberspaces, each of which responds to specific needs set out in the program. Special care is given to relating the spaces in a meaningful way – through symmetries, metaphors, and composition – so that the observer may infer the presence of non-physical entities with or without the use of electronic technologies. The theme of the project is the constitution of a whole from the relationship of physical and simulated parts.

10. Critique of the Case Study

The design for the Planetary Collegium is reviewed in terms of the seven principles described previously. Limitations and strengths of the proposal are noted as a summary of the design experiment.

11. Possible Effects on Architectural Practice

Based on the effectiveness of the principles it is possible to speculate on the effects that cybrids might have on architectural practice and product. Here we extend the Library Paradox into a practical scenario that defines the design process, its technology, and its likely effect on a variety of building types. Notably, many of the technologies and techniques for cybrid production are already in use, although deployed differently.

12. Conclusions

CD-ROM Attachment

A CD-ROM that provides documentation of the Planetary Collegium project as well as illustrations related to the thesis is attached on the inside cover of this dissertation.

A Note on Terminology

The following terms and their definitions play an important role in the dissertation:

Real/Virtual
Much of the polarity between these terms has been lost in recent years. Both terms have been so overused in the popular press that they have lost their use in more technical discussions. While *real* might connote *physical* and *virtual* connote *simulated*, both are freighted with philosophical implications, not to mention the different cast given the terms in cognitive science and literature on digital technology. For this reason we will avoid the polarity as much as possible. The term virtual, for our discussions, will apply mostly to the simulation of physical effects through the use of information technologies.

Matter/Simulation or Emulation
Matter here means a physical, material entity. Its appreciation by the observer derives from sensory perception. A *simulation*, or at times *emulation*, is the symbolic

representation of an entity. While the attributes of a simulation may be perceived – say on a screen or canvas – the observer's appreciation is largely due to an interpretation of symbols. We distinguish here *simulation* from *emulation* insofar as the former implies a material referent or original that has been replicated in some way. *Simulation* is commonly used in literature on computer technology and displays. However the term connotes a world of falsity and fakes that relegates simulations to a secondary status with respect to the original. Since this dissertation will argue a re-evaluation of these entities we will also use the term *emulation* whose dependency on an original is largely one of meeting or surpassing the original's performance. Here *emulation* carries with it a degree of authenticity appropriate to a material entity.

Space/Cyberspace
Space here refers primarily to the rich, dimensional mental image we create to organize and manage information taken through senses, cognition and stored in our memories. This empirical model of space is distinguished from that of the volumetric, material world whose sensations and stimuli inform the mental image. *Cyberspace* is the emulation or evocation of space in electronic - especially social – environments.

Comprehensive Space
The term *comprehensive space* which recognizes the sensory/cognitive role of space that includes both conventional space and cyberspace in a phenomenal continuum.

Anthropic Cyberspace
Anthropic cyberspace – also found in Section 3 – refers to electronic environments designed to augment our innate use of space to think, communicate and navigate our world. These definitions are the same as I used in *Envisioning Cyberspace*. (Anders 1999a)

Materialist/Idealist
This pair of terms is here used to distinguish the goals of architectural practitioners. *Materialism* denotes professional goals that may not be congruent with those of (idealist) theorists and academic practitioners. For this reason *Professional* and *Materialist* are here nearly synonymous. The explicit goal of a materialist practitioner is the construction of buildings and structures, while that of an idealist is abstract and without the constraints that it must result in construction. Architectural theoretician Sanford Kwinter has noted the difference between the profession and the discipline of architecture along similar lines. (Kwinter 1992) In addition we here use the term *Idealist* in the sense of Idealist views of virtual reality and related technologies. Although it is true that philosophy, history and theory bear also upon these terms and goals, we shall here confine our discussion to their value within architectural practice.