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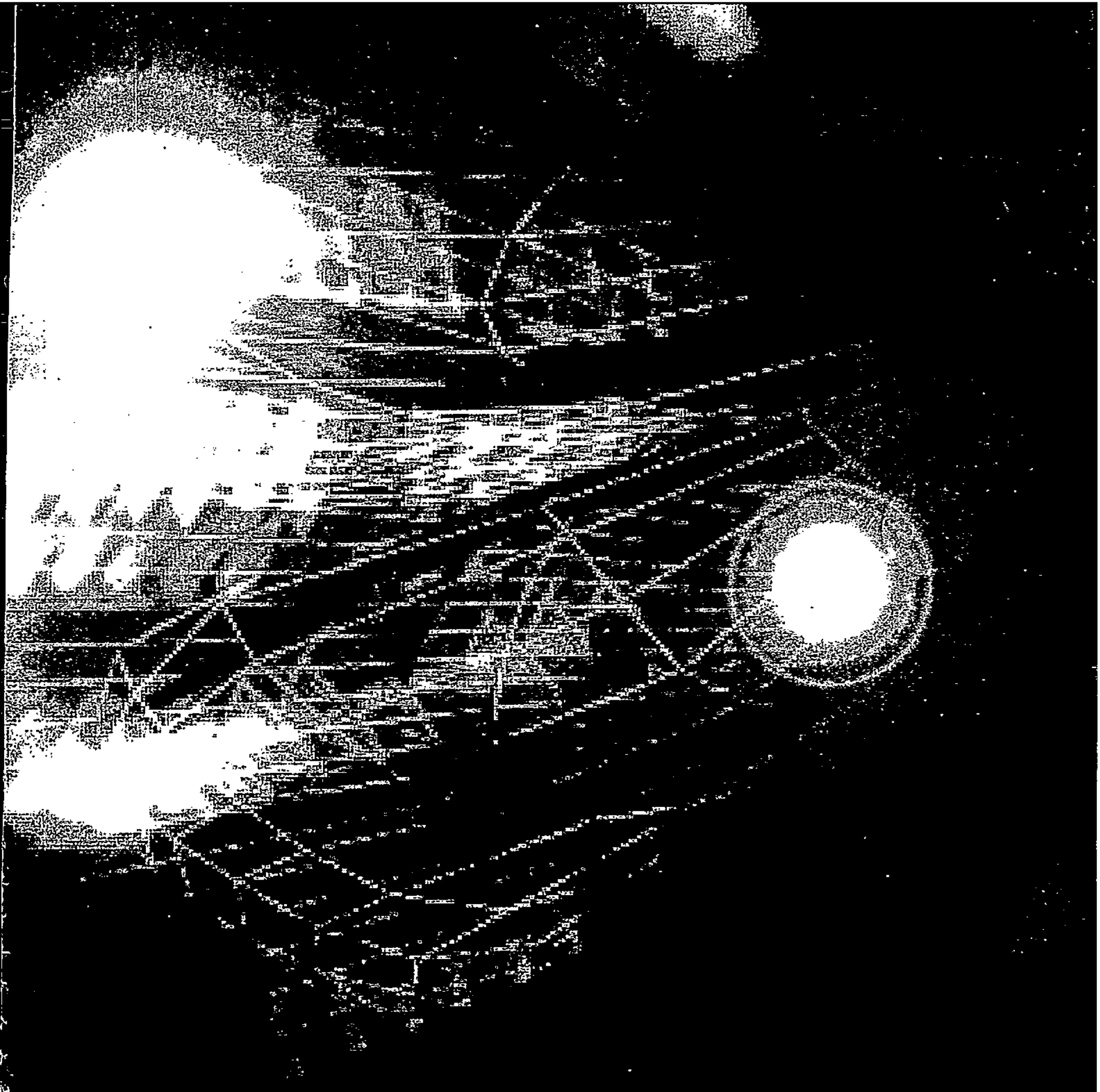

A Procedural Model for the Integration of Physical and Cyberspaces in Architecture

Peter Anders

A PROCEDURAL MODEL FOR INTEGRATING PHYSICAL AND CYBERSPACES IN ARCHITECTURE

by

Peter Anders

A thesis submitted to the University of Plymouth in partial fulfillment for the degree of

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A Procedural Model for Integrating Physical and Cyberspaces in Architecture

Peter Anders, CAiiA-STAR

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Abstract

This dissertation articulates opportunities offered by architectural computation, in particular the digital simulation of space known as virtual reality (VR) and its networked, social variant cyberspace. The thesis will argue that VR/cyberspace has exacerbated differences between architecture's materialist and idealist practices, widening the gap that separates them. In an effort to bridge this gap it presents a procedural model for how VR and cyberspace may be integrated within the practice and product of architecture.

The dissertation presents important developments in architectural computation that disclose concepts and values that contrast with orthodox practice. Virtual reality and cyberspace, the foci of this inquiry, are seen to embody the more problematic aspects of these developments. They also raise a question of redundancy: If a simulation is good enough, do we still need to build? This question, raised early in the 1990's, is explored through a thought experiment – the Library Paradox – which is assessed and critiqued for its idealistic premises. Still, as technology matures and simulations become more realistic the challenge posed by VR/cyberspace to architecture only becomes more pressing. If the case for virtual idealism seems only to be strengthened by technological and cultural trends, it would seem that a virtual architecture should have been well established in the decade since its introduction.

Yet a history of the virtual idealist argument discloses the many difficulties faced by virtual architects. These include differences between idealist and professional practitioners, the failure of technology to achieve its proponents' claims, and confusion over the meaning of virtual architecture among both architects and clients. However, the dissertation also cites the success of virtual architecture in other fields – Human Computer Interface design, digital games, and Computer Supported Collaborative Work – and notes that their adoption of space derives from practice within each discipline. It then proposes that the matter of VR/cyberspace be addressed from *within* the practice of architecture, a strategy meant to balance the theoretical/academic inclination of previous efforts in this field.

The dissertation pursues an assessment that reveals latent, accepted virtualities in design methodologies, instrumentation, and the notations of architectural practices. Of special importance is a spatial database that now pervades the design and construction processes. The unity of this database, effectively a project's cyberspace, and its material counterpart is the subject of the remainder of the dissertation. Such compositions of physical and cyberspaces are herein called *cybrids*. The dissertation examines current technologies that cybridize architecture and information technology, and proposes their integration within cybrid wholes. The concept of cybrids is articulated in seven principles that are applied in a case study for the design for the Planetary Collegium. The project is presented and critiqued on the basis of these seven principles. The dissertation concludes with a discussion of possible effects of cybrids upon architecture and contemporary culture.

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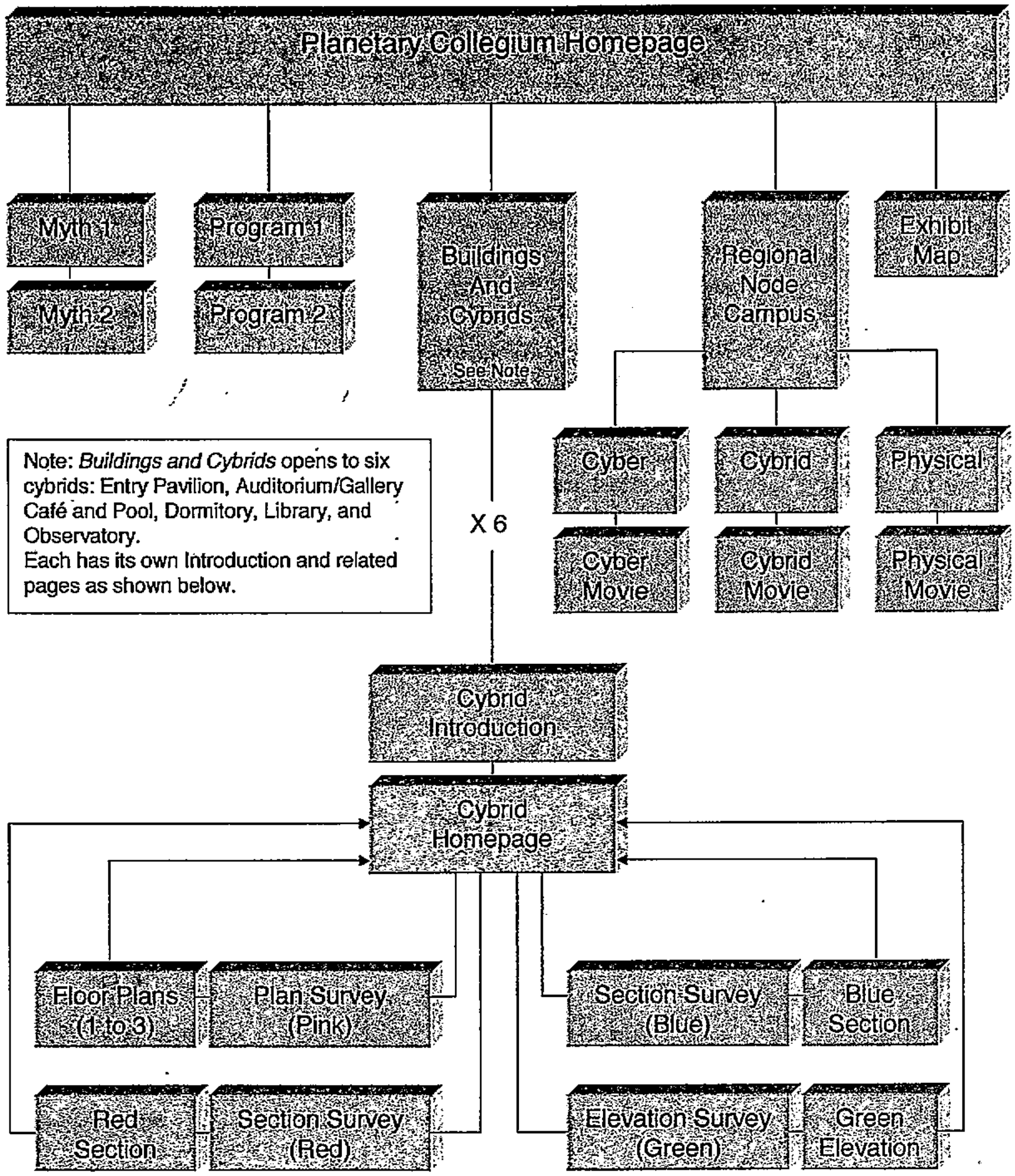

Planetary Collegium DVD Map

The file structure shown above is for the DVD disk accompanying this dissertation. All navigation between files is done either with forward/backward arrows, or via selections guided by written suggestions. Please use a Macintosh computer when viewing the disk.

Acknowledgement

I am grateful to the University of Plymouth, its staff and faculty at the School of Computing, and especially Roy Ascott who directed my studies with the CAiiA-STAR program. He and his co-director at STAR, Michael Phillips, as well as my colleagues there formed a community of support, giving me encouragement and critical input throughout my research. More than once their insights, corrections and admonishments changed the course of this study – and all for the best.

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Author's Declaration

At no time during the registration for the degree of Doctor of Philosophy has the author been registered for any other university award.

The present research and dissertation was financed with the aid of a research studentship provided by the University of Plymouth. During the course of study the author made several presentations at relevant architectural, arts and technology conferences and seminars. He also presented some of work described herein at invited lectures and keynote presentations at several international institutions. He has prepared several papers for publication and published a book on matters related to this dissertation.

Publications:

Guest editor for "A-WARE" Special issue on computation in architecture for JAE, *Journal for Architectural Education.* Winter 2002.

Anders, Peter. and K. Martini. 2002. ACADIA's Inforum project: A competition with a jury of peers. *Journal of Architectural Education* 56(2): 38-43.

Anders, Peter. 2002. Honk if you love BEAP. Review of BEAP festival in ISEA on-line news letter. September.

Anders, Peter. 2002. Moving vicariously: Tacit embodiment and the shape of on-line communities. *International Journal of Design Computing* (an online journal). Spring.

Anders, Peter. 2001. Anthropic Cyberspace. *Leonardo* 34(5): 409-416.

Anders, Peter, and Daniel Livingstone. 2001. STARS: Shared Transatlantic Augmented Reality System. In *Reinventing the discourse.* Proceedings of ACADIA 2001 conference in Buffalo, NY. W. Jabi, ed. Buffalo, NY: Gallagher Printing Inc. pp. 350-355.

Anders, Peter. 2001. Domains of body and mind. *Convergence: The Journal of Research into New Media Technologies* 7(2): 90-100.

Anders, Peter. 2000. Places of Mind: Implications of Narrative Space for the Architecture of Information Environment. In *Consciousness Reframed III: Art and consciousness in the post-biological era.* Proceedings of the Third International Research Conference convened at the Centre for Advanced Inquiry in the Interactive Arts, University of Wales College, Newport. August 23-26, 2000. eds. Roy Ascott and Michael Punt. Newport, Wales: CAiiA, University of Wales College. Paper also presented and published in proceedings at ACADIA 2000 conference in Washington D.C. October 19-22, 2000.

Anders, Peter. 2000. Defining Space: Defining Information. *ACADIA Quarterly.* Spring. pp. 3-7.

Anders, Peter. 2000. Toward hyperarchitecture. A book review of Luigi Puglisi's book *Hyperarchitecture. Archi-Tech.* Spring. pp.14-16.

Anders, Peter, 1999. Extensions: Some implications of cyberspace in the practice of architecture. In Media and design process. Proceedings of ACADIA '99, Salt Lake City, Utah. Philadelphia, Penn.: ACADIA. pp. 276-289.

Review of ACADIA'99 conference, *Architecture Magazine*, January 2000. p.49.

Presentation and Conferences Attended:

Semester keynote lectures given at the University of Caxias do Sul and the UCS School of Architecture, Caxias do Sul, Brazil. August 18, 19, 2003.

"De-Sign" presentation given at *FILE* festival of media arts, Sao Paulo, Brazil. August 22, 2003.

"Hybrids and Cybrids" presentation at the University of Sao Paulo, Brazil. August 23, 2003.

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"Spanning the gap: The crisis caused by computation within architecture" Presentation at *Remaking Realities* symposium at IAMAS, Ogaki City, Gifu, Japan. October 25, 2002.

"Comprehensive Space: Harnessing Consciousness in Architecture and Design" Paper presented at *4th International CaiiA-STAR Research Conference, Consciousness Reframed 2002: Non-local, non-linear, non-ordinary.* Curtin University, Perth, Australia. August 2-4 2002,

Presentation of research at *BEAP, Biennale of Electronic Arts* Perth, Curtin University, Perth, Australia. August 6, 2002.

Invited speaker at *The Edges of Wayfinding: Augmented Reality in Design,* SEGD conference Denver, Colorado, May 30, 2002.

Keynote address, *IDEAS (Interactive Digital Environments, Arts and Storytelling) Festival,* Indiana University, Bloomington, Indiana. April 21, 2002.

Participant in panel, Motion, Space & Technology, at the *Free Space Symposium* at Duke University. February 22, 2002.

Keynote address, *A2B* conference at Swissbau convention. Basel, Switzerland. January 25, 2002.

Presention at *Networks to Nanosystems: 9/11-N2N Art, science and technology in times of crisis* conference. University of California Santa Cruz, November 8, 2001, and UCLA November 13-14, 2001.

"Towards an Architecture of Mind," presented at *Extreme parameters: New dimensions of interactivity,* Universitat Oberta de Catalunya, Barcelona, Spain, July 11-12, 2001.

Invited presentation on cybrid research, presented at *E-naissance: New configurations of mind, body, and space,* Galleria Civica d'Arte Moderna e Contemporanea, Turin, Italy, March 28-29 2001.

"The Cybrid Condition," invited presentation at *L'Art a L'ere Post-biologique* conference, École Nationale Supérior des Beaux-Arts,Paris, December 12-13, 2000.

"An Interrogation of Space: A Panel in Three Acts," creation and direction of a panel presentation at *ISEA 2000* conference, Paris, France, December 7-10, 2000.

"Virtual Spaces on the Internet," panel and invited presentation at the *5th annual International Festival of Architecture in Video*, Florence, Italy, November 30-December 17, 2000.

"Reflections in Digital Glass: Doubling in Cyberspace and its Projected Uses," invited presentation at *Wie Wird Künstlichkeit Wirklich?* international conference, Luxembourg City, September 22-23, 2000.

Presentation of cybrid concepts and strategies to Haworth furniture manufacturers. Guest of Ideation and Design Group, May 4, 2000.

"Moving Vicariously." Poster presentation on movement in virtual environments *at Toward a Science of Consciousness Conference: Tucson 2000*, Tucson, Arizona. April 11, 2000.

"Minding Space", presentation at *Interfacing the Future: The Third Annual Digital Arts Symposium at University of Arizona*, hosted by the College of Fine Arts. April 6, 2000.

Presentation of research at the University of Wales, December 12, 1999.

Creation and direction of panel discussion entitled "Defining Architecture: Defining Information" at *ACADIA'99* conference in Salt Lake City, October 1999. Same discussion directed on ISEA membership list serve as a joint ACADIA/ISEA effort.

Keynote speaker at SIGRADI III Latin American conference for digital graphics; Montevideo, Uruguay. September 30, 1999.

Panelist in discussion on "Transarchitectures" hosted by Marcos Novak at *Paradox II: Cyberspace embodied.* The second experiential conference on cyberspace, habitat and human evolution, Arcosanti, Arizona. September 25, 1999.

"Anthropic Cyberspace" presentation at *Itau Cultural*, Sao Paulo, Brazil as part of joint ISEA, Itau Cultural, CAiiA-STAR, Leonardo conference.

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Cognate activities:

Board member for the Association for Computer Aided Design in Architecture (ACADIA) since 1997.

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Juror of *Auto•Des•Sys 2001-2002* Joint Study Awards in Computer Graphics and Design, Summer 2002,

Member Leonardo Digital Review committee. 2001 – present

Director, ACADIA International Design Competition committee 2001 – 2002.

Director of second ACADIA international design competition. Completed February, 2002.

Member , Advisory Board for e-ProCom, a professional conference developer for e-business in the architecture, engineering and construction industries. 2000 – present.

Signed ....

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Many rooms, many dreams, many countries

in the same space...

Yoko Ono 1966
from
The Blue Room Event

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.

Chapter 1: Architecture's Adoption of Information Technologies

The computer's introduction to architecture has had important effects on the discipline and its processes. Originally intended to emulate pre-existing drawing techniques, computers in architecture have over the past thirty years influenced methodologies of practice, design strategies, formal considerations and, to much lesser extent, the nature of the design product itself. Since their arrival, computer applications for architecture – paralleling developments in the information technology industry – have become more accessible in cost and availability. Concurrently, their performance and ease of use have improved profoundly, hastening their adoption by architectural offices as well as schools of architecture.[1] Architecture schools responding to growing demand from the profession now include courses in Computer-Aided Design (CAD) applications as well as computer enhanced design studios.

Architectural schools in the U.S.A. and elsewhere, while originally wary of the computer's intrusion into the design process, now accept information technology as part of their curriculum. This development was the product of several factors, many of which had more to do with economics than any innate fit between computation and architecture. Students with an eye toward employment insisted on training in appropriate software before entering the job market. Schools unable or unwilling to offer this training were at a disadvantage in getting students – a disadvantage aggravated by a weakening architectural market in the early 1990's. School administrators soon found themselves in a situation their professional counterparts occupied some years before. Professor Alfredo Andia, writing on the history of architectural computation, notes that a primary motivation for architectural firms to adopt computer technology was their clients' insistence upon receiving design documentation – drawings, specifications, text – in digital formats. Faced with this challenge, "[w]orried senior management became *executive champions* that clearly promoted CAD literacy programs in their firms." (Andia 2002) By the middle of the 1990's most large and medium-sized architectural firms had developed proficiency in computing and over 75% of their production was executed using CAD technology. The pressure to change from hand-drawn to computer-drawn designs filtered down to academia via the job market and other agencies and, like professional offices previously, many schools reluctantly adopted computation in response to economic considerations.

The adoption of computers in architecture paralleled the increasing use of computers in the businesses and institutions of architectural clients. The rising popularity of computers in business was accompanied by great fanfare in the press and rampant speculation on technology stocks in the markets. The 1990's may be characterized as digitally-obsessed, a period in which computers affected nearly all forms of culture ranging from science and government to social theory and the fine arts. (Gates 1999) (Mok 1996) Twenty years

[1] In a strange reversal, academia – the test bed for design computation in the 1970's and 1980's – now at times trails developments in professional computer use. The application of Computer-Aided Manufacturing techniques in the profession, for instance, preceded architectural academia's involvement by several years. See also (Novitski 1999).

earlier large architectural firms like Skidmore Owings and Merrill, and Perry Dean Steward, along with academic researchers conceived and developed precursors of architectural computation. However it was not until the late 1980s that computers and architectural software became accessible, allowing the profession to respond to its clients' computational demands. (Fridquist 1989)

Effect of Computers on Architectural Product

The computer has had an undeniable effect on architectural processes. Until recently, however, its effects on the architectural product have been minimal; computers are still used primarily to effect easy modification or replication of plans and details. The past decade has seen the ascendancy of computation both in the theory of architecture and in the buildings it has produced. We will shortly detail important themes of design computation, but it is useful here to outline the uses of computation as disclosed by best practices within the field. We shall see that theoretical practices take the use of computers much further than traditional, professional practices.

The most obvious effect of design computation has been in the unorthodox forms produced by both architectural practitioners and theoreticians. The fragments and curves of current styles can now be quickly calculated, fabricated and built because the softwares used earlier for the design of automobiles and jet planes now let designers create smooth, flowing forms of multiple curvatures. The Guggenheim Museum in Bilbao stands in testimony to the new geometric freedoms afforded by this technology. Besides Frank Gehry, other designers and theorists have employed the soft curvatures of animation software in the designs of their projects. A quick review of current design publications discloses a baroque/expressionist revival in full swing. Many of the designs of Greg Lynn, Lars Spuybroek, Bernard Franken, Ocean, and Objectile would appear inconceivable without the aid of the computer. This said, their practices still serve materialist ends directed at the construction of buildings. The computer, despite its importance as design tool, simply hastens conventional processes. (Aouad, Ormerod, Sun, Sarshar, Bairett, Alshawi 2000) Computer scientist Joseph Weizenbaum has written insightfully on the adoption of computers and how it often further entrenches existing institutions and modes of practice. (Weizenbaum 1976, 31-32) The emergence of seemingly new forms of digital design conceals an underlying conservatism, one that, with its attendant materialist focus, delays architecture's response to challenges presented by techno-modernist culture.[2] [3] Ironically these challenges spring from the very tool that now pervades architectural practice. (Anders 2003a)

[2] *Materialist* here refers to the value orthodox architecture places upon construction-oriented practice. Conversely, *idealist* refers to an architectural teleology that does not entail material fabrication, specifically in this case digital design practices

[3] A useful critique of the instrumental use of computing in architecture, particularly CAD, is provided by David Willey. He argues that further development of architectural computation should learn from the new digital techniques – VR, computer games, multimedia and the Internet – rather than proceed on failed models based on universal design standards and optimal design solutions. See (Willey 1976) and (Willey 1999).

Theorists within the profession have addressed the challenge posed by techno-modernism to architecture; however the limited effect computation has had on architectural teleology is often overlooked. Research at major institutions – MIT, XeroxPARC, and IBM among others – often stresses the use of digital technology to resolve needs arising from the technology itself. Former architectural professor now director of MIT's MediaLab, Nicolas Negroponte, has articulated the new digital lifestyle, one in which technology is so pervasive as to be effectively transparent. (Negroponte 1995) Another influential architect and writer is the dean of MIT's School of Architecture, William Mitchell. In a series of books he has laid out a future for architecture, one permeated with devices, modes, networks, and systems that accord with Negroponte's vision. It is instructive to read Mitchell's work, particularly to see an emerging subtext, one that – despite an overt emphasis on devices and smart buildings – begins to question the materialist assumptions of traditional architecture. And suggests a form of virtual idealism informed by the Internet and cyberspace. (Mitchell 1999b)

Architecture professor Michael Benedikt's seminal book, *Cyberspace: First steps*, was among the first to expand the domain of architecture to the digital world of cyberspace. (Benedikt 1991) It argued that architecture was well suited to lead development in this non-physical realm. His arguments included the adoption of architectural computation, the development of virtual reality technologies within architecture, and spatial/informational capacity of design. This theme was since taken up in the work of other theorists, among them Gerhard Schmitt, Richard Saul Wurman, and myself. Common to this literature is the belief that digital technology, embodied as cyberspace, offers new opportunities for architects and designers. The product of this architecture is non-physical, extant only in digital formats and selectively manifested in spatial displays and virtual realities. Designers and architects pursuing this logic, including Stephen Perrella, Hani Rashid, and Marcos Novak, have generated a variety of designs for environments that transcend the need for construction. These non-material spaces, unbounded by gravity and mass, have been claimed to free the mind from the body and terrestrial concern. According to Novak, a kind of Cartesian, abstract ideal has been achieved through use of computation. (Novak 1998) This view, reflecting a form of techno-utopianism, is not universally held. Indeed, writes architectural professor Richard Coyne, the romanticism of such assertions does much to undermine similar idealist arguments which themselves may have merit. (Coyne 1999, 28-31)

However, if we set aside utopian claims, the idealist argument opens a space of opportunity for architecture. It takes full advantage of the computer in bypassing the constructional bias of architecture while simultaneously expanding architecture's domain to electronic space. By avoiding architecture's materialism virtual idealism frees architecture to serve the needs arising from techno-modernism. It seems prudent then to consider how computation has affected architectural process and its capacity to transform the architectural product.

CAD and the Autonomy of Simulations

The influence of computation on architectural processes was first felt with the introduction of CAD systems in the early and mid-1970's. These were proprietary main-frame systems developed by large engineering and architectural firms along with specialists in academia. However, as early as the 1960's William Fetter, an engineer at Boeing Corporation, foresaw CAD and CAM (Computer Aided Manufacturing) and applied the term *computer graphics* to his design for airplane cockpits. Lockheed followed Boeing with a CAD system of its own shortly thereafter. In 1963 IBM produced the first commercial CAD system, DAC-1, developed two years earlier for General Motors. The following decade saw many advancements in CAD graphics, notably algorithms for plotting graphics, hiding and clipping lines, and a 3D drawing system by Adage. In architectural computing Donald Greenberg, a professor at Cornell University, developed a computer program in architecture in 1967.[4]

Since the early 1970's computer graphics have improved greatly in both their realism and their interactivity. Rendering software that gave 3D graphics a new plastic realism began with Gouraud shading algorithms, and continued with the introduction of Phong shading, Catmull's curved surface rendering, and visible surface algorithms by Fuchs and Newell, Newell, Sancha. Interactivity with CAD graphics likewise improved from card and keyboard entry to mouse owing to improvements in HCI (Human Computer Interface) technology. Interactivity was greatly enhanced by a reinterpretation of the design entity into a number of discrete components each with its own behavior. A line, for instance, was initially the simple connection of two points. In ensuing graphic development the line could be moved about *as an object* maintaining its length and direction but free of its defining endpoints. Moreover the endpoints could be selected and moved independently, allowing the designer to "tweak" the line, stretching or shrinking it graphically. Such pliability, extending also to squares, curves and circles, allowed the designer to remodel and test forms in the course of the design. This process has since become important to design methodologies both in academia and practice, where not only primitive geometries but their larger integrations can be similarly manipulated.

An increase in realism and interactivity not only affects the design process, but also the nature of the design document. The pencil-on-vellum drawings of traditional architecture have been technologically displaced in both obvious and subtle ways. While originally drawings were tracings by the architect's hand, they have now become printouts from a mediating design database. The intermediate role of the computer is two-fold: 1) it is an input/output mechanism whose interface with the designer involves 2) a high-dimensional, interactive simulation that resides on the screen. While the first matter technically augments the drafting processes, the second is more problematic. The design document – now a plastic, interactive model – is an independent simulation of a material counterpart. Unlike the products of conventional design – drawings, models, sketches – which are discrete and fixed records, the design document is a medium whose

[4] A useful time-line of CAD's development may be found at http://mbinfo.digitalrice.com/CAD-History.

manifestations take a variety of material forms. (Ozel 2000) These, along with standard printouts and laser-cut models, now include fabrication of buildings and their contents.[5]

The simulation embodies the symbolic nature of architectural processes, manifesting the plastic intentions of the architect. As an intermediary between the architect's desires and the brute materiality of construction, the simulation occupies a unique position. It is validated by its role in architectural processes while maintaining autonomy in the mind of the designer. (Flanagan 1999) This autonomy has come to take several forms using the algorithmic characteristics of the simulation. One form is VR, as we have noted. A second takes the algorithm as a manipulable generator of shapes and solids. Adjusting variables in the algorithm produces new shapes that then can be applied to a final design. It is a mathematical equivalent to sculpture.[6] A third form draws upon research in genetic algorithms. In this case the shape of an object derives from an algorithm utilizing an equivalent of genetic code. Each *gene* in this case determines an attribute of the object, and by combining genes of different objects a designer may optimize his or her solution.[7] (Fraser 1996) The validity of this approach is debatable given difficulties in defining genetic attributes in architecture, but this does not concern us here. In the minds of algorithmic designers the simulation and its generating code have an existence independent of the conventional artifacts of architecture. This independence could not be possible without the use of computers in the discipline; and it is the simulation's autonomy and its exploitation that we will later return to in our discussions of virtual reality and cyberspace.

Networked Computing and Concepts of Place

While computer networks were nascent already in the 1960's the following decade marked the birth of networking. The year 1970 alone saw the introduction of time-shared, on-line computing with IBM's 360 computer, the first wireless computer network – Alohanet – at the University of Hawaii, and the Associated Press's first transmission of news via computer. In the following year ARPANET, the precursor to the Internet, boasted twenty-two university/government connections and soon expanded its services to England and Norway. Local area networks, invented at Xerox, allowed communications between computers within offices, and were soon augmented with Ethernet technology to speed up signal transfer. Many of the programs used for computer – and interpersonal – communications entered common use during this period. These include Telnet, a software that allowed the transfer of files using digital packets, electronic mail or email systems first introduced at the University of Wisconsin in 1977, as well as Bulletin Board Software (BBS) that let users communicate live via computers using conventional

[5] This is particularly evident in work by Frank Gehry, proposals by Greg Lynn, Michael Silver and others. See (Silver 2002). Architect Bernard Cache has created furniture using computer-aided manufacturing techniques. See (Cache 1995).

[6] Although the use of algorithms in architecture pre-dates contemporary architecture by centuries, their use in architectural computing is fairly recent. Notable examples are found in the Liquid Architecture proposals of Marcos Novak. See (Novak 1991).

[7] Genetic algorithms have already had application in engineering and, more recently the fine arts. Artists Karl Sims, Darel Anderson, William Latham have made important contributions in this field.

telephone lines. By 1983 TCP/IP protocols for data transmission over computer networks and the Internet became standard. Many of the current applications of networked computing – the Internet and the World Wide Web – are indebted to the burst of innovation seen in the 1970s and early '80s.[8]

During this same period, as we have seen, large architectural firms introduced proprietary, mainframe computing to architectural practice. Among these systems were Skidmore, Owings and Merrill's *AES*, Helmuth Obata and Kassabaum's *HOK-draw-HOK-image*, and Perry, Dean and Steward's *ARK2*. As less expensive personal computers and off-the-shelf software entered the market in the mid-1980s many of these systems fell into disuse. (Andia 2000) In general architecture offices kept the computer isolated from the design studio since few architects were qualified to be CAD operators, and the cost of operation was too high to afford more than one machine. Firms using computers typically produced only 20% of their drawings by computer. This was to change drastically with the improved performance of commercial software and the steadily declining cost of equipment. By the early 1990's it was economically feasible to have several workstations and operators within the same firm. The sharing of current data files on a project necessitated networked computing which not only assisted in the production of projects, but helped administer the printing/plotting of drawings, manage job data, and improve computer system and software maintenance.

Both developments in professional network computing and the rising popularity of the Internet in the past decade have influenced work processes in professional practice. Recognizing that computers themselves could not benefit firms without accompanying changes in methodology some practices began to take fuller advantage of network technologies. The architecture/engineering professions slowly adopted concepts such as *concurrent engineering* and *re-engineering*, already popular in contemporary business practices. By fully employing networked computing and the Internet offices could "work around the clock," sending project data to collaborators in various parts of the world. (Catalano 1990) The projects followed the sun, effectively, in continuous evolution. Place and time of production became moot as office work became increasingly decentralized and asynchronous. The techniques that allowed such operation were more successful in the manufacturing community than in the building disciplines that, as Andia notes, have more complex dependencies upon local practices, legal structures, and traditions. However, regardless of their implementation, network computing and the Internet changed contemporary notions of the workplace – even within architectural offices whose practice *is* the creation of place.[9]

The physical location of things, offices and employees has been increasingly subverted by networked information technology. Several collaborators using files residing on the

[8] Detailed histories of computer networks are available at http://ei.cs.vt.edu/~history/ and at http://mauicc.hawaii.edu/unit/computing/plan/history.html.

[9] "Physical settings and virtual venues will function interdependently, and will mostly complement each other within transformed patterns of urban life rather than substitute within existing ones. Sometimes we will use networks to avoid going places. But sometimes, still, we will go places to network." (Mitchell 1999b) See also (Mitchell 1999a).

local area network server may now work on a CAD document simultaneously. The dat is stored on a server, but the document is in no particular place. It could be on th machines of one or several designers. In the event that a file is shared with sister office in other parts of the world, say using an extranet, the collective place of work is no longe physical but effectively embodied in the space of the project simulation. Arguably th simulation is the only *space* common to the work team, it is a document current *here an now*, but independent of time zone or location. The reality presented by advance computer networks challenges issues fundamental to architecture: locatio documentation, even space itself.[10]

Information Technology and the Responsive Environment

A third important effect of computing has been its on-going role in the physical producti of architecture. By this we mean the use of computers as control and responsiv mechanisms within buildings, resulting in what has been called an "intelligent building." (Bowen-James 1997) (Walsh, Nixon and Dobson 1999) Although this strand o architectural computing is still young it is presaged by a largely 20th century interest i mutable buildings of indeterminate design. Modular building systems, which had thei origins in the late 1800's with Joseph Paxton's Crystal Palace, applied to structures tha evolved with changing needs. Such building systems utilizing repetitive materia components were logical applications of Taylorist/Fordist production models that prove so successful following the Industrial Revolution. As early as the 1930's architec Buckminster Fuller proposed an "organic concept of building," one that offere flexibility and the capacity for reconfiguration to meet the demands of buildings' occupants. Fuller, whose own training was as a military engineer, brought his experience to the design of industrialized, deployable buildings, notably his Dymaxion Houses an geodesic structures. The values of indeterminacy, mechanization and the responsive environment embodied by these works form the foundation for much of ensuing work b Yona Friedman, Archigram, and Cedric Price in the 1960's. Price's own design for the Fun Palace (1961) and the Potteries Think Belt (1964) both employed indeterminacy i the service of a dynamic, changing constituency.

The Fun Palace, Price's project co-designed with architect Gordon Pask, was among the first to propose an environment that responded instantly to its occupants with moving walls, floors and ceilings, fog dispersal plants, and warm air currents. The inclusion of Pask, an architect whose own work was greatly influenced by Norbert Weiner's concepts of cybernetics, was important in describing the responsive *behavior* of the building. Whereas the image of the building as a dynamic machine, suggested by Le Corbusier years earlier, later manifested in the work of John Johansen, Renzo Piano and Richard Rogers, with Price's Fun Palace and particularly his later Generator project (1976) we see the introduction of computers as active – even autonomous – control mechanisms within

[10] High dimensional network experiences offered by the World Wide Web allow socialization to occur in three-dimensional spaces. These environments, called Worlds, only compound the challenge presented by computer networks to an orthodox understanding of architectural space. See (Anders 1999a). See also (Damer 1998).

buildings. Architect Gillian Hunt in a text on cybernetics and architecture wrote of the Generator:

> A computer program was developed to suggest new arrangements, and the embedding of electronics in every component enabled connections to the foundation pads. The site in Florida became a vast working model, where the configuration of the processor was directly related to the configuration it was modeling. Early on in the project, the controlling processor was dispensed with because adequate processing power was distributed throughout the structure. A novel anti-inertia program was introduced which involved the computer promoting unsolicited changes should human interventions not prove frequent enough...The Generator caused considerable architectural debate and was heralded as the "world's first intelligent building." (Hunt 1998, 54)

Architect Warren Brody, as early as 1967, characterized such building behavior as a"soft architecture," that not only responds to its occupants, but learns from them and anticipates their needs. Indeed Brody's writings and Price's Generator project posed a new model of architectural computing, one that used the processor not in the design of a building – as with CAD – but in enabling its human occupant. (Brodey 1967) This model has since applied to digitally controlled building HVAC, and security systems. (Amirante and Burattini 1996) And a substantial industry has formed around the concept with corporations like Siemens and Honeywell supplying the technology for institutional, commercial and residential buildings. The model takes its advanced form in responsive environments, or "Smart Rooms," developed by Alex Pentland, and Hiroshi Ishii at MediaLab at the Massachusetts Institute of Technology, Mark Weiser's experiments in ubiquitous computing at XeroxPARC, and cognate efforts at the Georgia Institute of Technology, Germany's Fraunhofer Institut, and elsewhere.[11] Current research on smart materials, sensors and actuators, and shape memory alloys extends the "intelligence" of the building to its very fabric, with implications for an artificial environment with life-like organic and dynamic characteristics. (Jones 2001) (Hunt 1998) (Coen 1998) (Fox and Yeh 1999)

Such an environment arguably could not be possible without the presence of the computer processor. Whether concentrated or distributed throughout the fabric of a building, processors change the behavior of the environment, transforming it from static to dynamic, passive to active, inert to interactive. This new quality of the physical environment – its capacity for real-time behavior – has largely been brought about by computation and its instrumental mutability. (Gabrysewski 1999) A building's *behavior* now has meaning..

Thus computation challenges fundamental concepts of architecture. We have seen in this chapter how the lines, shapes and forms used by architects in the design of buildings now manifest a spatial database that is itself subject to endless interpretation and manipulation. Computer networks and media technologies phenomenally stretch or shrink space according to the needs of the production team and, by extension, those of the

[11] For additional information on intelligent environments see also (Kirsh 1998) and (Mahdavi and Lam 1997) For work done at MIT's MediaLab see (Pentland 1999), (Wisneski, Ishii, Dahley, Gorbet, Brave, Ullmer, Yarin 1999) and (Wren, Basu, Sparacino, Pentland 1999).

Chapter 2: Transformative Possibilities for Architecture

In order to articulate the opportunity that virtual reality and cyberspace offer architecture this chapter begins with a thought experiment that considers the substitution of material buildings with digital, spatial environments. Although others have proposed such substitution, notably William Mitchell, Marcos Novak, Gerhard Schmitt and Eden Muir, this story proposes a transformation of practice, suggesting that while technology may not obviate architectural processes, it potentially transforms its products. We will then critically address the issues presented by the thought experiment, first by identifying its implications, and then by revealing its idealistic shortcomings.

The Library Paradox

Imagine that an architect with a small practice is stalled because of a slowdown in the building market. He is well equipped with computers, on-line connections with his engineers, and the resources of the Internet. One day a client arrives with a project for the design of a municipal library for a small town. It would house a reading room, stacks for 100,000 books, computer card catalog, staff areas - many of the features found in comparable projects. The client has a budget for the design work but still needs to raise funds for the construction. He retains the architect for a feasibility study: initial sketches and specifications for preliminary cost estimates. These are done quickly - there is no competing work in the office - and the client, happy with the results, asks for images to pitch the project to potential benefactors.

The architect has expeditiously created a computer model of the building and, by setting the parameters, quickly produces several lush renderings. Moreover, he generates a computer animation that leads the viewer through the unbuilt project. The client is delighted. The visuals generate interest and tentative commitments from the funding sources. The architect is given approval for design development of the scheme. He adjusts and elaborates the first proposal, and incorporates all changes into the original model's database. With this model he generates new images of the library and, for good measure, a virtual reality walk-through that lets the viewer freely navigate the building as though he were in it. Given the go-ahead to finish the design and produce plans for construction, the architect completes the job even as the client awaits final funding. By now the project model is very comprehensive, everything from furniture layouts to electrical outlets has been accounted for.

The VR model is stunning. So as to make his walk-through realistic the architect created book symbols to rest on the shelves in the library stacks. With extra time on his hands he (quite illegally) links the texts from the actual books to the symbols. This lets a viewer wander the stacks, reach for a book and open it. Not only can she read the text, but she can view - even fall into its pictures. The books interact with one another, cross-linking through hypertext so that a reader can automatically jump to another book by selecting a reference. In this way, the digital model of the library offers unique features not found in conventional libraries.

Ultimately, the library is not built - the funding never comes through. The architect is paid for his services and the project is closed down. But the project's digital model is huge, comprising spatial, graphic and textual information. It is rich, self-contained and offers a compelling experience to its users. It has itself become the space it describes. Inspired, the architect loads the library model onto the Internet. There in cyberspace it is open at all hours, not just to visitors from the original town, but from all over the world, anywhere with access to the Internet.

Implications of a Virtual Library

If we are to take seriously the library story we must first reconsider materialization as the goal of an architectural project. Other issues implicated in the story are 1) the unexpected effects of digital tools on architecture, 2) the ontological relationship between architectural inscription and the objects it represents, and finally 3) how materialization enhances or limits a project's performance.

The Effect of Digital Tools on Architecture

We can roughly divide architectural tools into those used to make symbols – say drawing boards and pencils – and the symbolic inscriptions themselves – sketches, drawings, notes. Symbols are the modern architects' stock-in-trade. Over the past 500 years the professional architect has evolved from chief builder/craftsman to a designer whose notation instructs the building team.[1] Architects' direct involvement in construction is attenuated by this evolution away from fabrication toward symbol manipulation. While they still visit construction sites it is mostly to ensure conformity of buildings to the building specifications. Much of their work is done away from the site, well before construction begins.[2] This work increasingly involves architectural computation.

The benefits of architectural computation include: the management of complex projects; the speed of replicating and modifying designs; the capacity for data to be represented in various media – printed documents, screen presentations, and rapid-prototyped models. These have all led to significant changes in the production of architectural designs. And yet the product that reaches the construction site is still largely the same: drawings and specifications. The goal remains the materialization of architectural symbols as buildings, and so the output remain essentially the same.[3] Our story of the library challenges this teleology and proposes that the goals of architecture could change or suggests that disciplines competitive with architecture might evolve from a more reflective use of

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[1] Philibert first articulated the distinction between architect and craftsman in 1567.

[2] At least until the mid-1990's the American Institute of Architects' standard contract for architectural services prohibited the architect's involvement in the actual construction of a building.

[3] Judith Blau's study of architecture firms notes particularly the economic and social issues that underlie these goals. The study, conducted in New York in the mid-1980's, happened at a time of stylistic and programmatic complexity in the industry. Despite her observation that architectural values of rational equilibrium, purism, and functional orthodoxy were under attack, the ultimate aim of material construction was never in doubt. See (Blau 1984, 10-15 and 133).

computation. At the root of this matter lie the changing natures of architectural inscription, its media, and use in practice.

Virtual Reality and Architectural Inscription

Traditionally our architect would have had to draw his project and perhaps model it in wood or plasticene. He would have compiled the project in sets of drawings, models, and specifications, each representing a different stage of design. While making these sets is still common even in computer-augmented offices, the ontological nature of the architect's inscription is crucial to our story. Prior to computers, the lines drawn at the start of a project would have to be re-drawn throughout its later stages. A line describing a wall would be drawn several times before its construction. Drawings marked stages of the design process and, as records, remained fixed. While mark on a drawing may be as inert as the paper beneath it, digital symbols are radically different.

An architect working with a CAD model may believe he manipulates symbols, but in fact he manipulates data. The symbols seen on the screen are representations of information entered in earlier stages of the project. The line drawn in a sketch – or more properly, its data – may persist throughout all phases. Although these phases are marked by a succession of printed documents, many of their notations simply re-present an evolving database. The persistence of data allows the model to evolve over time. The architect can assign width and height to the simple lines of the plan to make walls; material and color can be added to create renderings and animations. He can then link detail, texture and construction to the same set of lines. Ultimately, this database can be "printed-out" as abstract sketches, detailed drawings, or compelling virtual realities. In our story, the database supplanted the building it described.

There is an ontological tension between architectural notations and the spaces/objects they describe. Modern architectural symbols are by convention abstract while the buildings they denote are material. Architects' technical symbols may look nothing like the objects they describe; their notations are imperative rather than descriptive, directing the craftsmen in their work. On the construction site, buildings are inferred from the symbols – abstract symbols lead to concrete structures.[4] The Library Paradox challenges this end, slackening the tension between symbol and building. By the close of our story, the architect's database is so rich that experiencing its symbols approaches, or even surpasses, that of occupying the building itself. These symbols can, of course, be abstracted for the sake of construction drawings as before, but they can also be so rich and dimensionally interactive as to blur distinctions between symbol and object. In our extreme case the database obviates the need for construction.[5]

[4] Despite this tension, the symbols and building are mutually contingent. The building wouldn't exist without the preparatory drawings and models. Conversely – and traditionally – the symbols are only validated by their role in producing a building.

[5] We see the effects of related abstraction with the development of on-line stores, agencies and institutions. Amazon books, one of the most successful on-line businesses, has significantly affected the success of

However, the ultimate library was not the product envisioned by the client or architect. The original project would have served a small community, required a material site, physical construction and maintenance. It would have been prone to wear from its environment and inhabitants, and would have needed building services: electricity, heating and cooling, water, etc. The library's final incarnation was something quite different.[6] It served not just the original community, but anyone – anywhere – with access to the Internet. It required no physical site, nor the construction and maintenance of its material counterpart. Barring electricity and Internet access it needed no services conventionally associated with buildings. Finally, suspended in cyberspace, it sustains no damage from its weather or occupants.

Beyond these differences, the non-material library performs its functions differently from the physical library. While physical books are only available when they are on the shelf, those in a database are nearly always accessible. Text of material books is bound between covers, while that of digital books may be interlinked with others, allowing readers to jump instantly between books.[7] Illustrations in digital books may be richly dimensional, animated and interactive while those of conventional books remain inert on the page.[8]

The material library would resist change. It would be "set in stone." Modifications would require planning, construction, investments of time and capital. If the building doesn't change with evolving use its performance suffers. Eventually, as is often the case, the library may have to be replaced entirely. In contrast, the cyber-library conduces to change. Given the precedent of interactive Web-sites and on-line worlds, the library can be customized to different users and uses, making it uniquely responsive to individual needs.[9]

The benefits of the virtual library have here been overstated to contrast the project's two possible manifestations, building and cyberspace, and the resulting difference in their performance. In the story the project's performance was enhanced by *not* being

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conventional book vendors by increasing their competition, changing their practices, and arguably driving them out of business altogether. See (Tapscott 1996). See also (Gates 1999) and (Mitchell 1998).

[6] Professor Gerhard Schmitt anticipates this outcome: "...the creation of physical structures is not the main purpose. Rather, the goal is to overcome typical shortcomings of physical architecture." (Schmitt 1999, 59).

[7] While matters of copyright are still hotly debated, the technology offers unprecedented access to material till now available only in physical form. Arguably, this technological trend will force a reassessment of the law, rather than the other way around. It has been observed that technology creates genies that, once released, cannot be returned to their bottles.

[8] Apart from the architectural setting for this scenario, the digital linkage of text and image is now commonplace for users of the Internet and World Wide Web. This accessibility was forecast as early as 1960 by Ted Nelson as early as 1960. See http://xanadu.com/

[9] Buildings can indeed be designed to accommodate change. The projects described in our earlier discussion of Cedric Price were of indeterminate design so as to facilitate on-going change. However, the systems were physical rather than symbolic as in the present case.

materialized – a surprising result. A project's materialization has clear, at times constraining, consequences for its performance.

The Impact of Non-materialization on Practice

A model's rich dimensionality can, our story suggests, ultimately compete with the building it describes. Indeed, in some ways it could surpass the performance of the building itself. Architects could design elegant, efficient spaces for clients without bias toward physical resolution, for, following our discussion so far, construction may not always serve the client's best interests. This realization loosens the grip of materialization on the profession and has a dramatic, liberating effect on the architect's role in a project. With the affordance of information technology the gap between the design and realization of a project essentially disappears to the point where the CAD model might become the project itself. Note too that the architect changed from being a passive agent, waiting for a client to build a project, to the creator of a global library by realizing the full potential of his technology.

Claims similar to those above are common in literature promoting cyberspace, or virtual, architecture. (Asanowicz 1998) We have simplified them here to contrast with the following critical assessment of the Library Paradox. While there appear to be too many variables to accurately forecast the use of digital technologies in architecture, we have here a starting point for discussion.

Challenging the Cyber-Library Alternative

The Library Paradox is an idealist proposal, based on assumptions that demand further inquiry. Some are obvious. In creating the cyberspace library, for instance, our architect would need resources and expertise not readily found in practice, not to mention copyright laws that would preclude downloading books into a publicly accessible database. But, in principle, these challenges can be overcome since both laws and design practice can evolve to meet them. Other assumptions about the library's performance cannot be so easily dismissed. Contrasting material and cyberspace counterparts is a useful way to observe their differences. The physical and cyberspace libraries can be compared on the basis of programmatic, experiential, and social performance. Changes in any of these categories affect the premises and practice of architecture.

Programmatic Dependence on Materiality

A building's design program describes the building's spaces and their service to its owner and community.[10] Generating the program is usually the first step in the design process and assumes that the spaces described will be part of a building or otherwise manifested on its site as landscape features, parking lots, etc. While a program's development involves many other considerations we will focus on its functional aspects for now. Our library story stressed the informational aspects of the library, specifically the contents of

[10] A design program is the specification for the design of a building. This is not to be confused with computer applications, like AutoCAD or Form•Z, with which architects design projects.

its books. However, libraries are programmatically richer than being mere book repositories. Many have reading areas, information desks, reference areas, meeting rooms, and auditoriums, even theaters. While it is likely that the story's architect would have designed such spaces, they would not operate in the same way in cyberspace as in a building.[11]

For instance, reading areas, the information desk – even the stacks themselves – are places of interaction with staff and other library patrons. In simply loading the spaces onto the Internet, our architect only translated the archiving function of the library without attending the social interaction within the building. The cyberspace library would have to have been specially designed for social interaction. This is not an impossible task – online environments and worlds already perform this function. (Buxton 1992) (Damer 1998) (Gellerson and Beigl 1999) But it wasn't at issue in the story. In overly stressing the books' informational role, our story presents a simplistic interpretation of libraries and their purpose.

Yet, even if we limit our discussion to the informational service of libraries, the physical and virtual libraries are clearly distinct. In the story, both the physical library and its simulation provided their users with information found in books, and possibly magazines, periodicals, and film. But, even in matching this function our simulation is not a proper library. To be a library it must *house books*, not merely their information. Although Webster's Dictionary notes that a library can be "something suggesting a library, esp. in being a receptacle of wide or miscellaneous information," this is only one definition among many that doesn't invoke the presence of books.[12]

Whether or not our simulation is a library is more than a matter of semantics, however. Had the architect's project been built, the library would properly have had facilities for handling and storing books. These facilities would include storage and sorting areas, book returns, shipping/receiving facilities and all their attendant building services. Without physical books these tributary spaces would have been meaningless. In our story the cyberspace double retained these spaces as a procedural accident. While originally they were to serve the handling of books now, free of materiality, they are free of purpose as well. In its virtualization a large portion of our library has become *space without function* – a result antithetical to the original design program and architectural conventions.[13]

Differences in Experiential Performance

[11] Richard Coyne has written extensively on the difference between different spatial phenomena and their meaning. While the distinctions between physical and cyberspaces would seem obvious, when they are perceived in analogous ways and their phenomena may be correlated. However, the uses of these phenomena may differ radically. See (Coyne 1997b). See also (Coyne 1998).

[12] From Webster's Third New International Dictionary of the English Language. Definition of library 1f.

[13] This paradox applies not only to libraries, but to any building whose activity involves archiving, generating or conveying information. These include among others museums, schools, and governmental or commercial office buildings. See (Anders 1999b).

Buildings are massive, solid. They protect us from wind, rain and one another; their walls direct our actions, separate or contain us communally. Besides offering a spectrum of sensory experiences, building phenomena reinforce one another. We expect to hear a slap when we strike a wall and feel the sting of impact. Walking through a space we notice changes of view, the sounds of our footsteps, and the breeze of our passage. Each of our senses contributes to a coherent image – the product of our effortless coordination of perceptions. (Hall 1966) This corroboration of modalities is crucial to our engagement with the world.[14] Experiencing a building such as a library requires only our presence. It is part of our physical, mundane world, and its phenomena are available to all who enter. This contrasts with the reality offered by the cyber-library.[15]

Unlike a real building, the cyber-library is only one interpretation of a rich database. Using the computer we never experience this database directly, only its multiple and varied manifestations. This recalls our previous discussion of CAD elements and databases. The same data can generate a lush perspective, an interactive walk-through, or a rapid-prototyped model. Further, three-dimensionality is only one of several display options. The database – independent of architectural conventions – can generate drawings, text, even music.[16] Each manifestation depends on the user and can offer a radically different experience of the library. The computer generates these manifestations algorithmically, presenting them to us on monitors, printouts or other displays. This discrete presentation distinguishes a digital simulation from the building it portrays and influences our perceptions. For instance, viewing the simulation as a plan would be quite different from engaging a virtual walk-through. Moreover the walk-through differs whether we view it on a desktop monitor or through a virtual-reality headset. The effects of mediation are variable and seemingly arbitrary when compared with our direct experience of a physical building.

Beyond the technical matters of mediation, our experience of the cyberspace library is disjoint from the physical environment we inhabit. The sun in the simulation does not illuminate our world. The ground we tread is not that which lies beneath our feet. Depending on the interface, our motions in cyberspace may lag behind us, jerking periodically to catch up with our bodies. Our vital suspension of disbelief is constantly disrupted by inconsistencies between our physical and simulated settings.

Differences in Social Performance

Dramatic differences obtain in the social performance of the two libraries. This disparity owes both to the technological abstraction of space, embodiment and communication

[14] The corroborative nature of sensory and mediated phenomena is a matter we will return to in Chapter 7.

[15] There are other ways of experiencing a building, say via photography or film or even drawings. However these are lower dimensional representations derived from the actual building and require mediation via cameras or other tools. However, this is an important aspect of buildings that we will return to in this section.

[16] This intermodality of data representation was the subject of Marcos Novak's Liquid Architecture and Navigable Music projects in the early 1990's. It is also an important feature of many software applications and their interfaces.

issues in cyberspace, and to the roles of libraries as institutions and buildings within their host communities. While these effects are related we shall discuss them separately below.

Technological Abstraction of Space

In describing the programmatic paradox of the cyber-library we noted that the simulated public spaces served no purpose. The original library program was stripped down to an information interface rather than a venue for public interaction. The spaces' users, for instance, could not physically occupy offices and meeting rooms. Lobbies, lecture rooms and reading halls were rendered useless without special accommodations for visitor dialog.

Even if the cyber-library were equipped for social interaction – say as in a virtual world – the intervening technology would heavily influence the experience of its users. Visitors would engage the cyber-library through text, sound, graphic icons, or spatial representation. In addition, whatever the technological interface, users take on a digital proxy to interact with a domain. (Anders 1999a, 145-148) For example, in virtual worlds users interact spatially via their digital counterparts, digital avatars or other agents. Even if three-dimensional and dynamic, these agents are extreme attenuations of reality, disconnected from and often bearing no resemblance to the users' actual bodies. (Thalmann and Thalmann 1993) (Damer 1998) The masking of users' identities by avatars is well documented and has unavoidable effects on social interaction and performance. (Mark, Fuchs and Sohlenkamp 1997)

Embodiment and Communication Issues

Beyond concealing the identity of its user, avatars have a more subtle effect on communication. Body language changes because of its attenuation in cyberspace. The small gestures we make, our posture and eye contact play a vital role in conversation. (Hall 1959) We don't just talk; we effectively dance in accompaniment. (Fast 1971) These subtleties are lost in avatar communications. While some actions may be programmed – waving, smiling, jumping – they are deliberately selected rather than being the natural, unconscious gestures we associate with conversations. This shortcoming may be ameliorated by other technologies. (Kuroda, Sato, Chihira 1998) The transmission of video into digital worlds may allow for a more natural interaction within the cyberspace, for instance. Avatars may be simply video representations of their users. However, this begs the point. Even a video of the user is an abstraction of reality. It is flat, seen from the camera's angle, and situated in a space unrelated to the on-line environment. Abstraction and technological mediation have an inevitable effect on the social use of space.

We should also note the importance of avatar motion within on-line environments. (Anders 1999a, 84-98) (Greenhalgh 1997) (Anders 1996) Visitors to our cyber-library are unlikely to park in the simulated lot and enter via the front door. Instead they may simply pop into the stacks, seeming to other visitors to appear out of nowhere. Such avatar motion takes full advantage of the technology, but is deliberate and abstract. In most cases, it depends on the user pre-selecting his destination, and on his familiarity with the world and its interfaces. Chance interaction with others in lobbies and hallways is obviated by this

periodic maintenance, regular activities, hours or operation, and cyclical assessments. The building provides a setting for private research, public meetings, and informal gatherings. Its service to the local community extends beyond the archiving of information and books. Finally, the building is not isolated but literally a part of its locality. As a landmark it distinguishes its local community by its material presence.

In contrast the cyberspace library plays a quite different role for its community. To begin with, the community is not distinguished by locality, but by a demographic of technologically literate users with access to the Internet. As a landmark the library would likely be a favorite destination for Internet browsers, somewhat like a search engine, or chat room. But we wouldn't "come upon" the cyber-library as we might a physical building. Instead we would have to address it by typing or calling out its site location. Access to the library is linguistic and neither spatial nor intuitively obvious. (Anders 1999, 137-144) (Anders 1996)

Conclusion

The observations above don't invalidate the cyberspace library. Instead they prevent the casual equation of the cyber-library with its material counterpart. Abstraction from material reality may not be a problem if properly managed. After all, we engage with abstractions in the arts and media on a regular basis. Literal depictions of material places are not necessary for engaging works in theater, art and film. But is this so for architecture as well? The question remains whether a cyberspace like our library can still be called architecture. To get a better perspective on this we will examine architectural practice to see if it might support the concepts implicit in the cyber-library.

Chapter 3: The Unmet Challenge of VR/Cyberspace in Architecture

While the history of VR actually goes back to Ivan Sutherland's early experiments in the late 1960's and subsequent work by Myron Krueger, *virtual reality* was first coined in 1989 by Jaron Lanier of VPL Research. (Sutherland 1963) (Krueger 1991) (Rheingold 1991, 154-161) VR, according to Lanier, denotes an interactive, immersive experience generated by computers and a variety of interface technologies including, among others, head-mounted visual displays, data gloves, and spatially-oriented sound. (Heilbrun 1989) Brian Lingard, a cognitive scientist and VR researcher, has described three classifications for the VR experience: passive; exploratory; and immersive. These classifications are useful in understanding VR's acceptance within the architectural discipline. *Passive VR* denotes the spatial experience we get from movies, books or videos. The user is here a spectator of authored experiences. Conventional animations produced using 3D software exemplify this form. *Exploratory VR* lets users wander freely in the virtual space of computer games and architectural walk-throughs. Finally, *Immersive VR* (IVR) is the "classic stage of VR, where users can fully interact with the artificial environment, are provided stimulation for all the senses, and have their actions directly affect the computer generated environment. (Lingard 1995) It is this last, immersive VR, that we noted in the Library Paradox. Both passive and, to a lesser extent, exploratory VR have gained a foothold in architectural practice and academia. Once the investment is made in a computer, software and training, nearly everything is in place for generating passive and exploratory VR. Architects create the computer model and the software lets them navigate its spaces in snapshots or animations. Because both forms of VR require extra work – in setting up camera movement, lighting, processing and editing – they are specialties, usually employed in client/public presentations.

Immersive VR has made few inroads in architecture. This is surprising given the flurry of excitement it caused within the architectural community. (Alvarado and Maver 1999) In 1993 architect/media theorist Nicholas Negroponte predicted that within the next five years ten percent of the population would wear head-mounted displays in public on planes, busses and trains. In the following year researchers Avi Bar-Zeev and Robert Jacobson wrote that "some time towards the end of the 1990's, clients and regulators could join architects in the Virtual Design Environment (VDE) to evaluate design and constructions prior to the actual laying of the foundation. (Bar-Zeev and Jacobson 1994) Some, including Marcos Novak, Gerhard Schmidt and myself, projected a new architecture of cyberspace, one in which space was no longer defined materially but as digital constructs beyond the computer screen. (Novak 1991) The future proved otherwise.

Murali Paranandi and Tina Sarawgi, both educators in architectural computation, observe the limited headway VR has made in the profession. "Beyond a few demonstration prototype VR systems in select research facilities, [they could] not find any systems in daily use in architecture." They found no VR application that enabled "new possibilities in architecture that would not have been possible otherwise," nor any that were "efficient enough for practical use." (Paranandi and Sarawgi 2002) Most documented experiments in architectural VR were conducted in the mid-1990's and either spun off into other

applications or halted entirely. Fredrick Brooks, in his survey of architectural virtual reality, found there to be roughly 100 immersive VR installations in productive use worldwide. (Brooks 1999) Many of these are presently used in entertainment and vehicle simulation rather than architecture.

This situation is puzzling considering the role that architecture played in developing VR. Developers in the nascent VR industry foresaw architecture as a major customer. However, architects' uses of computers were limited and instrumental owing to the immaturity of the technology, lack of expertise among practitioners and the technology's high cost of entry. (Alvarado, Marquez, Vildosola 2001) Van Dam et al, in their comprehensive report on VR technologies, list the reasons for delay. "Immersive Virtual Reality is still in an early stage of development due to significant deficiencies on many fronts, including input and output hardware performance and ergonomics, interaction techniques, application software, development environments, cost, and reliability." (Van Dam, Forsberg, Laidlaw, LaViola and Simpson 2000) Adoption turned out to be a frustrating, ever-disappointing process especially given the promises of the technology and its aggressive promotion by its proponents. (Dorta and LaLonde 1998)

Architecture and Cyberspace

Another highly touted concept that influenced architectural computation was cyberspace. More a concept than a technology, *cyberspace* was first coined by William Gibson in his science fiction novel, *Neuromancer*, in 1984. Gibson envisioned cyberspace to be a consensual hallucination of space induced by networked computers and digital technologies. [1] The concept, which became popular at roughly the same time as virtual reality, took a strong hold among those in the architectural software industry and academia. John Walker, founder of Autodesk a leading CAD software manufacturer, created a division in his company to develop software for creating cyberspaces. Inspired by Gibson's account, he wrote of a new way to engage computing, one that was modeled upon an enveloping information space rather than a dialog with an individual. In a memorandum to his company, known as the "Looking Glass Memo" he defined cyberspace as providing "users a three-dimensional interaction experience that includes the illusion that they are inside a world rather than observing an image." (Walker 1990, 444) Cyberspace, he wrote, would "usher in totally new ways to interact with computers, new applications for computers, and, ultimately, new ways of thinking about computers themselves." (Walker 1990, 447) The cyberspace project at Autodesk closed shortly before a management change in which Walker left the company. However, the cyberspace theme had already been taken up in academia.

In May, 1990, the campus of the University of Texas in Austin, hosted a conference to explore the potential of cyberspace. Cyberconf I brought together researchers from a variety of fields including psychology, sociology, computer technologies, the fine arts,

[1] "Cyberspace. A consensual hallucination experienced daily by billions of legitimate operators, in every nation...A graphic representation of data abstracted from the banks of every computer in the human system...Lines of light ranged in the nonspace of the mind, clusters and constellations. Like city lights, receding..." (Gibson 1984, 51)

and philosophy. But it was significant that Cyberconf was conceived by an architectural professor, Michael Benedikt, and held at the university's school of architecture. At this and the second conference a year later Benedikt, Marcos Novak, and Meredith Bricken proposed an architecture that need not be manifested materially, but instead might subsist in the simulations of cyberspace. Many of the uncanny products of CAD – weightless and unconstrained – could be realized only in cyberspace and experienced as networked virtual realities.[2] This possibility, given the technological optimism of the time, was strongly compelling, liberating the formal opportunities of architectural computing for its designers.

The demographics of the audience and speakers at the first Cyberconf were broad, reflecting the interdisciplinary nature of cyberspace design. In addition to architects were members of technological and humanist disciplines. Each of these fields offered a unique aspect onto cyberspace. Their respective influence in the actual development of cyberspace varied greatly. With the perspective of intervening years we see that, despite the energetic efforts of a few, architects had only a marginal effect on its development. But at the time of Cyberconf I architects took the initiative. Benedikt projected optimism about architecture's role in cyberspace:

> "The door to cyberspace is open, and I believe that poetically and scientifically minded architects can and will step through it in significant numbers. For cyberspace will require constant planning and organization. The structures proliferating within it will require *design*, and the people who design these structures will be called *cyberspace architects*...Theirs will be the task of visualizing the intrinsically nonphysical and giving inhabitable visible form to society's most intricate abstractions, processes and organisms of information. And all the while such designers will be rerealizing in a virtual world many vital aspects of the physical world, in particular those orderings and pleasures that have always belonged to architecture." (Benedikt 1991, 18)

His prediction identifies the two important trends in architectural cyberspace that would emerge in the ensuing decade. The first was *Information Architecture*, at term used by Richard Saul Wurman to denote the design of information structures to facilitate human understanding and the science of organizing information.[3] (Wurman 1996) The second, variously known as *virtual architecture, liquid architecture, or cyberreal architecture*, asserted a model of cyberspace based on the plastic, empirical space we inhabit. (Bermudez and King 1995) Unlike information architecture, which drew its adherents primarily from graphic, Web site, and human-computer interface (HCI) design, virtual architecture was largely developed by architects investigating cyberspace and VR as a spatial extension of their field. (Dagit 1993) (Andia 2002) (Anders 1994) The fact that it came to be known by many names discloses the variety of individuals and perspectives on the matter.

Neither information architecture nor virtual architecture constituted a movement if we understand movement to mean a shared philosophy or ideology that produced a

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[2] Among cyberspace's primary characteristics is its networked nature. This can be represented in various ways without necessarily being three-dimensional VR.

[3] For an earlier use of the term, one more akin to virtual architecture, see also (Brath 1991)

consistent, emblematic result. Instead these two trends appear to emerge from separate interests coexisting within architectural practice. Information architecture recalls the ordering, organizing role of traditional architecture while virtual architecture arises from architecture's creation of spaces and social environments. Information architecture's precedent in conventional architectural practice is the managed information, specifications, drawings, and renderings that direct the construction process. Virtual architecture stresses the immediacy afforded by computers between architects and their designed products – namely, their ability to craft the very spaces they design. The two trends often overlapped as their themes were pursued in design schools in the ensuing decade. (Schmeltzer 1994) (Rocheta 1996) (Anders 1997)

The information architecture of cyberspace drew interest and expertise from the HCI community, computer scientists, and cognitive scientists as well as designers. Clarity of digital communications was the subject of high-priority research at IBM, Apple Computer and at MIT's Media Lab under Nicholas Negroponte. Work by the late Muriel Cooper and, separately, Michael Naimark explored the possibilities offered by digital displays and visual databases. (Naimark 1990) It is notable that the tools used to create this computerized information architecture were generated by artists who themselves were often highly skilled programmers. It is information architecture that we experience at the computer when we click on virtual tools to accomplish our tasks. Such interfaces require both graphic and technical skills in their design.

The theme of information architecture was adopted with enthusiasm at the school of architecture at the ETH in Zurich under the direction of Gerhard Schmitt. (Schmitt 1993) In the later half of the 1990's several of its computer-aided design faculty – among them Maia Engeli, Tom Sperlich, and David Kurmann led research into new uses of databases for the spatial display of information. (Engeli, Kurmann, Schmitt 1995) However, the pull of virtual architecture is also evident in *Bits and Pieces*, a catalog of these studio experiments. (Engeli 2001) In his introduction to the book, Schmitt projects an increasingly virtual architecture. Pure architecture will become rare, he asserts, being replaced by *bits and bricks* architecture comprised of innumerable sensors and actuators. "Virtual architecture will be an alternative...to the excessive production of physical architecture...With improved virtual reality environments and computers...realistic virtual surroundings will be the natural working environments for most people in information societies." (Schmitt 2001, 7)

In contrast to information architecture, virtual architecture drew its adherents primarily from architects whose expertise in digital technology derived from increasing familiarity with CAD software. Modeling software was also a tool of choice in that it not only allowed the plastic design of objects but facilitated animation and virtual reality simulations of space. Virtual architects appear to have been less inclined than (digital) information architects to create tools for design opting instead to produce the design itself from existing software. In many cases, the designs of virtual architecture were the product of intuitive, playful manipulation of existing CAD and graphic software packages. (Andia 2002) (Glasgow 1996) The results were formally and conceptually striking, all the more so since virtual architecture challenged the materialist, construction-oriented values of architecture.

As a consequence virtual architecture and its variants met with skepticism from the discipline's profession and academe. Even at Columbia University's Graduate School of Architecture – which fostered a vanguard of digital design and theory – the notion of a disembodied, immaterial architecture provoked unease. Stephen Perrella, who then edited the school's newsletter, recalled Dean Bernard Tschumi's situation at the time.[4] Tschumi, whose own background was in film making as well as architecture, accepted that students might eschew the production of buildings to explore the new formalism of cyberspace. His position was anomalous to practitioners who expected graduates to be able to design buildings. Virtual architecture was also regarded skeptically by fellow academicians who sought, with a measure of desperation, to render their cyberspace forms physical. Designer/theorist Greg Lynn, among others, looked to Frank Gehry's success with computer-aided-manufacturing in his complex, curved buildings. In coming years, under the leadership of Lynn and Eden Muir who directed the school's computer facility, the school of architecture adopted rapid prototyping and stereolithography as an answer to the school's critics. This concession to materialist demands was a blow to virtual architecture in academia. The computer, which had come to challenge the building-oriented values of architecture, was effectively re-instrumentalized – harnessed to entrenched modes of practice. The success of this reaction can be measured in the current purchase by many architecture schools of laser-cutting and rapid prototyping machines for students to print out their project models.

While virtual architecture still finds support among some academics – Mary Lou Maher, Julio Bermudez, Constantine Terzides, and Dirk Donath among others – its urgency has been tempered by this return to materiality.[5] Marcos Novak's early *Liquid Architecture*, set forth at the first Cyberconf, later transformed into *Transarchitectures* in which cyberspaces might manifest in the physical world. Stephen Perrella's *Hypersurfaces* – envisioned as liminal between computer graphics and physical spaces – became increasingly physical and grounded, taking form in material displays and structures. By the time Hani Rashid and Lisanne Couture produced their virtual, and seminal, Wall Street Stock Exchange and Guggenheim Museum projects, virtual architecture had lost much of its force in academia. (Rashid and Couture 2002) Perrella, in an interview, observes, "Now that architects have discovered cyberspace, they don't know what to do with it."[6]

Virtual architecture fared little better in architectural practice where materialist values understandably remained entrenched. Practice, which answers directly to the needs of its clients, is at the same time constrained by clients' expectations of architecture – namely, that its products were buildings. As a result, few practices sought distinction as virtual architects despite their increasing use of computers, Web sites and the Internet. Few

[4] From author's interview with Perrella, July 2003.

[5] See also (Kiefer 2000)

[6] Personal communication from Perrella.

clients were prepared to see the need for virtual architecture as the experience of Dace Campbell bears out.

Campbell, a graduate of the University of Washington's school of architecture, was a strong proponent of virtual architecture. His Master's degree project was cyberspace museum which could be navigated by using virtual reality technology. (Campbell 1996) The University, home to the Human Interface Technology Lab (HIT Lab), was ideal for this research, providing Campbell with both the technology and expertise to realize his project. Soon after his graduation he was hired by NBBJ, a large architectural firm based in Seattle, to develop virtual architecture services for its clients.

Campbell and his team divided their time between research and client development. Neither was easy. The technical limitations to research were well-known to Campbell. "The technology is always three years from being there," he notes, "Our designs always push the technical envelope, no matter how unassuming we make them."[7] However, the development of a clientele proved more daunting. Virtual architecture was poorly defined even within the profession.. The concept by this time was known by many names, each entailing a slightly different meaning. In addition, *virtual* and *cyberspace* had conflicting and ambiguous meanings in the popular media. This led to confusion when Campbell's team engaged NBBJ's clients. When the team proposed virtual architecture in favor of buildings, the client agreed that some of the building functions could be substituted with cell-phones and Web sites. The notion that virtual architecture could be a non-physical space like that of Campbell's thesis project never made it past the discussion stage. The clients wanted proven solutions. Investment in new, custom technologies was beyond the project scope and the clients' budgets. Campbell's team was eventually reassigned to creating virtual reality walk-throughs. Sadly, he observes, immersive VR is seldom used to explore or generate the designs, and is presently limited to promoting the firm's building projects.

Virtual architecture was dependent on ever developing information technology and the popular enthusiasm for cyberspace and things virtual. In part because virtual architects were largely users rather than developers of technology the fate of their calling was in the hands of the computing industry and its ability to sustain technological optimism in the culture. [8] Ted Krueger, a professor at Rensallaer Polytechnic Institute who has closely followed the use of computation in architecture, believes that virtual architecture rode on a popular enthusiasm that was fueled by the unrealistic, over-promotion of the information technology industry. However, as Campbell also noted, the actual technology was always several years behind the promise.[9] Eventually, the optimism of virtual architects waned in the face of developmental delays in the technology, frustration over equipment failures, the paucity of realized projects, and the confusion of potential clients. The collapse of the stock marked in 2001 – often referred to as the dot-com crash

[7] From author's interview with Campbell, July 2003. See also (Johnson 2002).

[9] From author's interview with Krueger, July 2003.

– put a stop to the optimism and hubris, and virtual architects along with others who depended on technology were forced to regroup.

Virtual Architecture without Architects

The design of cyberspaces for social interaction was not limited to virtual architecture. Emerging from the fields of networked communications and computer engineering were new disciplines: Human Computer Interface design (HCI), Computer Supported Collaborative Work (CSCW), and the design of Collaborative Virtual Environments (CVE). Three-dimensional, spatial simulations found use in computer gaming, virtual sets for television and film, and backdrops for on-line virtual environments. These developments ran parallel with virtual architecture during the 1990's although they rarely crossed paths.

Unlike architecture, which is predisposed toward the creation of space, the new disciplines have many alternative formats for conveying social and other information. For them, coming as they do from fields that specialize in verbal or algorithmic media, three-dimensional space is exotic. The text-based virtual realities of MUDs and MOOs, for instance, create spaces in the user's mind from verbal descriptions on the screen. They utilize spatial metaphors to situate the actions of its players in ways analogous to a game board in chess. More importantly, the implied spaces – rooms, buildings, dungeons, gardens – set the mood and behaviors of the players in role-playing games. These games still have a great following despite the success of three-dimensional on-line worlds. [10]

HCI has made many advances by recognizing the informational value of space. (Kay 1990) Not only do certain forms of information reveal themselves spatially – like graphics, and simulations – but the illusion of space itself creates the context for their understanding. (Norman 1991) (Schneiderman 1987) A well-rendered object on the screen implies a space to contain it and a light source by which to see it. Our tacit presence in the space is revealed by its orientation, position and scale. Each of these qualities bears with it information that can in turn be used by the observer. Although HCI stresses the interaction between the computer and user, it does so in many cases by evoking spaces and objects. We may see this in the simple icons of our computer desktops or in more complex renditions of computer-spaces.

CSCW also has benefited from spatial cyberspaces, and itself has led to a new field devoted to spatial interaction in on-line environments: CVE or Collaborative Virtual Environments. (Snowdon, Churchill, and Munro 2001) Matters related to CVE include perception and communication in simulated spaces, tele-immersion in virtual environments, and the culture of on-line communities. The field draws substantively upon the experience of computer game designers and developers of on-line worlds, like Black Sun, and Alphaworld. It is in these on-line worlds that we find the environments dreamed of by virtual architects. Three-dimensional, social, and completely virtual, they

[10] For a discussion of MOOs and MUDs and their architectural qualities see (Anders 1996).

have many of the attributes of virtual architecture, albeit without the serious inquiry into design that architecture would entail.

Curiously, when asked, researchers in CSCW and CVE and cyberspace-related fields often welcome the interest of architects. Having grown to appreciate organized space in their simulations, they have also come to understand architects' unique contribution in setting context, defining place, and creating, as Benedikt writes, "those orderings and pleasures that have always belonged to architecture." (Benedikt 1991, 18) Despite its difficult history, virtual architecture may yet find a place in the world. But for this to happen it may have to shed some of its idealism while, reciprocally, conventional practice might open to the possibilities afforded by computing, VR and cyberspace.

Chapter 4: Cybrids: Accepting Virtuality within Architectural Practice

Despite the difficulties that beset virtual idealist architecture's development, its basic premise remains true today. The simulation of space in concert with the interactivity afforded by computers offers useful and compelling environments that share many attributes of material spaces designed by architects. The challenge posed by virtual idealism offers architecture a chance for self-renewal. If viewed constructively it extends the discipline beyond buildings to the contemporary world of electronic media and digital culture. Virtual idealism invites a redefinition of space – the domain of architecture – to include its cognitive and empirical nature as well as the observer's complicity in its realization.

However, if this promise has held true throughout virtual idealism's difficult history, why should now be the time for its re-emergence? The answer lies, in part, with history itself. Since the time of virtual idealism's introduction much has changed both culturally and technologically. At the time of Cyberconf I the Internet had no recognition among the public. Modems operated at a fraction of the speed currently available. The World Wide Web, which opened the Internet to graphics, sound and animation, was still a few years in the future. The intervening years saw a wave of enthusiasm for information technologies that swept through many disciplines and popular culture. Computers and microprocessors may now be found in many homes, cars and appliances. The modern workplace requires a computer. Cell phones, once a rarity, now are commonplace. The World Wide Web's popularity and ubiquity needs no elaboration here except to say that its success validates much of the enthusiasm that attended its development. Its success reflects a receptive public increasingly literate in digital media and information technology.

Technological literacy might thus yield an easier reception for virtual idealism now versus a decade ago. As the increasing interest in computer supported collaborative work and three-dimensional on-line communities shows, virtual architecture persists even when architects are not involved. The prevalence of spatial computer games is also an indicator of popular acceptance of cyberspace among those who will occupy tomorrow's workplace. All this may indicate that a revival of virtual idealism, if carefully developed, could be timely and invigorating for architecture itself.

Emergence from Practice

Our optimism is tempered by virtual idealism's past. Given its history, how can architecture take up virtual idealism productively? One answer draws from virtual architecture's success in disciplines outside architecture. CSCW, HCI, and CVE have their roots in communications technology and electronic media. The cyberspaces produced by these fields emerge from practical application of psychology and cognitive science to needs posed by communications and media. Playing upon our innate use of space to think and communicate, these fields have employed space as a natural extension of their practice to orient computer users and contextualize social interaction over computer networks. Space in their case is imbued with social and cognitive worth, and –

in CVE at least – does not exist without occupants to engage in it. In short, the success of these cyberspaces owes a great deal to their development within disciplinary practice.

In contrast virtual architecture's cyberspaces remained the province of theory and academic discourse. Architecture's virtual idealists placed great value on virtual architecture as an alternative to mainstream practice, widening a rift between architectural theory and practice that predated the advent of computing. This rift, as the history of virtual architecture shows, could not be breached so long as conventional practice resisted the non-materialist premises of virtual idealism. Practitioners had too much vested in building-oriented processes, the expectations of clients, and the construction economy in which they operated, to justify the pursuit of untested ideas and technology. Unlike the cyberspaces of other fields, those of virtual architecture did not emerge from the core values of practice, and so today it remains a theoretical, academic concept.

If we were to resuscitate virtual architecture today with any hope of success we might well do so *from within* architectural practice. This could ground the concept of virtual idealism through practical application, while opening practitioners' views of space to include its cognitive and empirical qualities. Within practice virtual idealism would become one of many options designers could employ on behalf of their clients, theoretically extending their practice to the creation of alternative, non-physical spaces suited to contemporary needs of culture.

Models and Methods for Integrating Virtual Idealism in Practice

It is worth assessing and updating models and methods of conventional practice to give virtual idealism a context for development and eventual integration. We will pursue three avenues of approach: 1) presenting two models arising from architectural computation, 2) examining the role of symbols and agency in practice, 3) and re-evaluating the product vs. process orientation within practice.

Models Arising from Architectural Computation

The two frames of reference here presented we will call the *notational* and *hard/soft* models. We will first pursue the notational model that holds that computation reconciles two modes of notation used in architecture, denotative and connotative inscription. While denotative inscription is largely used in architectural practice, connotative inscription is more prevalent among theorists and academicians. Denotative drawings are imperative, essentially specifications for construction. They are highly detailed and integrated, providing an effective set of instructions for the builder. In the United States, for example, these denotative symbols, or *contract documents,* commit the builder to the fabrication of a structure. Indeed, much of an American architect's pay is for the time required to produce these documents from a variety of previous, connotative design drawings.

In contrast, connotative drawings are qualitative, suggestive, and generally precede denotative drawings. They convey a project's scope and visual impact to clients, evoking their response and stimulating dialog. They are rarely used in dialog with a builder whose needs are more definitive. Connotative inscription often precedes denotative drawings, anticipating them in sketches, rough models, perspective drawings and renderings. In the case of VR idealists, this connotational inscription is self-realizing, bypassing the mediation of denotative inscription *to become what it describes.*

The tension between denotative and connotative inscription is slackened with the realization that conventional practice uses both systems of notation; they are merely used at different stages of a project. Architects initially employ schematic, evocative images to stimulate and motivate a project. Later more specific, detailed drawings evolve from these images and lead to construction. In the course of a project a dialog emerges between the two kinds of inscription. One informs the other as renderings take shape from plans and, in turn, affect future changes in the building layout. This dialog conventionally reflects the cognitive effort of design, one that swings alternately between analysis and synthesis in its course toward material building. (fig. 4.1). In practice inscriptions characterize the phase of a project, from concept to construction. In academia connotative drawings often express the early stages of hypothetical projects. Students and academicians are unlikely to take their designs beyond the initial phases owing to students' lack of experience, institutional schedules, and other demands put on their instructors. But in many cases the academic product resembles in content and goals the early stages of work done in architecture offices. Regardless of the materialist or idealist end product both types of notation – denotative and connotative – mark the phases of its development.

Virtual reality, one product of virtual idealism, shares the attributes of both forms of inscription. It evokes strong responses in viewers through motion, sound and interaction. At the same time, because it manifests a rich, detailed database, the VR file holds actionable data for a project. The data model used to generate the VR is the same one that, with more information, produces construction documents. In this way virtual reality and architectural computation serve both materialist and idealist processes alike. The database is the designers' manipulable memory; VR is just one of its manifestations in a larger process. The matter of architectural processes is one that we will take up in greater detail, shortly.

Hard/Soft Model

Our second more radical frame of reference, the *hard/soft* model, employs the computer itself as a metaphor for architectural products. It observes that the computer is actually a symbiosis of hardware and software. Neither works without the other – operation only happens *through their relationship*. Machine and data, with their respective materialist and idealist values, are here synthesized in the very tool of architecture. The computer not only provides a model for resolving the materialist/idealist divide, but it suggests the nature of architecture's future products as well. (Anders 2001) These products may become dual entities, for instance, reconciling both the physical and virtual within the same composition. Like the computer, these hybrids could depend wholly on the relationship between their constituent parts. (Wake and Levine 2002) We suggest that the computer, by integrating material and ideal entities, itself prompts a new understanding of the architectural product. (Asanowicz 2000)

Symbols and Agency

Architectural agency resembles that of most design professions. In contrast to the fine arts, both architecture and design use symbols in service of eventual manufacture. In the United States architects rarely *build* their projects; construction is the role of tradesmen and builders. Since architects represent their client in the design, negotiation and contract supervision of a building, their role sometimes conflicts with the interest of the builder. As a result, contracts of the American Institute of Architects carefully avoid architect's responsibility for even construction supervision, limiting their engagement to verifying contract compliance and processing pay requests. The irony for architectural materialist practitioners is that, despite their projection toward material resolution, the building itself lies outside the practitioners' scope. Architects, materialist and idealist alike, are symbol manipulators regardless of their stated aims. This is tantalizing for architects who, denying the abstract nature of their profession, insist that their work is justified only by construction. Comparatively idealist architects often have a similar nostalgia for materiality in their designs, and so, suffer the same frustration as their materialist counterparts. [1]

Process vs. Product

Materialist architects' symbolic artifacts never attain the status of end-product, instead they are signs projecting an outcome that lies beyond their domain.[2] An emphasis on materiality ignores the tributary, symbolic artifacts that lead to construction – artifacts that may, in the case of VR, supplant or reduce the need for construction. This does not apply solely to VR, other design artifacts like full-scale mockups could conceivably make the proposed building redundant. However, it appears that many of the challenges posed by virtual reality in architecture can be resolved by shifting the discipline's emphasis from material product (or at least end-products) to process. (Knight, Brown 2001 and 2002)

An architectural project is expressed both materially and symbolically at multiple stages in its life. The project appears as symbols, drawings, models, and material mock-ups; the resulting building is only one of its manifestations. The project's life arguably extends

[1] Computation brings this irony into crisis by confronting architecture's materialist desires with the fact of its agency. This is especially true of virtual reality where simulation compellingly evokes material construction. While still maintaining the symbolic nature of architectural inscription, VR can emulate actual construction to the point of redundancy. VR idealists have momentarily evaded the predicament of their colleagues, if only by accepting simulation as a valid end of architecture. But the products of virtual idealism often seem brittle and rarified in contrast to the robustness of conventional architecture. It is for this reason that we seek to situate virtual idealism within practice. In turn the transformation of practice requires architects to accept their agentive role and the inherent validity of their inscriptions to abstract *or* material ends.

[2] This applies both to materialist practitioners and to many idealistically inclined theoretical designers.

from its inception, through its construction and demolition, to its erasure from the memory of all who engaged it. The project, understood in this way, has an informational identity that supersedes its ephemeral manifestations – symbolic, material, or otherwise.

As a process, design swings alternatively between concept and manifestation. This is part of the social interaction necessary for a project to develop. A designer generates drawings and models for consulting with clients, as well as to assess the project's progress. In dialog with others the designer gains new insights that, in turn, inform the next set of drawings and models. This feedback loop resembles that of many processes in technologies and the fine arts – it is characteristic of the social and cognitive act of creating something new.

Oscillation in the Design Process: An Example[3]

The following example shows this oscillation in the course of a typical architectural project, an office building. We will begin with the selection of the site for a project. Client and architect determine the site, conduct a survey and collect relevant materials for proceeding. The architect and engineers prepare record documents, drawings and text. The architect discusses options with her consultants and client – memos and phone calls are exchanged. Then she prepares sketches outlining the design options for review. Information from the review then informs another, more refined round of design. Products of this work are notes, sketches, renderings – perhaps even a model of the building. Prior to computers all these models, drawings and records were physically fixed: ink drawings, wood models, pencil sketches on paper. There was a clear distinction between the information underlying a project (program, intentions, data) and the artifacts used to support decisions (drawings and models). Any attempt to revise or update a scheme simply meant making more artifacts.

Once the design is approved, the architect prepares a record of the project and issues the drawings and text for bidding by contractors. Conversations and exchange of more materials leads to the construction of the building. While many architects see the construction of a building as the end of their involvement, the project lives on for the building's occupant. Beginning with move-in schedules and furnishing layouts, the production of post-construction artifacts includes drawings for building changes, additions and leasing, and – ultimately – demolition. The project spans from the drawing table to the archive; a range of incarnations mark its life over time. The life of the project is measured by a pendulum swing between concepts and the physical artifacts that manifest them. We may even consider the building itself to be an ephemeral "printout" of the project at a specific point in the process. The project design is not itself physical, only its manifestations are – and these vary with the project's development over time.

[3] Portions of the following appeared in (Anders 2001).

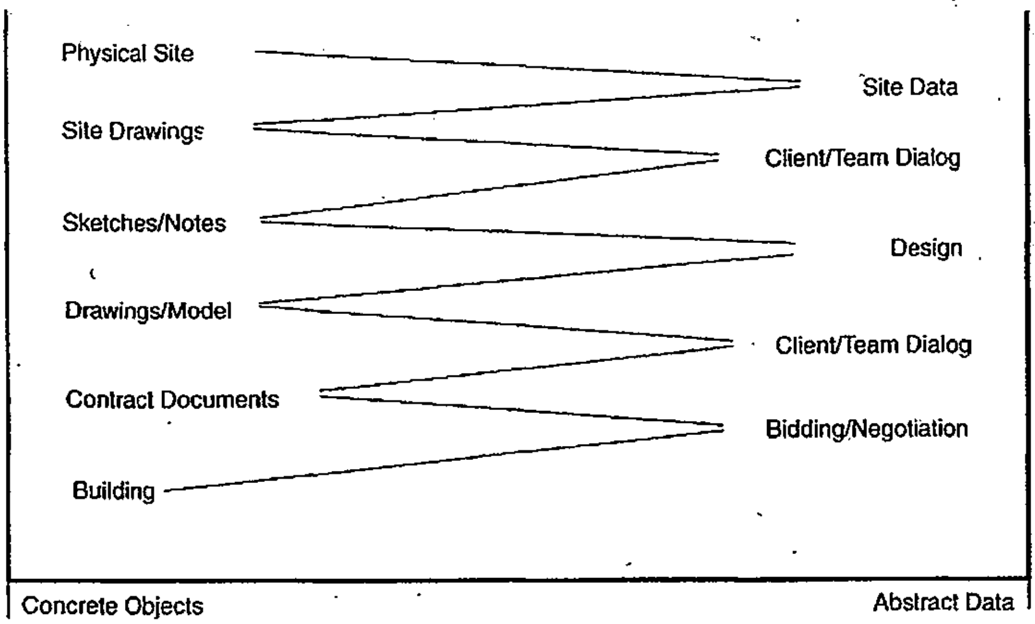

Figure 4.1. Oscillation in the design process
The diagram above shows the swing between design data and artifacts over the duration of a non-computerized architectural project. Apart from the contrast of concrete and abstract, note also the determined endpoint of the architect's involvement in a project. All architectural artifacts are tributary to – and validated by – the construction of a building.

A re-assessment of the project in the light of current technologies could result in improved economies for all parties and the project overall. These economies may be a product of improved communication over computer networks and on alternative means for presenting – or manifesting – the design for review. These benefits are well documented and need not concern us here.

Instead, we shall look at the project itself as an information environment, one that is manifested discretely on a range of dimensions and scales. This changes the project from being aimed teleologically at building, to embodying all participants, information and artifacts throughout its duration. A computer-aided design, or CAD, file is a record of design decisions. Its database can be represented in a variety of ways: as lines on a screen, a rendered video-projection, an animation, or as *printouts* in two or more dimensions. A line, or more properly the data of a line, drawn at the earliest stage of a project may persist throughout the project's life. It is part of the conceptual computer model – part of the project's cyberspace – and may be manifested before, during, and after the project is materialized as a building.

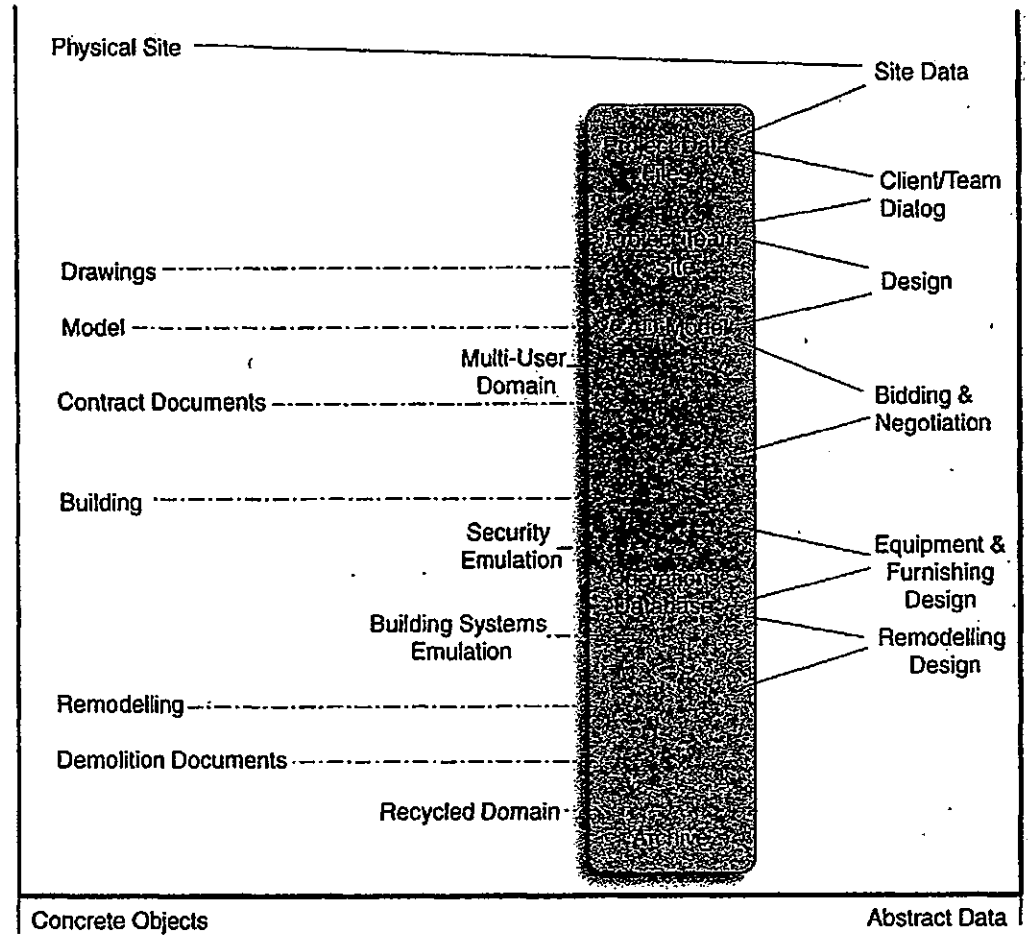

Figure 4.2. Oscillation in a computer augmented design process.

This diagram shows the continuous oscillation between abstract data and concrete artifacts over the entire life of the project. This is a diagram of how an architectural project would work in the context of modern information technology. Physical artifacts are temporal incarnations of the project. Envisioning a project in this way lets us encompass all participants, information and artifacts related to the building throughout its life – from conception to demolition.

In the light of the foregoing discussion the line can be emulated within the *project space* itself. By project space we mean the project's comprehensive environment: the totality of its physical site, the media spaces used in its development, the environments utilized for meeting, planning, telecommunications and the spatial resolution of the client's needs. The project space is the spatial field of possibility and VR is only one lens through which we observe and participate in it. All printouts from this comprehensive information space are derived, lower-dimensional renditions of the project space: paper, models, videos, virtual reality walk-throughs, or buildings.[4] [5]

[4] The project exists as a social reality that is formed from evidence of the enterprise (drawings, models, contracts) and the collective memory of the participants. Philosopher John Searle has written extensively on

This would matter little if the project were for a bicycle shed. But with complex projects, like an office building, the information space of the project team can live on to be reused in the space occupied by the project's tenant. A 3D multi-user environment for hosting design-team meetings could be re-utilized as a conferencing facility by the project owners. The reuse, remodeling and retrofitting of such spaces is nearly cost-free compared with their physical counterparts. The media and digital spaces created early in the project, like the CAD line, may persist throughout and outline any of the project's future manifestations. Architects and designers – specialists in spatial design – may in this way extend their services. Symbols embodied in the computer take on a validity of their own independent of their referential role. Hovering at the boundary separating information from the physical world, their increasing role in projects dampens the swing between abstraction and materiality. This dampening results in faster execution of the project, savings to the client and the designer, more versatility in communications and flexibility. (Anders 1999b) Such a change in process can radically affect its products. For example, the physical model of a building could be augmented with alternatives that, while apparently part of the model, are not physical. The project space is discretely manifested in the material world – at any scale.

Another example shows how the process and its artifacts are related. Conventionally an architect creates a master plan in which the unbuilt structures exist, if only in the minds of the planners. In a computer augmented project, however, the master plan has an autonomy, its buildings may be used long before they are materialized. In a proposal for a theme park called The Wonderful World of Oz, the Oz Entertainment Company intended for the entire park to be built as an on-line environment prior to its actual construction near Kansas City. The buildings and rides of the park could be visited and used before their construction. When built, however, the rides would maintain their on-line connection and allow the actual riders to interact with on-line visitors. [6] The project was to break ground in 2001, but has yet to proceed even as an on-line domain.

As the Oz case suggests, elements of a master plan may never be built – yet still be useful as on-line meeting places, work areas and archives. As we have discussed, the construction of a cyberspace may preclude actual construction. It remains coupled, conceptually, with any manifestation of the project, yet remains symbolic – accessed and manipulated only through our extensions and the Internet.

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similar social realities (money, institutions, beliefs) that have as much validity in social life as the objects that embody it. See (Searle 1995).

[5] A comprehensive data model that guides the construction and operation of buildings has been named a Building Information Model (BIM) by architectural computing researcher Jerry Laiserin. It is the subject of current research among leading architectural software companies including Autodesk, Bentley Systems, and Graphisoft. Significant to the present discussion is the fact that Graphisoft previously used the term *Virtual Building* to describe this model. See http://www.laiserin.com/features/issue18 for discussion and corporate white papers on the subject.

[6] As related by architect Paul Doherty in ACADIA'99 keynote address.

Chapter 5: Hybrids: Precursors of Cybrid Technology

Since the concept of cybrids extends the use of information technologies in physical buildings, it is necessary to see how cybrids relate to earlier efforts at hybridization. This would help articulate the concept of cybrids as well as demonstrate how the existing technologies could be employed on their behalf. We will describe three existing and important hybrids of physical space and information technologies: *Display Space*; *Computer Augmented Environments*; and *Mixed and Augmented Reality Environments.* We will start by defining the terms to be used in our discussion of merged physical and cyberspaces. Here we will rely on definitions used by designer/engineers involved in Human Computer Interface (HCI) and Computer Supported Collaborative Work (CSCW), and terminology of the arts and technology communities.

Terminology

Both *virtual reality* and *cyberspace* are too general and have been over-used by the public media to the point that they have lost their meaning. The term *virtual reality* promises more than can be delivered by technology alone.[1] For this reason computer engineers and designers involved in VR's development now prefer *virtual environments* and *virtual worlds* for greater specificity. (MacIntyre and Feiner 1996). In the present text we have used *virtual reality* to denote any computer-driven simulation of space.

Cyberspace here means any spatial illusion generated by the use of electronic devices. Defined in this way, cyberspace is generated by a phone call, watching the television, or wearing a head-mounted display. Cyberspace environments may be as abstract as text-based multi-user domains, or as richly dimensional as networked computer games. To communicate the relationship between human cognition and space we have used the term *anthropic cyberspace* to describe electronic environments that support our innate use of space to think, communicate and navigate our world. (Anders 1999a, 10)

A useful phrase for our purposes is *computer augmented environments*, or *environmental computing*, terms used by HCI researchers Wendy Mackay, Rich Gold and Pierre Wellner to describe the enhancement of our world through computational power. (Wellner, Mackay, and Gold 1993) Fellow researchers Blair McIntyre and Stephen Feiner say it is an "intentionally broad concept, ranging from physically embedded machines of ubiquitous computing to the overlaid graphics of a projection display or a see-through head-worn display." (MacIntyre and Feiner 1996, 3) Generally these are used to describe the user experience through the montage of virtual images and the material world. A field of research that focuses on the architectural implications of computer augmented environments is *cooperative building* which weds artificial intelligence technology with the building fabric. The products of this work are known as *intelligent*

[1] Even Myron Krueger's earlier coinage of *artificial reality* has this problem.

buildings, a term common in the building trades especially those involved in building systems.

Augmented reality (AR) employs transparent displays to overlay computer graphics onto the viewer's visual field. It has been used in the development of heads-up displays for equipment repair, in surgery that allows physicians to *see* into their patients' bodies, and as a means for seeing damaged pipes in murky water. While visual technology predominates in AR, some forms of augmented reality overlap the sense of sound and touch as well. The visual focus of AR is a challenge to its engineers. If the overlaid graphics are *linked* to external objects, a moving viewer's head and gaze must be tracked to maintain a consistent illusion. The spatial relationship between the external environment, the display, and the user's senses is crucial to the effect. For instance, a user of a HMD (head-mounted display) may be simultaneously aware of 1) his physical surroundings, 2) virtual objects that map onto physical objects, 3) virtual objects that float independent of the physical space, 4) and virtual objects that are fixed parts of the visual display – such as a menu or icon. Importantly, the user's bodily and cognitive use of space keeps the experience from being chaotic. The experience of a coherent, comprehensive space is maintained.

Mixed Reality refers to a spectrum of synthetic physical/virtual experience. Paul Milgram and Herman Colquhoun Jr. of the University of Toronto have developed a helpful taxonomy to distinguish mixed reality's varied effects. (Milgram and Colquhoun 1999) It is situated within a larger scale of experience, one that extends in their argument between "real" and "virtual" environments. Milgram and Colquhoun's description of Mixed Reality offers a variety of hybrid effects ranging from Augmented Reality on the "real" side of their real/virtual scale, to *Augmented Virtuality (AV)* on the "virtual" side. Augmented Reality, we noted, overlays virtual elements onto physical environments. Conversely, Augmented Virtuality, overlays "real" elements onto virtual environments. The effects of AV would resemble special effects in contemporary film, where images of real actors are collaged into animations or computer-rendered sets. The degree to which the viewer interacts with the result – whether AR or AV – determines the result's effectiveness as a mixed reality. Whereas virtual reality closes the user off from physical surroundings, most mixed reality opens the virtual world to the immediate environment. The resulting montage hybridizes the user's experience, and at its extreme blurs distinctions between simulation and actuality.

Cybrid denotes environments or entities that integrate both physical and cyberspaces in one design. These spaces may be distinct, overlapping, emergent from, or congruent with one another. Cases of overlap and congruency strongly couple the spaces so that action in one domain affects the other. The use of cybrids assumes that the phenomenon of space is a cognitive artifact tempered by our sensory, psychological, and social environment.[2]

[2] In later chapters we will discuss their cognitive unity, *comprehensive space*.

Hybrids in Architecture

An important theme in current information technology is convergence of physical and virtual entities. In the growing specialty of *cooperative building* – a term embracing intelligent buildings, distributed computing, and virtual environments – this has led to proposals for architectural integration of spatial types. Professor Norbert Streitz, at the Fraunhofer Institut in Darmstadt, Germany, has described how distributed, networked computing might provide environments conducive to collaborative work. (Streitz 1998) In this description he makes clear reference to the overlay of physicality and simulation:

> "...[It] is our understanding that the cooperative building originates in the physical architectural space but it is complemented by components realized as objects and structures in virtual information spaces. Combining real and virtual worlds in a computer-augmented environment allows us to design enabling interfaces that build on the best affordances of everyday reality and virtuality." (Streitz, Geißler, Holmer 1998)

Display Space

Streitz's research stresses the networking of mobile and fixed displays, particularly large screens for the display of collaborative material. His team's development of *roomware* effectively links the environment and its contents into a coherent display. This emphasis on the system's performance and its *material* presence does not consider the space of the contents on display. The room and its furnishings becomes substrates for projecting information, the space of the room irrelevant to the space "beyond the screen." This work often treats the environment as a robotic volume, a kind of extended appliance for interfacing with technology.[3] In Display Space architecture is effectively reduced to an enveloping television set with remote control.

The notion that buildings become substrates for arbitrary display underlies film theorist Lev Manovich's pessimism about the architecture's future. He notes that projected images overwhelm the presence of the physical, thereby devolving it into a mute background for effects.

> "...architecture is becoming simply a support for computer generated images. Virtual space created by these images replaces the physical space of architecture...the image terminates the space. The role of architecture becomes purely utilitarian: to be a shelter for the image, not unlike a TV set, a billboard, a cinema hall, turned inside-out." (Manovich 1993)

Along similar if more optimistic lines, theorist Peter Lunenfeld believes that the future of architecture lies in combining the *hardscape* of building with the *imagescape* of new technology. Imagescape for Lunenfeld comprises "electronic facades, linings, and elements on, in and throughout [the] hardscape" of buildings and cities. (Lunenfeld 1997)

[3] This approach resembles those used by researchers in artificial intelligence. However in this case the model of assertive, individual identity (as exemplified by the Turing Test) is replaced with that of a distributed, passive entity: the computer enhanced environment.

aspects of David Gelernter's *Mirror Worlds* (Gelernter 1991) and William Mitchell's *Recombinant Architecture.*

Mitchell, presently dean of MIT's School of Architecture, has written extensively on the effects of distributed computing on architecture. In *City of Bits* he carefully delineates the pressures of technology on building use and typology. (Mitchell 1995) If, he reasons, an automated teller machine (ATM) functionally stands in for the huge banking halls of the past, what becomes of the material architecture of banks? Moreover, as ATMs pervade public places, they change the use of the spaces they inhabit. The function of an airport terminal or regional mall now includes banking as well as travel or shopping. In what Mitchell calls *Recombinant Architecture*, buildings and cities become physical hybrids comprising networks, information appliances and the brute materials of construction. Simply put, machines provide services that affect the use and form of their environment; not vice versa. In this view – consistent with that of materialist practice – the user's experience is a mere consequence of the material surroundings, regardless of whether the environment is augmented with information technology.

Mixed and Augmented Reality Environments

Another form of environmental computing takes advantage of user perception to merge the physical environment with simulation. Augmented reality's (AR) origin coincided with that of virtual reality in the 1960's. In his groundbreaking work at MIT, Ivan Sutherland devised the first virtual reality environment using a head-mounted displays. The displays employed half-mirrored beam splitters to merge the vector graphics of small video displays with the surrounding environment, becoming in effect the first AR system. (Sutherland 1968) In ensuing years augmented and virtual realities expanded to include sound, the sense of touch and kinesthetics. Fred Brooks' force feedback systems combined with 3D graphics to assist biomolecular scientists in visualizing chemical systems. (Brooks 1988) Michael Noll's prototype force feedback system, developed in the early 1970's allowed users to *touch* virtual objects within the volume of a 10" cube. (Noll 1972)

Since augmented reality depends on the user's ability to merge image with actuality, much of AR's technology engages the user with increasingly intimate displays, HMDs (head-mounted displays), worn sensors and processors. In many cases this produces a solipsistic space in which only the wearer can experience immersion. Extending the experience to a social community requires replication of the displays for each user, plus the coordination of multiple-user tracking and computer systems

In the early 1970's Myron Krueger devised systems that deliberately avoided the awkward, encumbering technology of worn displays and sensor systems. These systems, examples of what he called *artificial reality*, employed video displays and camera-based tracking to free users' movement within their space. (Krueger 1991) Krueger's early work required the user to be represented as a silhouette within the display. On Milgram

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Bluetooth wireless technology allows appliances to exchange information without intervening wires, again layering an invisible, changing network over the fixed material environment.

and Colquhoun's scale of Mixed Reality these experiments would be labeled Augmented Virtuality. (Milgram and Colquhoun 1999) Although participants could move freely in a space, they had to view the screen to see their effect on the artificial environment. This doubling of the user abstracts the experience, and mitigates against the sense of immersion.

The display/actuality schism is prevalent in computer games, multi-user domains, digital worlds, and other communal cyberspaces. In many cases the user is replicated as a proxy, often called an *avatar*, within the virtual environment. I have argued elsewhere that this doubling is a natural feature of electronic communication. Even the mundane telephone caller is replicated as a tiny voice in the receiver. (Anders 2001b) However, the degree to which the user is conscious of his or her avatar relates inversely to the immersion sensed within the electronic environment. Unselfconscious engagement with the illusion makes for a more compelling experience.

Mixed Reality and VR technology

In another approach to unencumbered interaction Caroline Cruz-Neira in the early 1990's developed the first Contained Audio-Visual Environments, or CAVEs. These environments resemble aforementioned display spaces in that entire surfaces of a room become video displays. (Cruz, Sandin and De Fanti 1993) The result is that images on the displays conjoin, creating the illusion in users of being somewhere else. Because users are tracked they have the impression of moving within the display's space, much as one might experience in conventional virtual reality.[6] The difference however is that a CAVE may contain other participants and objects so that the virtual experience is mixed with physical actuality. Despite the sophisticated coordination of tracking and effects the images on the screen are often incidental to the geometry and occupants of the physical space.

Linking the physical space to that of the image is comparatively simple. Tracking the user presupposes a connection between the user's movement within *both* the CAVE and the illusory environment. One could claim that any interaction device – data glove, HMD, digital tablets, or even the mouse – correlates the user's physical and virtual movements. Interfaces that operate spatially and visually are the natural precursors to augmented reality and, we will see, cybrids as well. CAVEs are, in fact, direct precedents for architectural cybrids since they merge illusion, physical environment, and display technologies within a comprehensive and (potentially) social space. Despite its relevance to augmented reality, however, the CAVE is still considered a virtual reality because the world beyond the CAVE walls is occluded from the user's experience. Although it may appear to extend beyond the screen, the illusion is only effective within the confines of the CAVE. Any potential overlaps between CAVE illusions and materiality happen here. We would expect the same of any display space where fixed screens presuppose a stationary observer.

[6] Even so the displays are not entirely free of constraints. Many current CAVEs require users to wear head-mounted visors to see the illusions in three dimensions.

Going beyond the walls requires mobile computing, transparent displays and extended tracking systems. (Azuma et al 1999) The technology for merging the outside and virtual worlds into the user experience often means wearing encumbering sensors and displays. As a result augmented reality technology has developed most strongly in the design of HMDs and other wearable computing systems. While there are other methods of display – tactile and acoustic for instance – the visual interface with simulated environments is very advanced. This is, in part, due to the ready availability of VR equipment and software. Arguably, AR is simply the next step in VR's development. (MacIntyre and Feiner 1996)

In conventional virtual reality, a stationary symbolic object will appear to remain in place regardless of the viewer's movement. This is most evident if the user only views the VR through one eye while leaving the other to observe the surroundings. The reader may try this by holding a telescope to one eye while keeping the other open. Direct and mediated views visually converge. Augmented Reality is already suggested in this simple experiment. The binocular effect, conflating image with actuality, is like a montage in film where two otherwise distinct spaces are experienced as one. A similar merging of the two spaces can also be experienced with transparent displays, whether worn as HMDs or as external devices such as teleprompters. Such transparent displays typically rely on the folding of light with half-silvered mirrors so that the observer sees both what lies beyond the mirror as well as images from a reflected source. The benefit of having the reflected image apparent to both eyes, as in a stereoscopic display, is that the image appears to be three dimensional, further enhancing the spatial effect. (Tamura, Yamamato, Katayama 1999)

Notes on Illusion in Hybrids

While computer-based augmented reality is clearly a recent phenomenon, the illusion created by reflections in glass far precedes the present century. The illusion is called *Pepper's Ghost* (fig. II.1.1) in honor of Dr. Henry Pepper, the 19th century impresario.[7] Magician and author Nathaniel Schiffman writes:

> "A man named Henry Dircks invented an illusion that was produced by Dr. Henry Pepper in 1862, in which the audience was treated to live actors cavorting on stage with semi-transparent ghosts and skeletons...Up on the stage, the real live actors performed behind a tilted sheet of glass...The glass was tilted so as to catch the reflection of ghosts and skeletons down below [in the darkened orchestra pit]...By adjusting the lighting in the orchestra pit, the ghosts would become more or less visible." (Schiffman 1997, 142)

[7] The history of the illusion begins with the introduction of suitably sized, polished sheets of glass first available in the 1500's. In 1558 the natural philosopher Baptista Porta wrote of the effect in *Natural Magic* (Book 17, Chapter XII). It was periodically rediscovered in ensuing generations by conjurers Henri Robin, Pierre Séguin, developed technologically by Henry Dircks, and finally produced for stage by impresario Henry Pepper. It was a popular illusion throughout the later 1800's, employed by the major magicians of the time including the famous French conjuror Robert-Houdin. The technology survives in split-lens photographic techniques and the occasional theme park exhibit. For a fascinating account see (Steinmeyer 1999.

cinema, and now appears to propel both VR and mixed reality.[8] (Punt 2000) Illusion is inferred, not perceived – a result of processing sensory information and reconciling it with our memory and expectations. (Rössler 1992) Internal visualization, the imagination, and interpretive schemata play vital roles both in illusions and in the construction of our reality. Indeed the same mechanisms apply in constructing our view of the material world as those that support the effects of illusion. (Zeki 1992) Consequently the phenomena of illusion and actuality are linked by human perception and cognition. This is fundamental to the concept of cybrids.

Like magic, mixed reality hybrids depend on the user's complicity and imagination. This distinguishes it from the other hybrids we have examined so far. Where mixed reality blends empirical and imaginary experience, the other hybrids depend on material, external intervention into our environment. In the course of its recent development, mixed reality has expanded beyond the laboratory to domains of art, entertainment and display, medicine and architecture. In the fine arts we can already see mixed reality in the works like Thecla Schiphorst's *Bodymaps: Artifacts of Touch.* In this piece the observer strokes the image of a supine woman projected on a horizontal velvet sensor surface. (Anders 1999a, 185-186) The actions stimulate movement of the image, or its replacement by other images. Artist Paul Sermon has also experimented with body projection in works that incorporate telepresence. *Telematic Séance*, for instance, projected live images of remote participants are projected onto a couch in the gallery. These images of seated viewers map perfectly onto the couch, making it appear as if ghosts were present in the space. When present viewers sit on the couch they can interact with the images and, reportedly, feel a compelling body presence. Art historian Edward Schanken recounts that when he tried to sidle up to a woman's image, she squirmed away in response. [9]

More recently, Brian Lonsway of Renssallaer Polytechnic has used blue-screen video technology in performances that employ tracking and substitution of objects. Whereas in actuality an actor may move a simple blue box, on the video screen it appears as though he is moving a desk from place to place. The effect is startling as the object may change depending on use. For instance, a "desk" may change to a "chair" if the actor sits on it. In these cases, however, the actor does not participate in the illusion unless he or she views the action on a video screen. Immersion, as one might expect using a CAVE or an HMD, is not possible with this system. In this way, Lonsway's performances resemble Myron Krueger's earlier video pieces. (Lonsway 2000)

Lonsway's work stems from conventional use of blue-screen technologies used in virtual television stage sets and movie special effects. Technologies for merging materiality with illusion have a long history in the field of entertainment, extending from screen-viewed realities – whether on a television or in a movie theater – to specially constructed

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8 For a discussion on the relationship between virtual reality and Baroque architecture see (Ryan 2001).

9 Anecdote related by Dr. Shanken to the author.

exhibitions and theme parks.[10] The Pepper's ghost illusion, for instance, is employed in a Haunted House ride at Disney World, Broadway theater shows, and even saber-toothed tiger displays at the LaBrea Tar Pits. In these and other cases, projections, special lighting and spatial configurations conspire to make the illusion appear natural, or rather, make the boundary between actuality and fiction disappear.

Computer-based augmented reality has also found success in medicine. Andrei State and his colleagues at the University of North Carolina at Chapel Hill have developed techniques for performing surgery that merge simulation with the actual body of the patient. (State, Livingstone, Garrett, Hirota, Whitton, Pisano 1996) In one case a tumor may be observed "floating" within the breast, acting as a virtual target for the surgeon performing the operation. Similar models of organs and bones, or better, models produced from simultaneous body scans might be used in stereoscopic display. (Anders 1999a, 56) (Kaufmann, Rhee, Burriss 1999) As one might expect, the exact correspondence of the image to the actual body is a matter of life and death.[11]

Architecture and Augmented Reality

In the eyes of AR's developers the construction industry is a potential market for the technology. Their reasoning is straightforward: AR, like VR, deals with spatial and symbolic phenomena in ways potentially useful to architects, builders and facility managers. These industries' increasing familiarity with – and reliance upon – computers makes them well suited for mixed reality technologies. However, as we have already seen with virtual reality the success of such forecasts hinges on a variety of issues. Some of these lie outside the domain of technologists: compatibility, reliability, flexibility, and purchase costs, training and upkeep. Not least important is the degree to which AR systems serve the needs, and values of architects and their clients.[12]

The overlay of spatial computer models onto buildings has uses in nearly all stages of the building's life. As we saw in the previous chapter, a project's database facilitates a

[10] It is worth noting that the mixing reality with fiction is commonplace in children's entertainment. Although computers were not used in their production, many earlier films by the Disney Corporation merged actual actors into animated scenes, or conversely mixed animated characters into filmed footage. A viewing of Mary Poppins, for instance, yields the spectrum of Milgram and Colquhoun's mixed realities, ranging from augmented reality on one side to augmented virtuality on the other. Indeed, cinema is preceded by theater and literature. Legendary ghosts in abandoned houses exemplify augmented reality, while the real Alice's adventures in a fictitious Wonderland exemplifies augmented virtuality. These examples may not fit current technology-specific definitions, but we are arguably conditioned since childhood to understand the blending of reality and fiction. Mixed Reality's success depends on it.

[11] For additional information on medical uses of AR see (Alcuñiz, Grau, Montserrat, Juan, Albalaf 1999) and (Wei-te and Robb 1999).

[12] If we use the history of virtual reality to guide us, AR's best prospects may not be in architecture at all. Many of the VR and imaging technologies developed for architects found more lucrative markets in computer games and Hollywood's special effects industry. Still, despite these concerns, a review of AR's recent development yields many architectural applications. Unlike VR before it, augmented reality keeps one foot in the material world, and so may serve both physical and symbolic domains of design.

reality. Also, of all the hybrids discussed, augmented reality has only recently been recognized for its architectural potential – not so much by architectural practitioners as by the AR research community. This last merely underscores the paradox posed by VR for architectural practitioners and theorists. A full acceptance of Augmented Reality and Mixed Reality by the discipline would require a realignment of values, as well as a redefinition of architectural service and its products.

The present concept of cybrids draws on current developments in technology and the hybrids it forms with the built environment. With the exception of AR and mixed reality, these hybrids are largely physical, their informational nature limited to the behaviors of appliances and supporting systems. However the cybrid concept of the user is cognitive as well as somatic. The desired spatial effect is as much a product of consciousness and social convention as of material construction. In this way cybrids would combine physical and non-physical into a conceptual whole – a phenomenological continuum.

Below is a table that summarizes our discussion of hybrids of buildings and information technology. Included in this diagram are present uses of these hybrid technologies and – anticipating our next chapter – their prospective application in cybrids. Cybrids would employ these technologies in their integration of physical and cyberspaces.

Hybrid Type	Technology Employed	Nature of Effect	Present Use	Use in Cybrids
Display Space	Large screens and projections, TV broadcast, or computers for digital displays.	Material collage of unrelated screen images on physical environment.	Decorative elements on buildings, public announcement, broadcast.	Displays may be used to extend the observer's space.
Computer Augmented Environments	Computers, embedded sensors, actuators, sound/video displays	Physical environment that responds to human or other agency	Automotive and vehicular, intelligent building, HCI research	Computer used to monitor and coordinate sensors and displays
Mixed and Augmented Reality	HMDs, computers Body worn sensors and displays Screens, speakers	Psychological, Montage of situated simulation/ images onto the physical environment.	Equipment Maintenance/repair, Entertainment, games, building access for disabled, military	Correlation of material space with cyberspace in new compositions

Table 5.1 Hybrid types and their potential use in cybrids.

Chapter 6: Integrating Hybrid Technologies within Cybrid Compositions

We observed in Chapter 4 how architectural cybrids could evolve *naturally* from the digital design process. Simulation in computer aided design not only supports eventual construction, but may also maintain a *contingent presence* throughout the project. We see in augmented reality a technology for correlating the virtual with the physical, and their possible integration into new, cybrid wholes.

Cybrids and Augmented/Mixed Reality

Cybrids are augmented/mixed reality compositions – spaces, objects, entities – designed to be so from the start. For this reason, the simulation-to-construction methodology of architecture is well-suited to cybrid strategies: the configuration of the simulation and building are related throughout the process. However, in the case of cybrids such an overlap of physical and cyberspaces is not necessarily as congruent as it might be in a conventional architectural plan. We may see this in the experiments of AR's developers. (Klinker, Stricker, Reiner 1999) There is seldom redundancy between physical artifacts and simulations. Architectural cybrids avail themselves of the possibility of autonomous simulation while maintaining the option of direct, architectural correspondence between symbol and built artifact.

A great deal of ingenuity has been put to creating the illusion of merged spaces in VR and augmented reality. Head and eye tracking technologies both for indoor and outdoor use have made notable advances in recent years. (Azuma 1999) (Feiner, MacIntyre, Höllerer 1999) Yet, despite occasional exceptions, much of AR and mixed reality is still a private experience. As in much of VR the simulation is still enjoyed by the individual with the helmet, leaving others to wonder what he's seeing.[1] Since architecture provides spaces for social interaction, it seems reasonable that architectural cybrids would serve a similar purpose. However, in the case of head-mounted displays for AR, a shared, consensual hallucination for a cybrid's occupants would require HMDs for each user. While this may be possible with fast, inexpensive future technologies, it is also prudent to consider larger, fixed displays.

Cybrids and Display Space

Cybrids may benefit from Display Space strategies. The virtue of this approach includes easy viewing of information by multiple participants, and freedom from the constraints of headsets and sensors. Cost benefits over HMDs would be harder to assess since large displays are often expensive. This is so regardless of whether the display is a fixed, flat-panel screen, or a laser projection system.[2] We have already noted some of Display

[1] In public displays of VR technology viewers can often see what the participant sees by means of large screens attending the exhibit. However, only the wearer of the helmet enjoys immersive interaction with the scene. CAVEs allow viewers and participants to share the experience more convincingly.

[2] Conceivably, relatively inexpensive electronic paper displays may evolve that could enhance Display Space's prospects. However, the technology for such displays is still in development.

Space's drawbacks. The space of its images is rarely related to its surroundings in any way other than residing on the thin phosphor of the screen. By definition superficial, its spatial illusion is destroyed by changes in the viewers'parallax. By moving from the ideal viewpoint, the observer re-affirms the materiality of the display. A cybrid strategy integrating illusory and actual spaces would appear to founder on this limitation.

But there are ways around this. The trompes-l'oile of architectural surfaces evoking deep space is an architectural technique that pre-dates the Renaissance. One could overcome Display Space's limitations by increasing the distance between the display and the viewer. In this way a moving viewer's parallax changes little with respect to the display's distance. This would cause the remote image space – on a suitably large screen – to merge with the space around it. Subtle tracking of the viewer with consequent adjustments to the display perspective could enhance the effect.[3] Similar principles apply to stationary viewing. Plastic depth is best perceived as the distance between viewer and object approaches that of the space between the viewer's eyes. The mental reconciliation of disparate images plus the adjustment of eye muscles bring the subject into focus as a three-dimensional presence. Nearer external displays, then, would require each eye to receive unique images adjusted for *perceived* distance.

It is possible to do this without resorting to head-mounted displays or user tracking. Display systems are in development for providing three-dimensional effects, although at present few if any are available commercially. One promising technology uses diffraction grating filters applied to screen surfaces. (Zucker 1997) Diffraction gratings are common in toys and novelty cards, providing illusions of movement or depth by deflecting different images to each of the viewer's eyes. The display technique requires that the underlying image be parsed into vertical strips, alternating the image from one to the next. The binocular effect can approach holographic quality. This approach requires no tracking of observers to maintain its illusion, although the viewing angle of the 3D image is restricted. The anticipated use of diffraction displays lies presently in gaming and specialty applications. Large screen displays seem unlikely to emerge from their development, however systems are emerging that may not depend upon diffraction gratings on the screen.[4]

Another option takes advantage of the materiality of the display. Distributing the displays within an existing space and conforming the screens to their content offers compelling opportunities. For example, one could place displays around a conference table, such that each screen presents a different remote participant.[5] This effectively brings the remote

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[3] Such tracking suggests that the display would work best for an individual viewer, thereby mitigating against the cybrid's social function.

[4] For a discussion of holographic-like projected displays without the use of diffraction gratings see (Mendonçaa, Falcaob, Vannini, Lunazzi 2001). For haptic holography see also (Plesniak 2001) and (Benton, St. Hillaire, Sutter, Plesniak 1993)

[5] In his book, *Being Digital*, Nicholas Negroponte writes of the projection of facial images onto phosphorescent screens shaped in the form of a head. Although originally intended for military briefing, this technology has since found its way into exhibits at Disneyworld, notably the *Haunted House* and *Buzz Lightyear* rides.

participants together, although the illusion of a combined virtual/physical space is limited to those at the table. The contrivance falls apart quickly once a visitor's face leaves its screen.

The Pepper's Ghost illusion could also provide a convincing three-dimensional effect by strategic reflection of remote displays. This technique operates at both large and small scales – with transparent HMD's being its smallest incarnation. Although we will develop this option in coming chapters, it is worth noting here its effectiveness in combining actuality with illusion. The observer's parallax and movement do not affect the result, so long as the viewer is content to stay on one side of the glass. As with any fixed display, the illusion is limited to the location of its substrate, the glass. The observer is always on the "other side" of the screen from the illusion. Consequently the observed and occupied spaces are always distinct, although combined in the mind of the observer.[6]

Architectural cybrids' social use favors larger, environmental displays. However, the fixity of such displays constrains their use to specific sites, limiting the cybrid experience to discrete, non-immersive events. Head-mounted augmented reality displays might span the gaps between external displays, provided the designers correlate the different display modes for continuity. This coordination would also be required if several HMD users were to share an experience. Conjoining such displays with the virtual environment requires sophisticated sensing and display technologies. These might be worn or – equally likely – embedded in the material environment with wireless support for mobile displays.

Cybrids and Computer Augmented Environments

Computational support for such linked displays is typically housed in the surrounding architecture. While wireless networks allow for mobile digital devices, these devices rely on fixed support: network connections, modems, servers, and transmitters. Cybrids will require some degree of embedded, environmental computing to ensure the coherent merger of physical and cyberspaces.

Although *computer augmented environments* suggest uniform distribution of sensors and actuators in the material environment, their effect is local to individual observers. Lights turn on in occupied rooms, doors open for users, calls travel to the phone nearest to intended recipients. These effects require an imbedded system responsive to user position and – at times – orientation. Similar systems could apply also to generating electronic simulations. Such a system would have to be "aware" of the location and vantage of

[6] A recent product from Teleportechnologies illustrates the social use of this illusion. The device is a lectern equipped with an Internet connection for streaming video images. The lectern has an angled, one-way mirror behind which is a camera looking out toward the audience. The front of the mirror reflects a screen mounted in the top of the lectern. The effect is that the mirror reflects the image into a vertical position, looking as though the remote speaker were standing behind the podium. The camera behind the glass sends streaming video to the speaker so that he maintains "eye contact" with his audience. Readers may see a video of this device in use at http://www.teleportec.com.

individual users so as to generate suitable effects. Such monitoring and display would have to accommodate a number of occupants both physically present and telepresent. This results in a sophisticated, local computational network for a diverse spatial experience. While the specification of such a system lies beyond the scope of this study, we should note that computer augmented environments do not preclude either augmented reality or display space. Embedded sensor systems can support augmented reality just as built-in monitors might serve display space. They are all compatible within an appropriate hierarchy of use.

Cybrid Synergy

Cybrids take selectively from existing architectural/technological hybrids, resulting in a renewed, extended sense of space for the observer. We have seen the limitations of one hybrid overcome by another. AR's bias toward private experience is countered by Display Space's public nature. The challenge of Display Space's fragmentation is met by the subtle coordination of computer augmented environments. Finally, AR and Mixed Reality's cognitive model of the observer offsets the materialist focus of both Display Space and Environmental Computing. Within these three types of architectural hybrid we find the technology of cybrids.

Cybrids are not simple collections of hybrid technologies. They are compositions of interdependent material construction and electronic simulation. They are not the product of a specific technology, rather they use techniques to merge physical and cyberspaces in the minds of the observer. Just as an artist uses canvas, sizing and oils to depict a landscape, architects and designers would employ Display Space, Computer Augmented Environments, and Augmented/Mixed reality to compose and create cybrids. With this in mind we can now outline, even elaborate, a cybrid's technical behavior. The simulation – a product of a managed database – precedes, attends, and succeeds any material manifestation of the project. It *precedes* manifestation as does any specification for construction. It *attends* a project by assisting, monitoring and managing the physical structure. Finally, it *succeeds* the manifestations by persisting – in its database – after their demolition. The simulation would also be the locus of any mode of information provided to the user: telecommunications; telepresence; simulation; or annotations/diagrams within the environment. Most importantly, *all modes by which the user experiences the cybrid's cyberspace would be mutually reinforced.* Visual displays, spatial environments, sound, screen and head-mounted displays would corroborate one another, reinforcing the coherent, non-physical space of the cybrid. This space situates the images/avatars/environments conveyed from remote sites, as well as those emulations local to the project. Conversely, this space provides consistency for the activities of both local and remote users. It forms the phenomenological backdrop of the project and its occupants.

A Cybrid Scenario

A successful cybrid would require considered design of space and its behaviors. The design would serve the user's needs through concerted, coordinated technologies. Ideally this would produce in the user a coherent experience that would not be possible without them. The following scenario may help to visualize this.

Bob notices a spot of light moving across the floor to a point before him. The room's speaker system localizes a caller's voice to that point and Bob hears, "Hello!" Looking through his HMD, he sees that the light has been replaced by a 3D image of his caller. As their dialog proceeds, they realize that others should be in on the discussion. So assembling his colleagues, Bob ushers his caller's avatar to the nearest wall-display. The light spot moves up the wall to the screen and becomes a conventional video image for the rest of the viewers. Sound has also moved to the display, coordinating the caller's image and voice. A camera behind the display surface allows the remote party to see his colleagues.

The components of this multimodal representation are not necessarily realistic images of the caller. (Astheimer, Dai, Göbel, Kruse, Müller, Zachman 1994) His avatar proxy may be a rough abstraction, the video image may be monochrome and low resolution. Instead the *behavior* of the various visual and acoustic images follows a spatially consistent scheme. For this reason the spot of light moves to a point in front of Bob, in emulation of a physical visitor. Bob sees the avatar situated at the point of light, confirming both the caller's orientation within the implicit social space, as well as corroborating the location of the apparent sound and light spot.

In this scenario, these behaviors respond to the physical action of the observer. The avatar, hitherto only seen by Bob, follows him to the nearest screen display. There the point of light is *transformed* into a video image of the caller. The technique behind this transformation is complex; it involves close tracking of Bob, coordination of the light and sound sources with the observers' locations, and anticipation of the transfer from one mode to the next. However – ideally – the technique, like that of a magician, is transparent. It depends for its effect on 1) spatial construction by observers, 2) their expectations, and 3) their narrative account of events.

The Domain of the Observer

Seen in this way, the architecture of a cybrid resembles an elaborate theater set conducive to social, symbolic interaction. As in theater or cinema, fictional entities merge with the physical reality: facades recede within the faux space of the stage; real actors play fantasy roles; material props stand in for their magical counterparts. The history of theater is filled with examples of how materiality and fantasy converge on the stage. Theater, like the cybrid scenario above, *depends on the observer's imagination for its effect.* Trapdoors, greasepaint, scrims, mirrors, smoke are the theater's material attributes. But narrative coherence, magic of transformation, and spatial extension beyond the limits of the stage are all in the domain of the observer. (Glanville 1998) (Leevers 1998)

There are crucial differences between cybrids and conventional theater, however. One is the lack, in cybrids, of a narrative – story, plot or sequence – that renders the illusions meaningful. (Ryan 2001) However, as our scenario suggests, users create their own

narratives as they move through rooms and engage others. (Stappers, Saakes, Adriaanse 2001) Another difference between cybrids and conventional theater is the apparent lack of a proscenium. The classical proscenium is a window onto the world of the play – a boundary that exists simultaneously in both the world of the audience and in the fiction of the stage. It separates – yet links – the dark material space of the seats and the bright fantasy of the play. Cybrids merge the two to the extent that digital technology can be conveyed to the observer. If anything cybrids diverge from the spatial juxtaposition of proscenium theater, and more closely resembles the montage of cinema. Montage seamlessly overlaps disparate scenes – worldviews – into one image. Cybrids expand this cinematic notion to include the material ambience of the user as well as the emulated space and objects with which it exists.

Conclusions

We have here discussed ways in which cybrids depend for their technology upon three existing models of architectural hybrid: display space, environmental computing, and augmented/mixed reality. Cybrids bring these techniques together holistically in a way that depends as much on the observer for its consistency as it does on its comprising technologies. This synergy is a product of corroborative behavior between different modes, which provides cybrid users with a coherent social/spatial experience.

hapter 7: Developing Design Principles for Cybrids

rchitecture traditionally provides us with a communal social reality, a physical context, d a framework for the coherence of culture. Contemporary society has similar needs, it they have extended beyond the physical domain of conventional architectural practice include coping with demands caused by long-range communication, conflicting and onfusing modes of operation of information technologies, and disengagement due to verwhelming flows of information. Cybrids can help by providing coherence for ediated interaction, and a framework for various direct and mediated modes of ommunication.

he Need for a Shared Social Reality

here is, argues sociologist Daniel Bell, a need for a shared social reality, one that anscends materiality in support of the modern experience. He writes, "In the last 150 ears reality has been technics, tools, and things made by men, yet with an independent xistence, outside men, in a reified world. Now reality is becoming only the social orld, excluding nature and things, and experienced primarily through the reciprocal onsciousness of others, rather than some external reality. Society increasingly becomes web of consciousness, a form of imagination to be realized as a social construction." Bell 1973, 149) This observation offers us a new model for understanding and ccommodating modern culture, one conducive to the development of cybrids. In ddressing these needs it is useful to attend the differences and similarities between aditional modes of architecture and the characteristics of cyberspace.

ndeed many such needs would, in earlier times, have fallen within the scope of rchitecture. Environments for social interaction – whether for work, play or worship – ave to this day been realized in a spectrum of building types. Architecture's role in their reation is borne out not only in its history, but in studies conducted on territoriality and rchitecture's service to human need. Architect Byron Mikellides cites the work of thologists R. Ardrey and F. F. Darling and psychologist W. C. Schultz in outlining needs net by human territory. Among these needs he includes security, stimulation, identity, nclusion, control, and affection. (Mikellides 1980, 191-192) He notes the parallels of this ist with similar lists of sociologists A. Maslow and Kurt Goldstein and Michael Argyle, a ocial psychologist at Oxford. Differences between these lists vary between internally lriven psychological needs – such as sex and self-actualization – to physiological external demands of safety, sustenance, and even aesthetic need.

Architecture, a cultivated form of territorial control, would seem effective in meeting at east our externally-driven demands. This would accord with the work of Danish psychologist Ingrid Gehl who asserts architecture's unique capacity to meet human needs. In her book, *Bo-Miljo,* she presents the human environment as comprising four attributes: dimension, arrangement, location, and sensory stimuli. (Gehl 1971) These attributes – matters fundamental to architecture – are then shown to be useful in resolving physiological, safety and psychological needs. Gehl tacitly assumes that architecture and its built products are one – since architecture otherwise would neither shelter nor comfort us. However this holistic view is balanced by an assessment of psychological needs met

by architecture. Of particular interest is her contention that architecture *structures* our experience. That is it orients us, provides context, and lets us meaningfully place objects in our surroundings. Architecture, she claims, reinforces individual experience, sustains social contact, continuity and communal identity. These needs are not solely concerns of the modern day, but appear to be intrinsic to being human.

Despite its past success architecture's focus on materiality, both in theory and practice, has rendered it increasingly inadequate for the challenges presented by telematics and global culture. The premises of modern technological culture – its accelerated pace and distributed, asynchronous nature – strain architectural notions of materiality, permanence, and even of presence itself. (King and Miranda 1997) Traditional architecture, in contrast, serves a stable and localized clientele, its methods conduce to the production of physical structures. Many members of the discipline, among them technology's most avid proponents, maintain that the computer simply speeds up conventional processes – that the material ends remain the same. However, as we have noted, contemporary information and telecommunications technologies render these assumptions problematic at best.

Toward Principles for the Design of Cybrids

We have argued for a need to create a shared social reality in the face of increasing technological change. This overarching need could be met by attending 1) the need for a coherent communality, 2) the need for a context against which to assess change, and 3) a need for a corroborative, cognitive framework for the increasing flow of information. To expand architecture's role we must compare the traditional means by which architecture met these needs with their redefinition in light of contemporary technologies. We shall discuss them in the following order: 1) coherence and systemic behaviors; 2) context and space; and 3) corroboration and the extended sensorium.

Coherence and Systemic Behaviors

Buildings support our physical and mental well-being and, arguably, the cognitive and social processes of our daily affairs. Architecture's materiality is important not only in serving these individual needs but also in creating a *social reality* – one that may be observed directly by all that encounter it. The shared experience of such environments provides the coherent, communal foundation for society. The intransigence of buildings grounds a culture, distinguishing it with landmarks and places of gathering. Traditionally, at least, the coherence of a society was commensurate with the duration and consistency of its material environment. Such consistency was disclosed by various means, many of which remain techniques taught in schools of architecture and urban planning. They include materials of construction, spatial composition, service to occupant needs, physical setting, and relationships between constituent elements. Such consistencies are largely spatial and depend to a great degree on the material attributes of architecture. They are marked by architecture's stability relative to its changing contents and occupants. Built architecture's resistance to change, we argue, marks its behavior over time. Its immutability serves its coherence as much as any of its material elements.

Insofar as cyberspace may emulate physical stasis, many of the techniques of traditional architecture apply to cybrids' compositional coherence. (Bridges 1995) User expectations may be fulfilled by simple mimicry of physical effects. This has been the hallmark of virtual reality simulations and, by extension, the cyberspace components of cybrid architectures. (Charitos 1998) However, the contents of neither cyberspace nor virtual reality are inert by nature. They may change dynamically, altering shape and composition slowly or instantaneously depending on their system's design. An observer, unaware of the system's behavioral rules, would be confused as to cause and effect in such an environment. The experience would be incoherent if the program behind it did not take the user's expectations into consideration. Coherence in such an environment is a matter of behavior *over time* more than the static relationship between elements we find in physical buildings.

The behavior of computational simulations and their fulfillment of user expectations expand the subject of human-computer interface (HCI) design to an environmental scale. HCI is an established field of inquiry that brings together researchers in cognitive science, computer technology, psychology and industrial design. A belief commonly held within HCI community is that users' expectations directly affect their experience with the computer. (Heckell 1982) From the standpoint of HCI the capricious program above would exemplify a *bad interface* in that users couldn't anticipate the effect of their actions. The user infers coherent behavior from his experience with the system. It is through this coherence that the user takes meaning that will help him in his further dealings.

A theme underlying HCI is the search for what is called the *transparent interface*, a human-computer interface that so anticipates users' expectations that it quickly recedes from the users' attention as they go about the work at hand. (Norman 1981) (Bødker 1990) It is said that such interfaces employ a *natural* language based on observations and assumptions about the user. (Buxton 1990) (Coyne 1997a, 217) Underlying such assumptions are social, psychological, and physical observations of human behavior ranging from the orientation of the body to innate cultural values. (Anderson 1983) These are among the many dispositions that inform user expectations. Systems that deny these expectations call attention to themselves and, so, lose their transparency. Whether this is desirable depends on the purpose of the system; what may be good for art or entertainment may not be so for a production tool. Appropriate, coherent behavior is highly valued in spaces as well as their occupants. An observer entering a building expects the behavior of the structure to be static. Although the same observer entering cyberspace or VR may not expect a static environment, she will likely assume that body orientation, up, down, right and left still matter. Turning her head to the left should reveal virtual objects to her left side. She would expect as much in a physical environment except that in a simulated environment *nothing can be taken for granted.* The system could just as likely show what's on her right side depending on the program. For this reason in even apparently stable simulations the coherent behavior of a system – its response to human action and expectation – is vital to its success. (Coen, Weisman, Thomas, Groh 1999)

In systems that hybridize physical and cyberspaces, as would our cybrids, users are best served by attending the coherence of systematic static and dynamic behaviors. (Cajati 1994) We might expect static behaviors to follow the principles of conventional architecture: proportion, scale, and compositional relationships. Some qualities – form, orientation, and lighting for example – may transcend physicality entirely. Conversely, dynamic or time-dependent behaviors would follow a carefully crafted HCI interactive program. In contrast to the stasis valued in orthodox architectural practices, cybrid architecture entails a close coupling between static/dynamic behaviors in the light of user expectations. By creating such coherence the architect serves not only the individual user but others who communally share the system as well.

Context and Space

Social behavior is often subject to the architecture that houses it. Behavior at a pub is not suitable for a church, for instance. Nor would be gymnastics at the local library. Architecture in such cases serves the activities both by attending their functional needs, as well as by providing a meaningful – even symbolic – setting for their conduct. This implicates our earlier observations about coherence in architecture, but the coherence provided by context operates on many levels. Of particular interest is the way architectural space informs its contents, providing a format for a spectrum of information and sensation. An art museum provides us with a useful example.

The interior of a museum is designed for meaningful display. Exhibit halls, information desks, meeting areas all conduce to a satisfying experience for the visitor. This aesthetic and cultural context tempers the viewer's expectations and informs all objects that he encounters. The museum's contents provide an inter-modal spectrum of experience: three-dimensional sculpture, paintings, labels, brochures, posters, books, film, video and, now, computers. Each artifact is inflected by its surroundings. They and the museum itself comprise the context of the visitor's *museum experience*. The power of the setting to charge its contents is amusingly demonstrated by the cartoon that shows museum-goers pondering the mop and bucket of the gallery's custodian.

The matter of context extends beyond building typologies to questions of place and space itself. If, following Webster's Dictionary, we take *context* to mean the inter-related conditions or environment in which something exists, we tacitly accept the observer's role in relating those conditions – spatial or otherwise. The cognitive act of relating things discloses our use of space to help us think. [1] Here we enter the domain of cognitive science which we cannot elaborate here except to observe the informational role that space plays in human consciousness. The various modes by which we attain the museum experience include moving about the spaces, seeing sculpture, reading text, interpreting paintings, talking with the staff. All these modes – whether or not innately spatial – are implicit within spatial experience. We may thus regard space as the coherent, internally generated display of sensory information conditioned by body, mind and memory.

[1] Curiously, we do so in the very act of generating the percepts and phenomena of space itself.

This psychosomatic definition of space owes much to twentieth century philosophy and science, particularly the phenomenology of contemporary philosophy, and science's implication of the observer in his observations. Curiously, this understanding contrasts with concurrent architectural practice that, in stressing the built environment, often neglects the cognitive, empirical nature of space. The materialist view of space – a subject which architects claim to master – is at odds with a long history of philosophical and scientific inquiry. Challenging the priority of materialism, then, asserts a more idealist view of space, one conducive to the creation of cybrids, and one that mediates between older cultural values and the realities of contemporary technology.

The designer's task, then, is to provide meaningful settings within which information – or data – may be turned to knowledge. This setting needs not necessarily be material, nor even spatial. However, since we are disposed to locating and identifying stimuli, we can expect spatial presentation to be useful for apprehending a range of audio, visual, tactile, symbolic and textual information. Space would form a context for their appreciation. Whereas orthodox architecture might limit its scope to the space of construction, this reconceptualization proposes a greater space of consciousness, a *comprehensive space* that mediates between physicality and the evanescence of data structure and flow. This comprehensive space is a context for modern culture and its technologies. It is grounded in the phenomenology of space and forms the foundation of cybrid development.

Corroboration and the Extended Sensorium

A building is part of our normal empirical world in that a visitor's sensory observations corroborate one another. The hand confirms a wall to be where the eye sees it. The tap of our footsteps comes from the floor we feel below us. Any discrepancy between sensations either seems strange, is ignored, or – in the case of the eyes and ears – yields a higher dimension that accounts for the error. In short, the building seems natural so long as our senses corroborate its effects. Sensory corroboration seems fundamental to our conception of the world and, using it as a point of departure, we can quickly see its relevance to modern information technologies. (Ascott 1995) Indeed, as Marshall McLuhan argues, these technologies have extended our senses beyond our bodies and have disclosed to us a world otherwise unseen. (McLuhan 1964, 300-311) The corroboration of technological effects with those of our direct, unaided observation is crucial to the cybrid entities discussed in previous chapters. Cybrids depend on the meaningful conflation of mediated and directly observed realities.

The media instruments that comprise our extended sensorium fall roughly into two classes: *sensory* and *symbolic media*. *Sensory media*'s products resemble those of direct observation. The image seen though a telescope, for instance, is analogous to the image we perceive directly. Body orientation, and the direction of our gaze are the same regardless of whether we use the instrument. We can easily corroborate what we would see without the telescope. This holds true also in the case of mechanical and electrical hearing aids. The artificial acoustic image resembles that sensed by the unaided ear– the relationship is obvious. However, the relationship between *symbolic media* and direct observation is not so clear. The digital read-out of a Geiger counter may have no resemblance to the rock we see before us. Yet they are phenomenally related, each tells us something different about the rock. Reconciling the symbolic and visual information is not as easy as relating stereoscopic images; it requires processing in different parts of the brain and a degree of abstract thought.

Symbolic media differ from effects of direct observation in other ways. While photography *extends* our sight, it is temporally and spatially distinct from direct viewing. A photograph may show a scene that happened years ago. It requires altogether different viewing angles and body positions than actually seeing the source of the image. Similarly, a stereo recording of a symphony is disjoint from the time and place of the performance – and thereby attenuated in ways different from an electronic hearing aid. Despite these abstractions synthesizing experience from symbolic media and direct observation is an everyday act. Viewing exhibits in our art museum, for example, is greatly enhanced by the labels and texts that annotate the displays. We experience the show in distinct modalities, mediated and unmediated – yet we are able to unify them within the same experience. This is no accident, for a museum exhibit is *designed to be coherent*. The label/explanations must hang next to the displays otherwise the viewer may miss the point of the exhibit entirely. A pile of labels disjoint from their paintings is useless. The more we attenuate symbolic media from their source (in time, space, or resemblance) the harder it is for the viewer to synthesize their relationship. Conversely, the more that symbolic media relate to their source, the easier it is for observers to corroborate them and derive meaning from their experience. This is particularly important in the creation of cybrids in which physical and cyberspaces are meaningfully integrated.

Defining Cybrid Principles

Below is a diagram of the social and psychological needs laid out previously. Shown is a relationship between the overarching need and tributary needs by whose solution the larger need may be met.

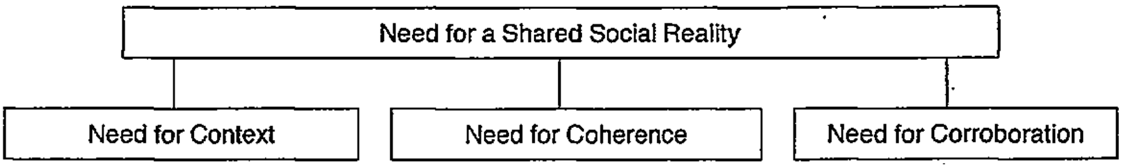

Figure 7.1 Relationship of Needs

Each of the tributary needs might be accommodated by the extended architecture of cybrids. Such accommodations would typically range between mundane attributes of buildings to those of digital, electronic environments. For example, the need for context may be resolved by environments, either material (buildings) or simulated (cyberspace). The need for coherence can be met with a range of behaviors whether static (relationships between solids) or temporal (dynamic, time-based). Finally the need for corroboration may be addressed in environments that we experience or sense directly (buildings, cities), as well as those we detect through the extended senses of media technology (digital worlds, VR). Below we have expanded the diagram to show possible architectural resolutions.

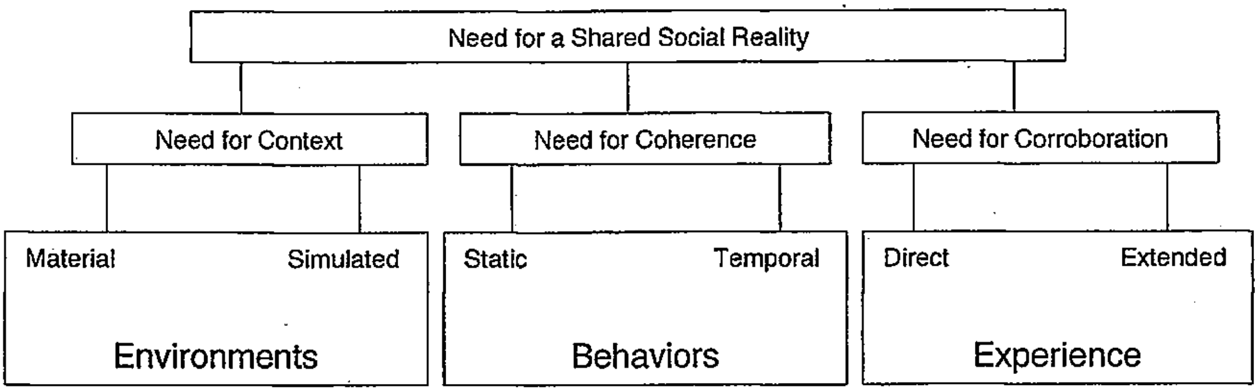

Figure 7.2 Needs addressed through architecture

This diagram embraces opposing qualities of architectural resolutions under the terms of architectural *Environments*, *Behaviors* and user *Experience*. It reconciles extremes, for cybrids by definition would 1) integrate material *and* simulated environments 2) exhibit both static *and* time-sensitive behaviors 3) and be experienced both directly *and* through the extensions of media. We propose below seven principles for the creation of cybrids, defining their service and setting the stage for the designers, occupants and society that create them. Readers will note that the principles are pragmatic in two senses, one practical the other philosophical. They are practical in that they stress the user's experience rather than specific technologies. This avoids over-refinement and obsolescence that would encumber what should be general principles. A philosophical pragmatism is evidenced by provisional definitions that assist in developing cybrids. An example would be *comprehensive space*, the gestalt for designing cybrids. Despite its overtones this term is specific to cybrids' design, and makes no claims to philosophical or scientific truths. Its pragmatism lies in providing the mental framework for cybrid architecture's designers and users.

1. Comprehensive Space: Cybrids exist in a comprehensive space that comprises the material, symbolic and cognitive attributes of spatial experience.

While *comprehensive space* implicates the cybrid user's experience, it is particularly useful to designers of cybrids. It encourages development of projects free of bias toward either material or simulated solutions, offering instead the broad spectrum that lies between. As a mental frame for cybrid development it has useful entailments. For instance cybrids evolve from a space recognized as a product of consciousness. This space pre-exists any of the project's manifestations, surviving until the last memory of the project is lost. This suggests that the *life* of the project extends from the earliest inclinations of its creators to well beyond its construction. The cybrid is thus understood to be an evolving entity rather than a final product, it embodies the information of its design, production, its use, transformation and eventual dissolution.

2. Composition: Cybrids are mixed-reality compositions that comprise material and simulated elements.

This principle stresses the integration of physical and cyberspaces in the mind of the designer and, in turn, that of the observer. The cybrid's composition may be observed in a variety of modes, through direct observation as well as by means of technology. The design of the cybrid would determine the nature of constituent elements, as well as the type and number of techniques that would support it.

3. Corroboration: Cybrids offer a range of empirical modes that corroborate one another to a determined degree.

The corroboration of modes conduces to holistic readings of the cybrid and its constituent parts. The modes may be through direct sensation or mediated through instrumentation. Corroboration is important to users' cybrids as compositions rather than mere aggregations of effects, a subject addressed in Principle 2. The degree to which the modes corroborate one another is determined initially by the designer, and later may be modified by the cybrid's occupants.

4. Reciprocity: There is reciprocity between a cybrid's physical and cyberspaces such that actions in one domain may affect the other.

This principle describes a reciprocity or coupling of states determined at the outset of a project and modified thereafter. This reciprocity addresses the coherent behavior of the cybrid composition, or the integrity of the cybrid, rather than the technology whereby it is manifested. Strong or weak reciprocity of these states depends on the needs of the user. Weak reciprocity includes the coincidence between a spatial data base and a building, as in the CAD files used to build a structure. In such cases coupling only serves the instrumentality of the CAD file to the builder's actions. This is a weak coupling because it is barely reciprocal – if at all. Strong reciprocity entails a tighter coupling between material and cyberspaces such that changes in one state affect the other. This would suggest a cybernetic, self-regulating system at work in cybrid operation. Current examples would include monitoring/control systems, surveillance and building operation networks.

5. Extension: Cybrids provide users with a coherent spatial environment that extends their awareness beyond the concrete world to a dimensionally rich, mediated space.

This principle stresses the spatial qualities of the cybrid and the ability of users to generate spatial experience from a variety of informational sources. As cybrids would make possible the observation of abstract and simulated artifacts, we may consider them to be part of the extended sensorium described earlier. Also, because of the reciprocity of states in cybrids, occupants in a cybrid's physical domain may be observed from cyberspace, and vice versa. In this way the presence of the observer is extended into the reciprocating domain. As is the case with other principles listed here, the degree to

which observers are extended is determined by the designer and later adjusted by the occupant.

6. Social Context: Cybrids provide an extended social space.

In light of the foregoing principles and the degree to which both physical and cyberspaces conduce to social activity, cybrids may form a structured social space. (Downes-Martin, Long, Alexander 1992) Beyond sustaining the activities of its occupants, cybrids may host telepresent users and offer a meaningful social context for their interaction with those physically present. It is conceivable that such interaction may be based on historical/anthropological models for interaction with non-physical presences. These could be founded on myth, legend, structured metaphors, or possibly occult practices.

7. Anthropic Design: Cybrids shall be designed to augment their users' innate use of space to think, communicate, and experience their world.

Anthropic cyberspace has been defined as "an electronic environment designed to augment our innate use of space to think, communicate, and navigate our world." (Anders 1999a, 9-10) Our seventh principle expands upon this definition to include both the material and cyberspatial aspects of cybrids. The cybrid environment is structured for ease of use much as one might expect from architecture. While this would seem obvious in a building, it is not so in cyberspaces where spatial artifacts and their presentation may seem arbitrary. The design of cybrid space considers the awareness and presence of the observer. It is here assumed, as it was in the first principle, that the observer/occupants of the cybrid mentally complete the cybrid's composition from the evidence of their direct and extended senses as well as their cognition and memory.

Below is an extension of our earlier diagrams. It shows how the seven principles described above apply, primarily, to architecture's accommodation of contemporary needs. In practice, however, one would find the principles would overlap or otherwise reinforce one another. These seven principles are intended to guide the design of cybrids and provide a foundation for a polyvalent practice of architecture. In the next chapter we will put these principles to use in a design project to help demonstrate their application in practice.

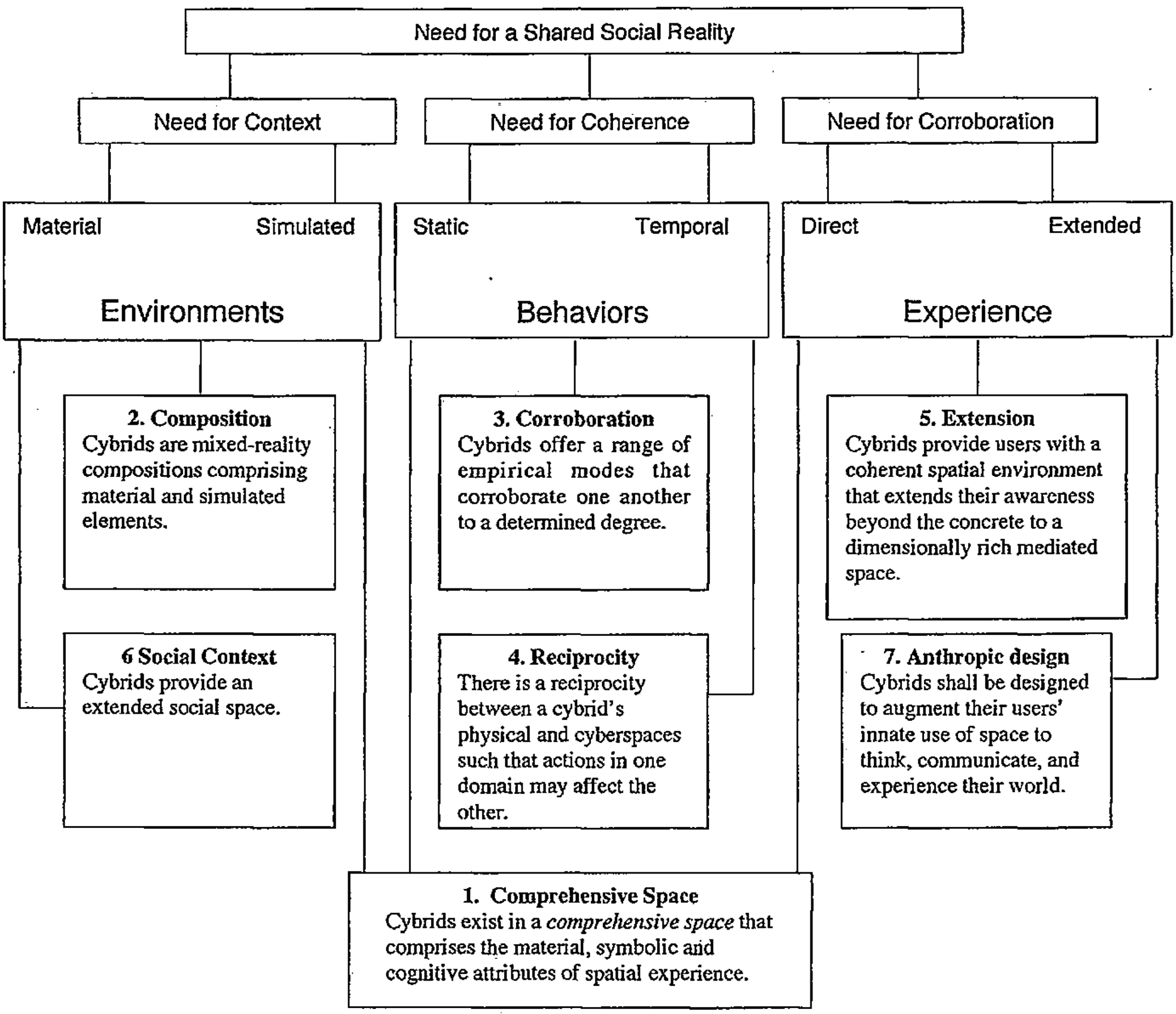

Figure 7.3. Service of cybrid principles to needs.

Chapter 8: A Case Study Application of Cybrid Principles

The Planetary Collegium Project Overview

Although cybrids are nascent in contemporary architecture they may be recognized in security and building mechanical systems that closely couple sensor/actuator systems with symbolic interfaces. There are unfortunately few examples – proposed or built – that illustrate the wider implications for the cybrid aesthetic in design. And while many examples of mixed-realities exist in laboratories, few go beyond the bounds of specific experiments to employ the cybrid model of space in social, planned environments. In order to test the cybrid hypothesis, then, we have devised an experiment. It takes the form of a case study, an architectural project for a hypothetical client, the Planetary Collegium. The project will integrate physical and cyberspaces in the design of a cybrid, an integration that will affect all stages of the project, from the program statement to the design product itself. The design process and product will then be evaluated according to the principles set forth in the thesis.

The following pages will describe the project and generate a program specification for its development. This last will involve the concept of *project space*, the comprehensive space of the project. As we will see this space contains all aspects of the project – material and otherwise. It is from this space that the project emerges as a network of social artifacts and spaces. The resulting program resembles those of conventional buildings with one crucial difference. It will project not only physical spaces, but non-physical ones as well. This program will accommodate the Planetary Collegium's activities by recognizing inherent tensions between the locality and ubiquity of the Collegium – tensions that are exploited in developing the cybrid project.

Project Description

The project presents a new form of learning institution, one distributed globally, yet unified through electronic networks and periodic meetings. This institution – the Planetary Collegium – is the vision of Roy Ascott, an internationally recognized leader in the field of interactive media arts and founder/director of the CAiiA-STAR center. As CAiiA-STAR is the direct precursor of the Collegium, we first need to understand CAiiA-STAR's operation in order to understand that of the Collegium.

CAiiA-STAR

Established during the 1990's, CAiiA-STAR comprises two centers. The Center for Advanced Inquiry in the Interactive Arts, CAiiA, is situated at the University of Wales, Newport, while STAR, the Science Technology and Arts Research center, is based at the University of Plymouth in the United Kingdom. These centers are the focus of advanced research on the integration of science, technology and the arts. To date, CAiiA-STAR has succeeded in attracting doctoral and post-doctoral researchers whose work transcends conventional subject boundaries. Presently, doctoral candidates working with the center receive their degrees from the hosting institution.

CAiiA-STAR's operation is unique, distinguished by its composite sessions conducted both in-residence at the host universities, and by invitation from media centers and institutions in other parts of the world. Doctoral candidates are required to attend three, ten day sessions per year to consult with their advisors, meet and critique their fellows, and perform thesis research. For the remainder of the year candidates work at their home-based institutions and maintain contact with their advisors and colleagues via the Internet.

The Planetary Collegium

Unlike CAiiA-STAR, the Planetary Collegium will be independent of any host institution. It resembles its predecessor in its mission: the exploration of human possibility through new integrations of arts, science and technology. The Collegium aims to embody the future in its operation, community, and public presence. To achieve these ends the Collegium will develop synergies with future-oriented industry leaders to ensure both its cultural eminence and fiscal viability. The Planetary Collegium will closely resemble the current CaiiA-STAR model in operation. As before, it will couple face-to-face interdisciplinary dialog with the decentralized, nomadic affordances of an Internetworked community.

However, as proposed by Ascott, the Collegium will have attributes quite different from its precursor. (Ascott 2002)[1] In departing from host universities the Collegium would appear to lack the localized infrastructure necessary to conduct its business. In answer Ascott proposes that the Planetary Collegium be a distributed presence, embodied in seven campuses situated strategically around the globe. Each campus would be an infrastructural sub-center – or node – of the Collegium, replacing to varying degrees the amenities of a host institution.

Post-biological Organization

Despite the decentralization of the nodes, the Collegium would act as an organic whole. This biological analogy is integral to the institution's vision. Its founder perceives a trend away from the orthodox, industrial model of research institutions toward one that embodies a transdisciplinary, post-biological future. The organic metaphor is apt given contemporary concerns about cloning, genetic mapping and modification, artificial life and intelligence that all play a part in today's cultural dramas and projected research within the Collegium.

But the organic metaphor appears at odds with the distribution of the Collegium's nodes. Classically, the organic integration of parts depends on physical contiguity. This would be the view held by "organic design" proponents of the twentieth century, Frank Lloyd Wright and Eliel and Eero Saarinen among others. Today, however, space can be collapsed with electronic media. While the nodes would be scattered, the whole of the Collegium would be centered in cyberspace. This centering is experienced in time (the system is always "on") and as a spatial/empirical continuum, a refined blend of physical

[1] See Appendix 2 to read the Planetary Collegium Charter.

and telematic presences. Within one node, we would be in the presence of all nodes. Engagement with a part implicates engagement with the cybrid whole.

Collegium Community

As proposed, the Planetary Collegium staff would consist in 21 supervisors and 126 researcher agents worldwide. Researchers would engage in doctoral or post-doctoral inquiry and would include both individual researchers and two or more persons working in tight collaboration. Eighteen researchers and three supervisors are identified with each of seven nodes. Their research seeks the integration of practice and theory in pursuit of the Collegium's mission: the exploration of human potential through technology. Researcher degree-candidates who successfully complete their studies will be awarded formal recognition equivalent to doctoral degrees from traditional universities. Just as the physical nodes are dispersed, so too would be the research agents and supervisors throughout much of the year. As in the CaiiA-STAR model they will be engaged in research at their home-bases and communicate via the cyberspaces of the Collegium and the Internet.

At regular intervals, they will convene at a pre-determined Collegium node to engage in face-to-face dialog, confer, and advance their studies. Although such convocations would have to be physically situated, the Collegium's cybid organization would allow on-going dialog between nodes. Similarly, the 21 supervisors, while in continous contact over the Internet, will meet on a regular basis to further the research goals of the Collegium. Finally, a presiding Governing Board will provide institutional and financial direction for the venture as a whole.

Planetary Presence

Each node of the Planetary Collegium serves as a functional hub of activity and as an iconic presence in its host community. The nodes will be purpose-built, residential seminar centers and their architecture will address the needs of an ecologically and technologically informed social environment. As proposed by Ascott, the nodes will "be embodied in an architecture of unique distinction while contributing to a planetary infrastructure of extreme sophistication and subtlety." (Ascott 2002) This infrastructure is represented locally as an immediately recognizable, iconic building, and globally as a networked, continuously updated communications environment.

Physically the seminar centers will be situated away from major cities in communities and countries desiring to actively participate in global culture and so define their role for the future. This serves not only the retreat-like nature of Collegium's activities, but its financial considerations as well: real estate and labor costs are directly affected by a node's location. Also, by siting the centers in this way, the Collegium distinguishes itself from the urban-centric norms of contemporary cultural practice.

Annual operation of Nodes

Functionally the seminar centers service two kinds of clientele: the Planetary Collegium and "corporations and organizations who wish to be identified with the high level, creative ethos of the Collegium." (Ascott 2002) In serving these clients, each center

hosts colloquia and small focused gatherings lasting several days, whether those be the regular activities of the Collegium, or services leased to other clients. Each node will have an on-site administrative and residential support team. These teams – comprising a concierge and two technicians – will serve the needs of the Collegium's sessions, whether those of the group assigned to the node or visiting groups from other nodes. At all other times of the year, the nodes are available for use by the node's non-Collegium clientele as a state-of-the-art retreat.

Defining the Project Space

Before proceeding, we may imagine a conceptual space occupied by our project. Although the contents of this space are ill-defined we already know something about them from the project description. We know, for instance, that they will serve an identifiable institution but are physically situated in several remote communities. They are dispersed yet in constant contact through state-of-the-art media. And they will house a number of residents for several days at a time. Although no part of the project presently exists, it occupies this mental space. While some parts of it are propositional – verbal descriptions shared by readers – others exist in an evolving *project space* of the mind. This space, the designer's comprehensive space, is informed by memory, experience, and by the artifacts of production itself. The project space exists prior to, during and after the project's completion.

Expression of the Project

From an idealist perspective it would appear that the project needs nothing but thought to sustain it. But this is not the case programmatically or procedurally. Our project description calls for physical structures in various parts of the world. It specifies housing for visiting scholars, meeting rooms for gathering and presentation, and an infrastructure for telecommunications. For other reasons, the planning effort itself will demand intermittent materialization as plans, notation, and computer images. Such manifestation is a natural consequence of the social nature of planning. Such expression takes the form of artifacts, shared by others, either sensed directly or through our extensions.

The Coherence of Project Space

The relationship between these expressions is, at first, defined by their service to the planning process. In conventional practice sketches lead to more refined drawings, drawings then inform specifications, etc. Later, however, these expressions take a different role. Planning drawings become reference documents for repair and modifications after the project is occupied. The actual built project and its planning drawings offer distinct, yet coherent views for directing new work. Thus, the compatibility of the documents with the actual building is crucial for very pragmatic reasons. If we understand both the building and the drawings to be expressions of a coherent project space, it would conduce to consistency among its artifacts of planning, record, building activity, etc.[2]

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[2] Note here a subtle change in the role of the drawings. Originally the drawings were used to direct new work, say the construction of a building. Their role was imperative: the lines denoted the construction of

Digital Technology and Project Space

This consistency is readily attained by introducing digital technologies. CAD sketches may be easily turned into technical drawings and 3D models, for unlike conventional design on paper, the vectors of sketches simply merge into the next stage of design. The vectors used to denote construction may be reused in perspectives and animations. They have applications ranging from lush renderings to prescriptive contract documents. CAD files are a living, spatial archive of the project's development. They form an increasingly important part of the project space, its cyberspace. The cyberspace of a project's digital files and the physical space of its artifacts are subsets of the comprehensive Project Space. This nesting of spaces provides a clear mnemonic structure for approaching and understanding the project.

Opportunistic Use of Project Cyberspaces

The products of CAD in architecture can be employed to other ends. The spatial configuration of the project's cyberspace, for instance, can help in creating an on-line community for the project owner. The conceptual framework for construction can become a context for external telecommunications. Internally, abstract information workspaces may be affixed to the framework, extending the project well beyond its physical scope. This surprising resolution of spatial/informational needs is a by-product of the design process. As the demand for high-bandwidth, image-intensive communications increases, so too will the need to organize its content and orient its users. Designers can exploit the subtle connections between physical surroundings, digital technology and memory to new, unforeseen ends.

Telecommunications and Project Cyberspaces

For example, telepresence – a technology that conveys the visual and acoustic likeness of callers – is implicitly spatial. In some cases the transmitted presence is so realistic that it allows the sender to make eye contact with those on the receiving end. (Lanier 2001) This is quite a leap from the conventional, disembodied phone call. It requires orientation both with the receiving space (an office) and with the conversational partner. Its realism evokes a social/spatial response otherwise only found in physical interaction. As telepresence technology develops beyond screen-based communication the spatial framing of interaction will likely become more important. (deVelasco and Hutchinson 1999) Presences observed via head-mounted displays or projection in virtual/augmented realities will need to be appropriately situated in the receiving space. This orientation of the caller's image can be more easily managed in an environment that has a digital double with appropriate sensing and display technology. The same holds true for spaces and objects in telepresence. (Singh and Serra 1994) We use artifacts to communicate (pointing to them, displaying, and arranging them) and think. (Anders 1999a) We also use artifacts – objects, documents, displays – to communicate and pursue our goals. (Benford and Greenhalgh 1997) Telepresence entails the negotiation and exchange of these instruments.

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new walls. However, as reference images they are more connotative, offering different perspectives onto the building itself.

Space, Memory and Project Cyberspaces

I have argued elsewhere that space is a product of – and an aid to – cognition. Situating objects in space helps us create mnemonic links, mental hooks to extend our memory, using space and its objects to think. (Brown, Collins and Duguid 1989) (Johnson-Laird 1981) (Ehrlich, Mani, Johnson-Laird 1979) (O'Conner and Hermelin 1973) For example, while I may not remember the definition of "syzygy", I do know where my dictionary is. I can locate the book and the appropriate page within a few seconds. The orderly placement of objects (books, pages, text) in space in this way extends my memory into my environment. As the environment becomes more complex so does my search. If I lose the keys to my car, for instance, I have to mentally re-trace my steps upon entering the house, recalling the door, entry, kitchen... By spatially recreating the incident I can – with luck – find the keys in a few minutes.

Finding the keys is a result of associative thinking, using the space of the house as a mnemonic prompt. By visualizing the layout, I recollect my actions and ultimately my keys. My house incidentally also contains the bookshelf where stands the dictionary wherein we found the definition of "syzygy." The space of my house has become a localized framework for memory.[3] The imagined space of my house is like our project space, a product of actual experience and memory. (Perron and Miller 1991) Many artifacts support this project space: plans and sketches, photographs taken at Christmas, the house itself. Were there any computer files of it available, they would comprise the cyberspace portion of the project space. These files conceivably could become part of the memory matrix of the house, used to jog our memories, extend our capabilities. (Gavin 1999) (Gavin, Keuppers, Mottram, and Penn 2001) (Hoisko 1999)

[3] For a fascinating discussion of localized memory systems, or *memory palaces*, I refer readers to Frances Yates' book, The Art of Memory. (Yates 1966)

The Collegium Program

We will now use the concept of the Collegium's project space to develop a program for the project. Although it will resemble that of a conventional architectural project it differs in several ways. For instance, many parts of the project may not end up as portions of a building. Instead they may be manifested as features of the project's cyberspace. This program will define the cybrid's integration of built and media spaces rather than directing us solely to the construction of a building. Our program's development will consist of five steps: 1) defining a project space conceptual structure, 2) distinguishing activities within the project space, 3) determining the degree of abstraction of these activities, 4) establishing the need for physical or cyberspatial support for each activity, and 5) defining program spaces/resources with the intent of integrating the physical and cyberspatial infrastructure within the cybrid whole. This will result in a program for the Planetary Collegium and its nodes. Each developmental step will be informed by issues and principles developed in earlier chapters in the effort of creating an amenable, stimulating environment for the Planetary Collegium.

1. Defining the Project Space Conceptual Structure

The Planetary Collegium would comprise several, linked, yet discrete nodes placed strategically around the globe. Though physically independent, the nodes are slices taken from a whole, reflecting in their makeup the Collegium's goals and organizational structure. Each node will locally express aspects of the overall structure physically and through electronic emulation. These physical and cyberspaces will relate, merge, or "map onto" one another as necessary. The Collegium's structure serves the following activities: 1) management; 2) operations; and 3) public presentation. Each of these activities takes global and local forms as described below. Note that these distinctions are provisional only, and we will see that portions of the Collegium structure overlap, as well as many of its global/local attributes.

Management

Global form:

> The Collegium's Governing Board provides the Collegium's strategic and institutional direction. The Collegium's 21 supervisors advise the Board on academic and operational affairs. Both groups meet physically on a regular basis and are otherwise in contact throughout the year. Although meetings of the two groups may or may not coincide, they can be mediated telematically using Internet technologies.

Local form: Academic Management

> Local management of the centers involves both academic and facility administration. The former applies to the Collegium's educational/research mission; the latter to the infrastructural support of these goals. Academically,

three supervisors represent the Collegium locally, and are responsible for advising their student researchers and reporting to the Board.

Local form: Facility Management

In parallel, facility administration serves all infrastructural support for a Collegium hub including building operations and hospitality services for both the Collegium and outside clients who wish to lease the facility. The facility administration staff includes a concierge and two or three on-site technicians.

Operations

Global Form:

The global operation of the Collegium centers on the collaboration between nodes. This involves sharing resources, one-to-one and group teleconferencing, and physically meeting at different centers throughout the year. Such physical meetings may coincide with conferences or other public presentations. Other operational activities include matriculation of research candidates, grant acquisition, coordination of events among nodes, and accounting and records keeping.

Local Form: Academic Operations

Academic operations within each hub focuses on the work of eighteen Collegium research candidates. Their support includes: information resources, administrative services, academic advising, and research facilities. In addition a hub will support its researchers while not physically on-premises through an array of network services.

Local Form: Facility Operations

Facility operations include building operational systems, computer/network services, and telecommunications. It also includes coordinating and providing hospitality, food service and lodging both for Collegium students and faculty, and – at other times – for other clients who wish to lease the hub facility independently.

Public Presence

Global Form:

The Planetary Collegium will have a strong Web presence, both in its permanent site resources, and in its use of the Internet to unify the Collegium nodes. Any significant outreach activity on the part of any node will be paralleled in its on-line presence through either live transmission, or other publication.

Local Form:

Each hub will be housed in a distinctive building that expresses the spirit of the Collegium. This facility will be coupled with a dedicated cyberspace: a high-dimensional, interactive multi-user environment combined with the amenities of a Web site. All publicity, conferences, workshops, exhibitions, and publications will share the services of the hub both in the building and its cyberspace equivalent. The two domains will reflect one another to varying degrees, occasionally merging and overlapping for different uses.

2. Distinguishing Activities within the Project Space

We will here distinguish the activities according to their global/local nature and the role they play in the institution. This will give us a foothold for developing and spatializing the program. We present the following assessment of project space activities using the categories of the Project Space Conceptual Structure just described.

Management Activities

Global Form:

Meeting, planning, conversing, presenting, sharing

Local Form:

Advising and reporting to the Collegium's Governing Board

Operational Activities

Global Form:

Conferencing, sharing resources, accounting, coordinating events, acquiring grants, matriculating students, keeping records.

Local Form: Academic

Student/faculty – conferring, advising, researching, writing, studying, presenting, filing, eating, drinking, sleeping, dreaming, creating, exploring. Administration – consulting, filing, shipping, communicating

Local Form: Facility

Planetary Collegium – administering hospitality, housing, eating, drinking, sleeping, serving, swimming, bathing, resting, telecommunicating, computing, storing. External clients – administering hospitality, leasing, booking, storing,

Public Presence Activities

Global Form:

Communicating, coordinating, conferring, posting

Local Form:

Presenting, conferring, teaching, learning, housing, containing, hosting.

3. Determining the Degree of Abstraction of Activities

Identifying the abstractness of an activity determines the degree to which it may be mediated electronically or otherwise. However, determining abstractness can be difficult since each activity may have within it several levels of abstraction. For example, a face-to-face meeting may, in addition to its highly concrete elements – personal presence, furniture, enclosure – have abstract artifacts such as text, graphics, projections and the like. These latter artifacts lack the richness of physical presence, but serve the propositional nature of formal dialog. In their abstraction they appeal to specific modalities, and are increasingly susceptible to mediation through digital networks and displays. (Benford and Greenhalgh 1997) (Brooks, Ouh-Young, Batter 1990)

In the following diagrams and in Table A[4] we will analyze each of the Collegium's activities for its degree of abstraction. We will locate the activity within a variety of scales that are concrete at one end and increasingly symbolic at the other. This will help distinguish which activities are dependent on physical support from others.

The Scale of Abstraction
I have elsewhere [Anders 1999, Anders 2000] employed a scale of abstraction to evaluate both conventional and electronic artifacts.[5] The scale proposes that artifacts range from the most concrete to the most abstract to the degree that their use serves our senses or cognition. For instance, a brick may appeal less to the intellect than, say, a mathematical proof. For this reason the brick and proof would be situated nearer the concrete and abstract poles of the scale respectively.

> Of course, it's not that simple. An archaeologist would protest that he could find significance in a brick... Likewise, a cognitive scientist could claim that thought is a product of concrete physical processes. Consequently our scale of abstraction can only serve as a rough guide for distinguishing artifacts. Despite its limitations, the scale illustrates how nearly all meaningful artifacts have a dual nature comprised of both form and meaning. [Anders 1999, p.48]

In my previous work the scale helped to evaluate the artifacts of physical and cyberspaces, demonstrating how they relied both on spatial presence and cognition.[6] However, the scales' use differed from its application here. Whereas it originally distinguished artifacts, the scale will in our present analysis help assess the concrete or abstract nature of the Planetary Collegium's activities. In addition, while the scale originally contrasted conventional and electronic artifacts, it will here help to determine

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[4] This and other tables mentioned in this chapter may be found in the Appendix of the dissertation.

[5] The term *artifact* is here used to denote anything created through human agency. It applies to both brick and text. In our scale of abstraction they are merely distinguished by their appeal to the senses or intellect. See (Bødker 1991).

[6] See also (Bergamasco 1994)

the nature of those artifacts (buildings, services, systems) needed to support the Collegium's activities.

Using the Scale to Assess Activities

Activities, like artifacts, have concrete and abstract qualities. The verb *build,* for instance, connotes physical materials and effort – attributes of our sensory world. However *build* also implies assembly, coordination, and goals which are more abstract than concrete. *Build* is more or less abstract depending on the way we look at it. Many verbs are not absolutely abstract or concrete, but exist on a continuum somewhere between. The abstractness of a verb also depends on the measuring stick we use. The labels we assign to the extremes of our scale affect the verb's status. These labels are polar opposites within a category and demonstrate the contrast between *concrete* and *abstract.* For instance, within the category "Nature of Activity" we might assign the terms *material* and *symbolic* to the poles. Or, in the category "Temporal Participation within Activity" we could label the extremes *synchronous* and *asynchronous.* Each category reveals something different about the verb. We can observe the abstractness of an activity by subjecting it to different categories of abstraction.

Example:

Let's view the term *meeting*, in this case that of the Collegium's board members. Since the "nature of the activity" ranges from symbolic to material we might argue that *meeting* is symbolic because of dialog, but it is also somewhat material in the physical/spatial gathering of participants. Since the (abstract) dialog is often the purpose of meeting, we might say that *meeting* weighs more heavily on the abstract/symbolic end of our scale. On our scale of abstraction, we could map *meeting* with the "weight" of the verb tipping slightly toward the symbolic. In the diagram below (Fig. 8.1) the shaded area indicates the spread occupied by the verb between material and symbolic extremes:

Figure 8.1 Material/Symbolic scale for *meeting*

However, if we view *meeting* with respect to duration – with the concrete and abstract poles occupied by *permanent* and *temporary* – we would find that its location on the scale changes. Since *meeting* is usually a scheduled, temporary activity we'd expect it to be nearer the abstract end of our scale. (Fig. 8.2) Compared with our previous diagram it might look like this:

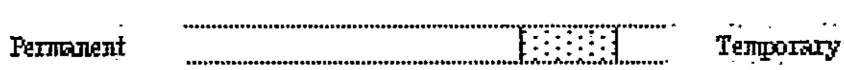

Figure 8.2. Permanent/Temporary scale for *meeting*

This method, admittedly subjective, relies on individual judgment to set the levels of abstraction. However, we are not relying on the scale to pinpoint values but, instead, to give us a qualitative sense of how abstract the activity is. We do this by subjecting each activity to analysis according to several categories (a matter we will pursue shortly). To get a greater accuracy – or relevance – of the data we can increase the sample by having a several subjects evaluate the verbs. For instance such an evaluation could be played like a game with a number of partipants – ideally the prospective users of a facility.

Categories of Abstraction

To create the program for the Planetary Collegium, we will use scales of abstraction to allocate material and informational resources. Each activity will be mapped onto scales of abstraction in seven categories. These categories contrast the activities' levels of abstraction, *but also help distinguish electronically mediated entities (abstract) from those that require material fabrication (concrete).* The seven categories – with their polar pairs – include the following:

1. Nature of activity	Material	Symbolic
2. Appeal of activity to participant	Sensory	Conceptual
3. Site of activity	Local	Distributed
4. Likelihood of activity	Consistent	Contingent
5. Duration of activity	Permanent	Temporary
6. Temporal participation in activity	Synchronous	Asynchronous
7. Regularity of activity	Cyclical	Spontaneous

The scales' categories and, particularly, their extremes were determined by their relevance to digital media. For this reason we find *symbolic, temporary, asynchronous* at the abstract end of the scale, and their opposites at the concrete end. While there is nothing necessarily abstract about *distributed,* the term is associated more readily with computer networks than its opposite, *concentrated.* And it is for this reason that we find *distributed* at the more abstract end of the scale. A similar logic applies to placing *symbolic, conceptual, contingent, temporary, asynchronous* and *spontaneous* nearer the abstract limit.

Example:

Returning to our examination of *meeting* we can map the verb's abstraction within the seven categories described above. With reference to our list of categories one such mapping results in the following scalar diagram:

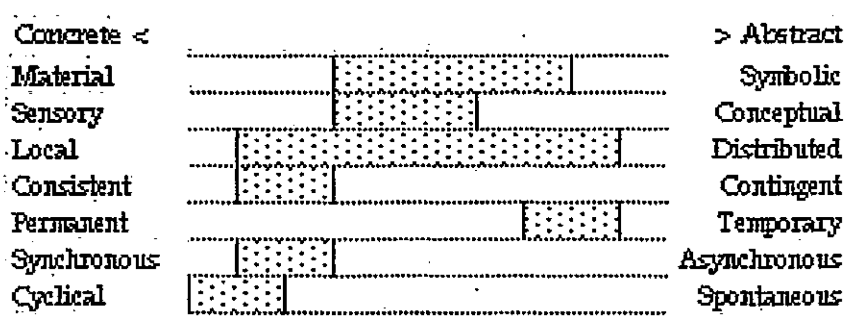

Figure 8.3. Composite of cognate scales.

The diagram can be debated. In this case we assumed that *meeting* referred to Planetary Collegium activities. *Meeting* would map differently if we were describing a nightclub or church function. The method is also relative to its users. For, even among the Collegium staff, an administrator may interpret the activity differently from, say, a researcher. All those who will occupy or use the project should, ideally, map their activities in this way during the design process. Planners could then prepare an aggregate diagram for program development.

Interpreting the Scalar Diagram

Scalar diagrams that weigh toward the abstract end of the scale conduce to digital technology resolutions. Those weighing more toward the concrete are best resolved with material spaces and constrution. But in our example the overall tendency is unclear; *meeting* seems to be poised between extremes. Fortunately the diagram comprises several smaller scales for each topic: *Nature of Activity, Appeal of activity, Site,* etc. Each of these sub-scales may be verbally translated to describe *Meeting* in the context of the Planetary Collegium.

For instance, the fourth scale offered by the diagram, *Likelihood of Activity*, ranges from *Consistent* to *Contingent.* Since our shaded selection area weighs heavily toward the *Consistent* extreme we could say that meetings at the Collegium are fairly regular. With verification from the client, we could say the scale describes "Regular meetings several times a year." Similarly, the fifth scale describing *Duration of Activity* could be interpreted to mean that the meetings are of short duration: "Meetings [of the Board Members] have a duration of a few days." In discussion with the client the sixth scale, *Temporal Participation*, may be translated to say "Co-local discussion is concurrent and synchronous." And from the seventh scale, "Meetings are held on a regular basis." In this rote, line-by-line fashion we can write a short paragraph describing Board meetings within the Collegium. Enhanced by client discussion, one such paragraph may read:

> Board members meet face-to-face (F2F) to discuss Collegium strategies.
> Engagement in dialog is richly modal, contents of dialog can be conceptual.
> Periodic dialog is F2F, although teleconferencing may be used at other times.
> Regular meetings several times per year.
> Meetings have a duration of a few days.
> Co-local discussion is concurrent and synchronous.
> Meetings are held on a regular basis.

Note the importance of client/designer discussion in interpreting the scales. The scalar diagram is an armature for developing the project's description and program, only a starting point. Its interpretation is subject to dialog between consultants, designer and owner, even those who separately developed diagrams for the same activity. Ultimately a statement describing Board meetings is agreed to, and the designer and client determine the support for the activity, be it physical or otherwise. The results of this analysis may be found in Table A in Appendix 1.

4. Assigning Support for Activities

By teasing out the various modes attending each activity, we can determine the extent to which the activity must be physically sustained and/or served through emulation. With reference to the preceding analysis and Table A, we can estimate the resources and support required for each activity. This support may be physical – a building or room –

or more abstract such as a Web site or digital archive. If the activity requires a mix of physical and cyber-amenities the support itself may become a cybrid. Table B tabulates the activities and their support requirements according to the resources' informational, cybrid or physical ontology. As in the foregoing analysis this table assesses activities according to their role within the Collegium: Management/Global; Management/Local: Academic; Management/Local: Facility; Operational/Global; Operational/Local: Academic; Operational/Local: Facility; Public Presence: Global; and Public Presence: Local. Some miscellaneous local support – circulation, parking, mechanical/electrical spaces – is also accounted for at the end of the table.

A set of resources is assigned to each activity according to the activity's description in Table A. The elements of each set may be unique to that activity or – more likely – be shared with others. For this reason we find that *Archive Space* is required for a variety of activities, among them *Meeting, Planning, Sharing, Advising* on both Global and Local scales. Amenities may be shared by taking advantage of their use durations. For example the same auditorium may serve several activities in the course of a week. Sharing may also occur simultaneously through concurrent use of physical or simulated environments. A library might serve research, teaching and social functions simultaneously. Or several visitors can concurrently use a digital resource, like a Web site, for a variety of purposes. Additional spatial or temporal overlaps would be likely in cybrid resources like teleconferencing facilities or a media resource center.

Table B includes quantitative information – number, population, area – that further defines each resource. A separate *Comments* column offers additional clarification. Readers will note the resemblance of this table to conventional functional analyses provided by architects and planners. The primary difference between Table B and those of traditional practice is that simulations and cybrids are among the resources necessary to support client's activities. These resources' further resolution as spaces is the subject of Table C.

5. Defining Program Spaces and Resources

At this stage, we will seek synergies between activities through their service to the Collegium and their physical/cyberspatial attributes. We will array the infrastructural requirements according to their service to the Collegium. This will resemble a conventional architectural program with the crucial difference being that although some of the spaces remain unbuilt they are still functionally operative. This will become our foundation for designing the Planetary Collegium.

Having assigned support to each of the Collegium's activities it is now possible to determine the kinds of spaces and resources that the Planetary Collegium requires. Table C is a reinterpretation of the previous table that delineates the resources/spaces required for the project. The table lists these resource/spaces according to their increasingly physical nature. For instance we find the *Web Site* and digital *Archive Space* at the top of the list, while *Janitorial* support and *Mechanical Rooms* are at its conclusion. The listing of spaces in this way – from informational resources at the top to material resources below – implicitly merges the "upper" realm of abstraction with the "lower" physical world. This metaphorical strategy will help to spatialize the project and will be used again later in the project's development. Table C also vertically separates the resource/spaces into informational/digital, mixed/cybrid, or material categories. This distinction of resource type is evident also in the table's initial columns that further define the types as material spaces, simulations, services and/or systems

The columns to the right of *Resource Types* recapitulate much of Table B as we may note from the table's legend. The columns are arranged according to the degree that the activity categories are private to the Planetary Collegium. For example, *Public Presence: Global* is the first of these column categories while *Management: Global* is the last. The vertical and horizontal axes of the table help distinguish physical from digital resource/spaces as well as their public or private natures. While it is only two dimensional, this table is a first step in spatializing the Planetary Collegium's program, a process we will pursue in following tables.

Localizing Space and Resources

Table D derives directly from Table C as its vertical and horizontal ordinates indicate. Unlike the previous table, however, Table D shows the degree to which a resource is located specifically or distributed generally throughout the project. The intensity of color in each cell denotes suitability of a resource to a specific activity. As indicated in the table's legend, the color – yellow, green, blue – depends on whether the resource/space is informational, cybrid, or material. This table is tributary to the spatialization diagrams found in Tables E1, E2, and E3.

Spatialization

The diagrams in Table E1, E2, and E3 lay out the resource/space rows of Table IV.D individually. A loose bubble is drawn around the activity cells with the greatest intensity of color. The diameter of the bubble is roughly related to the color intensity and the concentration of colored cells. While this process appears subjective it quickly shows the degree to which a resource is distributed or local. In some cases, such as the facility's phone network or HVAC support, the resource is general to the entire project. In others, bubbles show where the resources may be most concentrated. Table F1, F2, and F3 are identical to the Table E series except that the underlying cells have been removed. Finally Table G concatenates the Table F series into a single diagram. Table G is entitled *Programmatic Section Diagram* as it will be used shortly to develop the sectional design of the Collegium.

In order to consolidate a schedule of program spaces and winnow out redundancies Table H shows the various versions of all resource/spaces described in Table B. The winnowing process is best explained by example. Table B contained several listings for *Archive Space* each with its own requirements. Table H shows these redundant listings and indicates the one with the most demanding specification. This specification will be part of the final program space area for the resource/space. This process is carried out for

all resource spaces. Table H concludes with a summation of areas required for the project.

A feature unique to this analysis is its assignation of area, volume, and location to non-physical resources. Quantities for area and volume in cyberspace have no conventional meaning besides the creation of an icon, metaphor or other symbol within the space of the cybrid composition. Such resources/spaces may take the form of Web sites, digital worlds or other cyberspaces. Regardless of their informational nature, they have a place and presence different from – but analogous to – material components of the project. This situates the element for the end user, giving it identity and presence despite its abstraction. (Pfister, Schuckman, Beck-Wilson, Wessner 1998) Such reification is a natural – and useful – part of planning a cybrid.

A final analysis for spatializing the Collegium program is familiar to architects and planners, a proximity schedule. This schedule, shown in Table I, relates the spaces defined in Table H to one another to determine their need for adjacency. For example one would expect the café and food service areas to be close to each other – indicated by dark shading of the appropriate cell in the diagram. Light shading, or no shading at all here means that proximity is not a great concern. Once again this analysis differs from conventional proximity charts in its inclusion of information cyberspaces. Since the focus of Table I is to relate spaces any cyberspaces so linked to a physical amenity effectively render it to be a *second order* cybrid. That is, the cyber and physical spaces are contiguous but not integral to each other.

We have to this point stressed the relationship of physical and cyberspaces in the project. This was in response to the program requirements. However, aside from functional/utilitarian aspects of the project, we have yet to address the end users and their cognitive role in completing the project. We need to create a mnemonic context, or frame, whereby the user can understand the project. Consequently, in addition to our analyses, we will employ metaphor, myth and narrative in generating the Collegium's design.

At this stage we have a schematic strategy for the spaces of the Collegium's global and local configurations. Although it is subject to refinement, it already has traits that will serve us in the next stage of development. These include: 1) the polar orientation of the Collegium; 2) the roughly triangular form of the Collegium's constituent nodes; 3) the southern location of most public spaces within the nodes and 4) northern location of most spaces private to the Collegium; 5) that cyberspaces are found at higher elevations than material resource/spaces; and finally 6) the metaphoric use of space (form and location) within complex. We will see metaphor employed in developing a mnemonic structure, *frame* or *schemata* for the spatial understanding of the occupant or visitor. The frame will help establish relationships between physical and cyberspaces within the scheme, allowing the viewer to infer the presence of these spaces whether they are directly sensed or mediated through technology. This mental *completion* of the scheme by the observer is crucial to the cybrid's effect. All corroboration between technology and form conduces a phenomenological continuum between sensed, mediated and imagined spaces.

Configuration of Collegium Nodes

The following brief narrative serves as a generating *myth* for the Collegium nodes. This myth, while not a literal depiction of how the nodes are created, helps to frame the configuration of the cybrid node. It suggests the structure of metaphors and spaces we will use in the project.

> As the Collegium develops, it sends its nodes to various parts of the world, detaching sections of its disk to travel south to their respective sites. The nodes leave their cybernetic shadows behind, linking back to the Collegium disk through their live, virtual presence. Each node's cyberspace retains its orientation and triangular shape as it settles on the remote landscape. The former simplicity of the node's configuration becomes more complex as the forces of the site affect it. Symmetry breaks down in the face of siting considerations: climate, site features, access, geography, local customs and resources. As the cyberspace descends, the ground shifts and rises to meet it. The horizon between cyberspace and land thus becomes a blend of physical and cyberspaces.[2]

The narrative reinforces the geometrical, somewhat organic, form of the Collegium, and the wholeness of the organization despite its dispersed nature. It also describes metaphorically the relationship between the global entity of the Collegium and the materiality of its nodes. The resulting cybrid in this sense is a merger between local and global contexts as well as material and simulated entities. The cybrid node balances the Collegium's virtuality with its instantiations on earth. To further develop the configuration of the node we will use a staple of architectural planning, the bubble diagram.

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[2] Brief animations in the accompanying CD show the gestation and grounding of a Collegium node as suggested by this narrative. The images show the final configuration of a subject Collegium node's cyberspaces, colors are not related to the analysis diagrams.

4. A café with outdoor pool
5. Dormitories for visitors and residents
6. A library/resource center
7. An observatory, a structure for public events/presentations

Each cybrid/building will have its own attendant cyberspace – a subset of the Collegium node's local cyberspace. These cyberspaces will incorporate 1) the data model that attends the cybrid's construction, 2) simulations of the constructed spaces, 3) ancillary social/functional spaces to support the resource/space, 4) data displays relating to the use of the physical structure and building systems, 5) audio-visual communications and data displays of occupants and activities. All these data, represented spatially and audio/visually would be updated as necessary. Since social interaction is an important use of the cyberspaces, audio and visual communications data would have highest priority and consequently be updated continuously. The information demands of the cyberspace would require sensors, actuators, digital relays and processors to be part of the final construction. Although each cybrid supports interaction often attributed to "intelligent buildings," the purpose of such interactive technology is mainly to sustain for the occupant an integrated cyberspace within and around the structure.

Relating Physical and Cyberspaces

The cyberspace literally generates and enhances the physical structure while, in turn, the physical structure sustains and manifests the cyberspace. This mutual reification recalls the corroboration of displays discussed in chapter 7. All effects, whether physical or simulated, reinforce each other in creating a comprehensive space for users, situating them within an extended phenomenal environment. This environment, although sustained through form and technique, depends on the user for its effect – much like the fact and illusion of a theater play are empirically integrated in the minds of the audience. In both cases – theater and cybrid – the designers' effort aims not so much at deception as at an enhanced experience and understanding. In the best situations the result is an expanded awareness, emotional satisfaction, and that moment of revealing clarity called *topsight* by computer scientist Gelernter and *the operational bubble* by Gene Rochlin. (Gelernter 1991) (Rochlin 1997, 109)

The cyberspace and physical structure mutually reinforce the cybrid's comprehensive space. An on-line visitor to a cybrid would see not only the configuration of the cyberspace but evidence of the material construction at the Collegium node. Conversely, the physical elements of cybrids would reveal contingent cyberspaces to the observer. Experiencing the cyberspace is not limited to viewing screens and wearing head-mounted displays. Sound and light projections manifest the cyberspace to the unaided observer. Also, building configurations can hint at invisible presences through fragmented, overlapping or bracketing configurations. Such design effects have been characterized as *phenomenal transparency* by artist/theoretician Robert Slutsky and may be found in the work of LeCorbusier and Louis Kahn, as well as many subsequent designers. Similar strategies shown in figure 9.18 below include the use of laser projection to complete compositions of fragmented geometries.

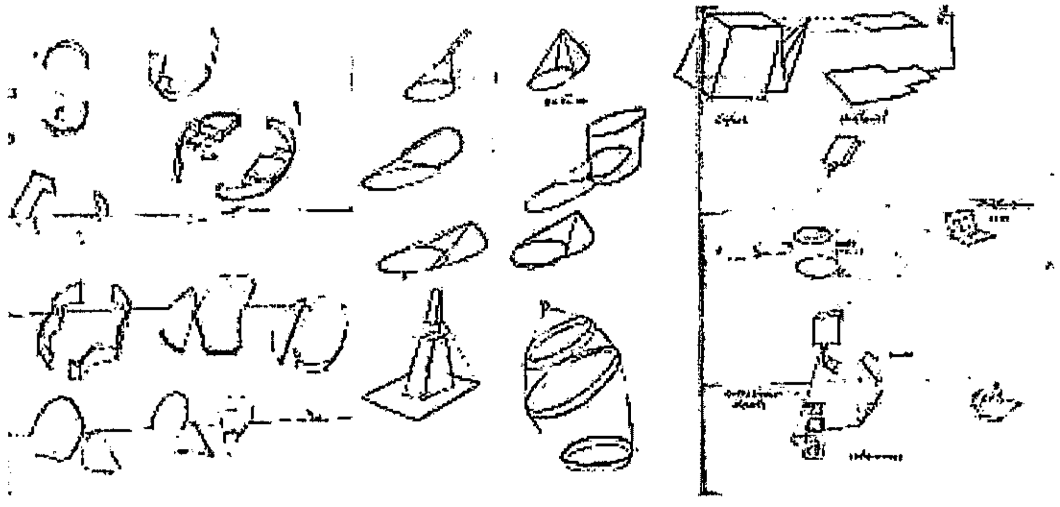

Figure 9.18. These sketches by the author show ways in which physical objects may suggest the presence – or better absence – of another form that completes a composition. Red lines indicate laser projections that would delineate the absent forms.

The use of laser projections to complete a composition is well suited to cybrids since the strategy employs both material and simulated elements. Another related technique uses the material construction – glass, mirrors, projection surfaces – to redirect projections thereby extending the phenomenal space of the composition. This last technique recalls the Pepper's Ghost illusion. In an update of the illusion laser projections would replace the actors in the orchestra pit. Their reflection in the glass would appear to hover on stage beyond. This effect manifests the fictional space of the stage – our cyberspace – to the viewer, extending the auditorium space or that of the building beyond the mirrored glass. Like the laser projections themselves, this illusion is environmental and does not encumber the viewer with special glasses or other worn displays.

Refining the Conceptual Frame

Since the reconciliation and corroboration of effects depends on the occupant's expectations and experiences within the Collegium it is important to establish a frame for relating parts to the whole. We already have one such frame set forth in the generating narrative, one that relies on organic and geometrical metaphors. Each Collegium node is a sub-part of a larger disk, giving it a roughly triangular shape that points to the pole of its origin. This geometry is retained both in the cyberspaces and the physical manifestation of the node in buildings and other structures. We also have noted the importance of symmetry in creating an imposing presence on site. The need for this presence is subtle. The impressive nature of such symmetry is less important to its physical operation than in creating a memorable effect upon the observer. This effect remains with the viewer even when he or she is no longer physically on site. The symmetrical frame, or schemata, is an identifying, orienting feature of the Collegium that anchors and situates the effects of the Collegium in the consciousness of the observer. In this way the physical and simulated attributes of a Collegium node may be mnemonically available to the observer even when off-site or off-line. Yates, Spence and others have described such a use of memorable features in the creation of mnemonic structures, or memory palaces. (Yates 1966) (Spence 1985) Traditional memory palaces were created by memory arts practitioners, often with reference to their available environments, city plans, buildings – even bodies. The present project is intended to exist most effectively in the mind and experience of the user, and draws from both mnemonic traditions and recent psychological research to create a empirical frame for the user.

A reinterpretation of the geometry allows us to further develop this frame. An aerial view of this configuration discloses a roughly anthropomorphic image with the head at the apex of the triangle and the feet at the base. This may appear to be an accident of geometry – given the wedge shape and symmetry – but it yields fruit by reinforcing other aspects of the Collegium and its nodes. For example the current node scheme weighs the cyberspaces toward the head of the triangle and more physical structures toward its base – or feet. The anthropomorphism also reflects back to the Collegium disk which now connotes a communal embrace as well as a cellular organism. Although, pushed to an extreme, this interpretation risks a bland, uniform utopianism, we should recall that the nodes are physically in vastly different parts of the world. They would inevitably bear the stamp of their own cultural identity within the project. In any event the anthropomorphic emblem is also a sign of deeper commonality, despite the nodes' overt cultural differences.

It is also an easy sign to remember, one that has resonance in many cultures. Architecture and archaeology offer many examples of structures that echo the human form. Vincent Scully and other architectural historians have remarked upon the use of the human image in the construction of religious structures. (Scully 1962) Ernst Cassirer writes on use of bodily reference in creating a world-view: "It is a natural trait of human thought to view and order the objective world by taking one's own body as a starting point of reference." (Cassirer 1922) The design of the Collegium node acknowledges that the human body and its limbs are a tried-and-tested reference system. The body is in Cassirer's view,"the model on which the whole of the world is constructed." Shown below in figures 9.19 through 9.22 are examples of anthropomorphic imagery used in architecture. The imagery in the Collegium scheme not only is sustained by the body of individual observers, but resonates with the historical use of anthropomorphism in ritual and sacred architecture which often conflate the material and spiritual worlds. As the scheme evolves we will see the anthropomorphism developed to situate elements within the scheme. The Collegium's symmetry, its corroboration of media, and the anthropomorphic metaphor frame for the user the Collegium's memory structure – its comprehensive space.

Video camera	Direct imaging
Ambient sensors	Thermal, microwave, infrared, pressure sensors
Desktop controller	Mouse, joystick, keyboard, palette or other devices
Virtual Reality	Head-mounted display, CAVE environments
Body tracking	Rotary or directional motion sensors

Output:	
Direct sensory	Unmediated, direct sensory experience
Speakers	Ambient or worn sound display
Projection	Data projection on surfaces – video, laser, other
Virtual Reality	Immersive VR, HMD, CAVE environments
Mixed Reality	Augmented reality overlap with physical space
Screen	Fixed, self-contained, electronic diplays.
Haptic	Kinesthetic, force feedback, thermal displays

We should note here that some of these modes overlap. For instance tracking video cameras may assist in body tracking and screens may be used in mixed reality displays. Since the lists show various options that corroborate one another, it should come as no surprise that the modes themselves should share common purposes as well. The categories shown above are represented in the small charts that attend each of the following cybrid descriptions. The values given in each chart cell indicate on a scale of 0 to 3 the degree to which the mode applies to the cybrid with 3 meaning strongest application.

Roles of Spaces

Cybrids employ both physical and cyberspaces in their composition. The service that each spatial type offers differs according to the purpose of the cybrid. For example the cyberspace of a theater would have different functions than that of a dwelling or office. Some important services offered by physical and cyberspaces are categorized in the following list.

Data Model	Spatial representation used for orientation and construction.
Building Support	Physical or digital support of building systems/operation.
Information Display	Multimodal display of information, art, objects.
Social Interaction	Multimodal display of remote participants or agents.
Transaction Support	Support for financial transaction and exchange.
Program Support	Support specific to the cybrid equivalent (café, office, etc.)
Aesthetic/Cultural	Enhancement of user's experience through cultural reference, ritual or aesthetics.

These categories are represented in the small charts following the empirical modes (Input, Output) charts at the end of the verbal description of the cybrid in question. The values given in each chart cell indicate on a scale of 0 to 3 the degree to which the role applies to the cybrid.

The control and safety of such laser projection is enhanced by the introduction of crystals into the surfaces of the scrims. Infrared laser light causes these crystals to glow without presenting danger if an observer should get in the way. Infrared lasers are fairly commonplace, being used in remote-control devices for television and other appliances. An added benefit of using infra-red is that images that penetrate the screen disappear. Only surfaces treated with the crystals, such as the scrims, reflect the projections.

The cloud is also a scrim, although one that is more opaque than those in the observatory. It holds the weight of observers/participants and is accessed from the supporting bridge structures, or *wings*, to the east and west. The cloud receives images projected from below using color laser projection. The relative opacity of the cloud scrim protects viewers' eyes from the laser light. Images projected onto its surface may be conventional images, or they may be markers for use in creating a mixed reality using Billinghurst and Kato's ARToolkit or similar systems. (Billinghurst and Kato 1999) Projections onto the northern portion of the scrim can also be reflected in the observatory's glass to present images of remote participants in the hall beyond. This allows outside observers to participate in an unencumbered mixed reality. They would otherwise be limited to the scrim and worn displays when out of doors. (Azuma 1999) (Neumann et al 1999)

Input Modes

	Physical	Microphone	Video	Ambient	Desktop	VR	Body
Cyberspace	0	3	3	2	3	2	2
Phys. Space	3	3	3	3	1	3	3

Output Modes

	Sensory	Speakers	Projection	VR	MR	Screen	Haptic
Cyberspace	0	3	2	2	3	3	2
Phys. Space	3	3	3	3	3	1	2

Roles of Space

	Data Model	Building Support	Information Display	Social Interaction	Transaction Support	Program Support	Aesthetic/ Cultural
Cyberspace	3	2	3	3	0	3	3
Phys. Space	0	2	3	3	0	3	3

Table 9.7 The Observatory, modes and roles of space.

Mutability and Flexibility of Cyberspaces

The Collegium node is a cybrid whose physical domain is situated locally while its cyberspace is shared with other nodes in the Collegium's disk configuration. At a smaller scale, every component of the node is also a cybrid. Each of these sub-cybrids – Entry Pavilion, Gallery, Auditorium, Café, Dormitory, Library, and Observatory – has a cyberspace attendant to its physical structure that serves the program of the Collegium.

In the previous descriptions of these sub-cybrids we described their cyberspaces to serve as 1) a data model of the physical structure, 2) support for building systems operation, 3) information display, 4) a context for telematic social interaction, 5) support for exchange, 6) service to the cybrid's programmatic function, 7) and as a means for enhancing user experience.

Cyberspace joins the programmatic components of the scheme at various scales. At the largest scale the cyberspace attending a node is the entire cyberspace of the Collegium. At a smaller scale the various cyberspaces of the node's sub-cybrids merge, abut, and overlap one another. Although the contents of each of these smaller cyberspaces may be programmatically distinct, it would be possible for them to share information. In this way, an avatar leaving the auditorium for the café will successively appear in the appropriate cyberspaces. The cyberspaces may also merge with one another to form new cybrid groupings. (Anderson and McGrath 1998) For instance the library cyberspace may join with that of other Collegium nodes to create a larger library space. More radically, it is also possible for the sub-cybrids to join into new configurations by heterogeneously sharing their cyberspaces. A dormitory cyberspace, for example, could join with that of a present or remote auditorium or library. This could conceivably overcome the inconveniences of physical location – like the spatial equivalent of a telephone call.

Navigation by Metaphor

Each example of cyberspace reconfiguration described above is a form of navigation. In the last case the dormitory has effectively been *moved* to adjoin the auditorium or library. This movement may be gradual and spatial, like motion in the physical world, or instantaneous, like changing the channel on a television set. The choice of navigation style would be determined according to user need. However, the design of the cybrid should consider the metaphors used in this non-physical motion, and their coherence within the scheme. Below are some scenarios that employ navigational metaphors, each at a different scale. Although these scenes are impressionistic, they convey the expected behavior of the cybrid system.

Scenario 1: Large Scale Navigation
The European and South American Collegium nodes are holding a concurrent arts/technology festival. During the starting ceremonies the directors of each respective event meet at the round table in the Data Garden near the library. The backrest of the bench surrounding the table displays a live image of the remote director team. Under the glass of the table surface is an image of the local node with a hologram of the rest of the Collegium. By grasping the edge of the table the directors rotate the node image to align with the hologram of the remote node. This overlaps the remote cyberspace onto the present node, resulting in a montage of remote and present nodes. Those present in Asia see the activity in South America and vice versa. Telematic visitors from other places see a hybrid cyberspace merging the two. (Yang et al 1999) (Majumder et al 1999)

hold an icon that represents a Collegium node or building. Instead of seeing the icon, they see on their screen (or HMD) a 3D image of the structure and its cyberspace. By rotating it they may see the avatars of others occupying the structure. The observer would likewise be present as an avatar to those in the viewed building.

Chapter 10: Critique of the Case Study

The following critique of the Planetary Collegium project is based on the seven principles for cybrid design outlined earlier. We will describe the projected performance of the design as it applies to these principles in order to show the strengths and weaknesses of the cybrid design process and products. Before proceeding we should note some limitations in the project as it stands. First, the project is still at a schematic design stage and, as a result, cannot conclusively demonstrate the interaction between physical and cyberspaces. It can only demonstrate the application of principles and intentions of the designer. At a higher degree of realization we would be able to see the technology that makes possible the corroboration and integration of modes. Secondly, the design program differs slightly from that of the final design. This is due to discoveries made during the design process and ensuing dialog with the client. Notable among these changes are locations of several cyberspaces (archive and Web sites in particular), the association of specific cyberspaces with built counterparts, aspects of the Observatory, and the on-site residence of the concierge. Such changes in final programs are common in conventional practice and were expected in this case. However, a review of the project based on its principles sheds light both on the process and product of cybrid design.

1. Comprehensive Space: Cybrids exist in a comprehensive space that comprises the material, symbolic and cognitive attributes of spatial experience.

The comprehensive space of the project included all related spatial phenomena, whether material, simulated, or cognitive. Realizing that the project did not need to take entirely material form opened the design to non-physical solutions and spaces. As a result cyberspaces and material spaces proved to be coextensive in the final design and integrated within its configuration. Although we cannot demonstrate the degree to which the Collegium exists in a mental, cognitive space, we note that the composition and technology of the Collegium node would likely yield an experience greater than the mere sum of effects. This synergistic result resides within the mind of the observer.

The project's comprehensive space manifested at a variety of scales extending from the global Collegium disk and the anthropomorphic node, down to the outlines of cyberspaces adjoining buildings in the scheme (as seen between the Entry Pavilion and Gallery, and the garden surrounding the pool). The outlines disclose the cybrid nature of the buildings, the human form of the node organizes its parts while forming a constituent wedge of the larger disk of the institution. Geometry and metaphor unify the various components of the scheme, and help the observer reconstitute the material and symbolic identity of the project.

2. Composition: Cybrids are mixed-reality compositions that comprise material and simulated elements.

The Collegium is a composition of physical and cyberspaces at all of its scales: 1) The Collegium disk, although itself a simulation, depends on the material reality of its nodes for operation; 2) the cyberspaces and built spaces of the nodes are integrated within the scheme; 3) each construction within the node is itself a cybrid. The scheme's physical construction and cyberspaces relate to one another in a variety of ways. A congruency between physical entities and cyberspaces results from the buildings manifestation of the project database. This database also serves as the framework for building systems, maintenance and operation, and so would necessarily maintain congruency for its effectiveness. Physical and cyberspaces may overlap one another as seen in the case of the Entry Pavilion where the building is a mere sliver of its constituent cyberspaces. In another case the large window of the Auditorium/Gallery is the intersection between the building mass and external gallery cyberspaces. Nearby the Café is a buried cyberspace that metaphorically pushes aside the terrain to form caves and the valley of the data garden. Flanking the upper level of the Data Garden the Dormitory and Observatory buildings take their forms in part to support the attendant cyberspaces. The space of their illusions is made possible by their physical configuration.

In the present composition there are also spaces that are pure cyberspaces, such as the archival space, Web site, and balloon-like spaces within the node. This raises the question as to why the project's virtual spaces – which ideally are free of physical constraints – should have specified boundaries and placement within a physical scheme. We suggest that this reification and placement forms a recognizable schema or composition that the user can interact with and remember. With reference to the physical layout the observer can infer the virtual spaces even without the use of digital technology. Reciprocally, on-line visitors who see only the cyberspace can anticipate what the physical node would be like. The generating myth of the polar Collegium disk, its dissemination about the globe, and the generation of nodes conduce to meaningful spaces that render their contents coherent and memorable. Although the cyberspaces may conceivably take any shape or location for special events, the present design shows their default, stable configuration.

3. Corroboration: Cybrids offer a range of empirical modes that corroborate one another to a determined degree.

At the present stage of project development, the corroboration of modes cannot be determined. If *corroboration* means that all manifestations of the project conduce to a larger holistic effect – the cybrid identity of the Collegium – we would have to produce all the supporting systems, material and electronic, to validate their effect. As it stands we will have to suffice with the intentions of the program. These are disclosed in buildings that reveal the cyberspaces through projections and optical illusions. Examples include the Observatory and Auditorium/Gallery buildings whose glazing reflections corroborate digital projections of the attendant cyberspaces. These resulting effects would be coordinated with other media – sound, light, buildings – to reinforce the cybrid entity. Such coordination of media cannot be demonstrated in the present state of the project.

4. Reciprocity: There is a reciprocity between a cybrid's physical and cyberspaces such that actions in one domain may affect the other.

Interaction between physical and cyberspaces cannot be demonstrated since the project presently has no physical form. However we note from the program that interaction of these spaces varies according to programmatic need. In cases where the cyberspaces were the products of building documentation (CAD files) the spaces are closely coupled. If these same cyberspaces were used to control building systems the physical and cyberspaces would mirror each other perfectly – each would reciprocate the other. However, such strong coupling is not required in all cases.

The system that presents virtual events in the buildings also monitors changes in the physical environment. These include activities of its occupants, building systems, external environment and weather.[1] Monitoring and transmission to cyberspace depends on the space's program and needs of its users – and the representation of sensor data would be suited to its programmatic use. For instance telecommunications between individuals would likely be high-bandwidth in order to support rich interaction. Conversely, building systems may take a fairly abstract form according to the needs of the building engineers.

5. Extension: Cybrids provide users with a coherent spatial environment that extends their awareness beyond the concrete to a dimensionally rich mediated space.

In the present design for the Collegium user's awareness extends beyond the physical surroundings to the Collegium's cyberspaces and remote nodes. Such extension is the composite effect of intermodal corroboration and the spatial composition of the node. Various techniques effect the user's extension to other occupants, objects and spaces within the Collegium. For example the sensors, projectors and speakers of each node are capable of manifesting the user's image in other nodes using live, networked connections to aid interaction between the user and the occupants of the remote nodes. Reciprocally, the remote participants extend into to the local cyberspace of the user.

The same technologies used for this social activity apply to projecting or observing objects. The primary difference is that the objects so experienced may not be physical at all, existing instead only as images in the node's cyberspace. Interaction with such virtual objects may simply result in changing the cyberspace contents – for example moving a virtual artwork from one place to another. However, virtual objects may also be control mechanisms for actual, physical devices. A virtual control panel for building maintenance or security would thereby extend the user to whatever device is being controlled. The status of the device could be displayed on the virtual panel so that changes in the physical device would register on the display. This would close an interactive loop between the extended user and remote devices, other objects, or spaces.

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[1] Appendix 2 shows a successful proposal for a cybrid installation on the campus of the University of Plymouth. It presents a computer supported network of building atria which display, through sound and image, data taken in through the buildings' mechanical, electrical, and digital systems. The author consulted on this project, which became operational in the summer of 2003.

One of the costs of such extension is privacy. We anticipate that the necessary monitoring and transmission that attend cybrid operation would seem intrusive to occupants and other users of the Collegium. For this reason further development of the project requires protocols allowing occupants to choose their level of participation with the Collegium media. One such possibility is that only those using mobile HMD's would be monitored. All other people would be invisible unless so equipped. This technology would require development but seems within reach given the current state of Global Positioning Systems and motion sensing technologies.

6. Social Context: Cybrids provide an extended social space.

The design prioritizes the social interaction between Collegium occupants and users. It does so through the creation of a spatial context for a variety of group activities. These activities range from the most private to the most public in both material and cyberspace settings. At the most private end of the spectrum we find the virtually extended living rooms and bedrooms of the dormitories. At the most public end are the Data Garden, Café, pool, as well as the Observatory and tensile cloud above. Each space – whether wholly physical or not – bears with it a mode of activity and social expectation of its inhabitants.

While the focus of this study has been upon cybrid spaces and structures, the scheme also shows cybrids that take the form of furniture. Examples include the conference table in the Data Garden, the pod-shaped enclosures in the café and outdoor terrace, as well as the benches outside the living rooms of the dormitories. Each of these are surfaces for the projection of digital images of remote participants which mingle with the actual participants in the node. They are sites for intimate interaction within the larger scheme, and would require further development in later stages of the project.

7. Anthropic Design: Cybrids shall be designed to augment their users' innate use of space to think, communicate, and experience their world.

Despite its abstracted, digital qualities the design of the Collegium node is grounded by its materiality, metaphors and configuration. The node's cyberspaces generate and conform to its physical manifestation. The cyberspaces associated with the cybrids frame zones of possibility and freedom within the node's configuration. Within each of these attendant cyberspaces it is possible to exploit the most radical spatial experiences that cyberspace has to offer. The framing of these experiences anchors them, giving them a coherent place within the scheme.

Anthropic space serves and augments our ability to spatialize information, using space to think, communicate, and navigate our world. The cyberspace of the design scheme has many features that derive from our experience of the physical world: a clear spatial configuration, overhead light sources, an orientation that distinguishes right from left, up from down, a provisional horizon. The user's experience of the node's cyberspace echoes his experience of its physical environment. The unit of reference and orientation in both spaces is the user's body. This conservative approach to cyberspace is deliberate and contrasts with the belief that cyberspace is free of physical, mundane constraints. The anthropic principle requires that our expectations be anticipated and utilized to the user's advantage. Without reasons to subvert these expectations anthropic spaces will conform to them so as to highlight the unusual features they may contain. The spaces and their contents relate to one another as do the picture frame and the painting it contains. The containers of local cyberspaces obey rules of conventional reality (duration, stability, orientation, extension), so that their contents may be appreciated and meaningful.

This critique of the Collegium design is limited to the current state of the project's development. As it stands the project is only a database representation and we can only point to features or programmatic elements that relate to the principles. An important limitation of the project and its process was the absence of a design team comprising engineers and programmers whose feedback and contribution would better resolve the technical design issues. Indeed the principles of corroboration, reciprocity, and extension apply as much to technological resolution as they do to design intentions of the architect. Our next chapter will illustrate the process of cybrid development within a professional setting.

Chapter 11. Possible Effects on Architectural Practice

We have seen in the Collegium project how the architectural product can change when cyberspaces and virtual reality are incorporated into their design. The programming and design of the Planetary Collegium posed alternative means by which simulation could play a vital role in the final project. In describing the project development, however, we did not discuss how a design team would handle the process with the client or with consulting parties. Because of the hypothetical nature of this dissertation it was not possible to present details of this process. However is worth describing here anticipated stages of design and production that cybrids will require, and their possible impact on specific building types. To help us articulate these matters let us recall the Library Paradox from earlier. This time, however, our scenario involves the implementation of the cybrid strategy.[1]

Imagine that a client approaches an architect to plan a new facility. Assume it is the client's place of business, a business having informational as well as physical needs. It could be an office building, a school, a library, a factory – any number of building types.[2] Table 11.1 is a provisional guide to the projected effectiveness of the cybrid strategy. It breaks down the phases according to different building types and uses, and should be consulted while reading the scenario description below. Our scenario also includes notes describing technologies and products potentially involved at each stage of the project. We refer to these technologies only to indicate their present availability and the possibilities for their use. A more critical assessment of technologies would, of course, have to be made at the inception of an actual project.

DESIGN PHASE

1. Team Site

After initial meetings and correspondence, the architect contacts his consultants and engineers. Some may be local but others are in remote places and time zones. The team agrees to meet in a shared space for progress updates. The architect creates a site on the World Wide Web that allows many modes of interaction. Text, graphics, spreadsheets, 3D computer models, databases, materials libraries, sound files, animation are all supported by this multimedia site. Most importantly, the site is a 3D simulated world that lets the team meet continuously either through use of avatars or by live video feeds from their workplaces.[3] Participants in different time zones may participate asynchronously by leaving messages, entering comments in a thread of published

[1] Portions of the following were presented in (Anders 1999b). See also (Schuman, Burtescu and Siering 1998) and (Tuzman 2000).

[2] Or, indeed, non-architectural projects. See (Palmer and Reeve 1998).

[3] Technologies: Groupware, file transfer protocol (ftp), telnet, email, 3D multi-user domain software (Chaco Systems World Gen software), HTML, virtual reality modeling language, modeling software, word processing software, spreadsheet software, animation software, video streaming software, high-speed computer network with Internet connections, video projection, data and telephone connections. See also (LeGal, Martin, Durand 1999), (Peri 2000) and (Shakarchi 2000).

Table 11.1 Cybrid Effects on Development Process & Applicability to Building Uses

Key:

1 Negligible benefit to process/product	a Owing to programmatic complexity	d Depending on size
2 Possible benefit to process/product	b Owing to technical complexity	e Depending on occ.
3 Likely benefit to process/product	c Owing to scale	• Applicable

Activity Building Precedents	Service Office Buildings Administration	Manufacturing Factories Utilities	Cultural Libraries, Museums	Commercial Merchandising, Stores	Hospitality Hotels, Resorts	Health Hospitals, Clinics	Learning/Research Schools, laboratories	Residential Apartments, Condo. Community Infrastr.
Design Phase								
1. Team Site (MUD)	3 a c d	b	2 d	2 d	3 a c	3 a b c	3 a b c	2 d
2. VR Site Model	3 a c e	3 b e	3 e	2 e	3 a c	3 a b c	3 a b	2 d
3. Heuristic Gaming	2 d	3 b	2 e	1 d e	2 a c e	3 a b c	2 a e	1 d e
4. Algorithmic Design	2 c e	3 b d e	1 e	1 e	2 a c	3 a b c e	2 a c e	2 a c
5. Programmatic Assessment (phys. vs. cyber.)	3 e	2 e	3 d e	2 e	3 d e	3 a b c	3 a d e	1
Domain Data Display								
Text	•	•	•	•	•	•	•	•
Graphics	•	•	•	•	•	•	•	•
Images	•		•	• e	•	•	•	
CAD Model	• e	• e	• e		• e	• b	•	
Animation	• e		• e	• e	•		•	
Virtual Reality	• e	• e	• e	• e	• e	•	•	• e
6. Project Promotion	2 e	3 e	3	3 e	3	3	3	2 e
Design Phase Subtotals	15	14	14	11	16	18	16	10
Ranking re: effect on phase	3	4	4	5	2	1	2	6
Construction								
7. Bidding Process								
Physical Plant	3	2	3	2 e	3 e	3 d e	3	3
Cyberspace	3	2	3 e	2 d e	2	3 d e	3	1 e
8. Const. Team Meetings								
Physical Plant	3	3	3	3	3	3	3	3
Cyberspace	3	2 e	3	2 e	3	3 b c	3	1
9. Model Update/ As Built	3	3	3	3	3	3	3	3
10. Owner Use of Cybersp.	3	1	3 e	2 e	3 e	2 e	3	1
11. Monitor Deployment	3 c e	3 b	3 d e	3 d	3 e	3	3 e	2 d e
Construction Phase Subtotals	21	16	21	17	20	20	21	14
Ranking re: effect on phase	1	4	1	3	2	2	1	5

Activity Building Precedents	Service Office Buildings Administration	Manufacturing Factories Utilities	Cultural Libraries, Museums	Commercial Merchandising, Stores	Hospitality Hotels, Resorts	Health Hospitals, Clinics	Learning/Research Schools, laboratories	Residential Apartments, Condo. Community Infrastr.
Occupancy and Usage								
12. Team MUD transfer to Occupant for:	3	2	3 e	3 e	3	3	3	3 e
Maintenance	•	•	•	• d	•	•	•	•
Operation	•	•	•	• d	•	•	•	• e
Telecommuting	• e		• e		•	• e	•	•
Storefront	•		•	•	•			• e
Production	• e		• e	• e			•	
Service support	• e	•	•	•	•	•	•	•
Promotion	•	• e	•	•	•		•	• e
Database	•	•	•	• e	•	•	•	• d
Administration	•	•	• e	• e	•	•	•	•
13. Building Documentation	3	3	3	2	3	3	3	2
14. Modifications/Additions	3	3	3	3	3	3	3	3
Occupancy Phase Subtotal	9	8	9	8	9	9	9	8
Ranking re: effect on phase	1	2	1	2	1	1	1	2
Post-Occupancy								
15. Sale/Lease Document.	3	3	2	2	3	3	3	3
16. Demolition Plans	3	3	2	3	2	3	2 e	2
17. Reclamation	2 d	3	2	1	2	3	3 d e	2 e
18. Reuse of Domain	3 e	1	3 d e	2 e	3 e	2	3 e	1 e
19. Archival Usage	3	3	3	2	3	3	3	2
Post-Occupancy Subtotals	14	13	12	10	13	14	14	10
Ranking re: effect on phase	1	2	3	4	2	1	1	4
Totals (21 min. and 63 max. possible)	59	51	56	46	58	61	60	42
Ranking re: effect on project	3	6	5	7	4	1	2	8

dialog, or video clips much in the way that email and Usenet newsgroups operate.[4] (Carrara, Fioraventi and Novembri 2000)

2. Virtual Reality Site Model

The site is an information space, rendered three-dimensionally by the architect. By modeling data taken from a satellite, he simulates the terrain of the physical site within the cyberspace. All pertinent information is included in this recreation: vegetation, power lines, water and sewer utilities, power, gas and media connections. Nearby buildings and streets are also part of this space. The architect may include sun angles, wind directions, celestial alignments, symbolic features – any number of elements that might influence the design.[5] Significantly, he creates a platform on this model that symbolizes the meeting space within the project's 3D domain. When consultants, architect and client gather, they do so in the presence of the site's simulation in cyberspace. During the design process the team collaborates there, referring to graphics, text and other displays as they develop the scheme.[6] (Ohya, Miyasato and Nakatsu 1999) They may use a number of design strategies, some of which might be computer assisted. Items 3 and 4 below are among them.

3. Heuristic Gaming

One such strategy involves a form of game that encourages imagination and cooperation on the part of the team members. (Brown and Berridge 2001) (Hirschberg, Gramazio, Höger, Liaropoulos, Legendre, Milano, Stöger 2000) In a series of quick agent-assisted exercises the team produces a number of optional solutions that are manifested in alternate incarnations of the site. (McCall and Johnson 1996) (Knapp and McCall 1996) The computer evaluates each schematic solution for fitness according to predetermined constraints such as cost, energy consumption, air flow, daylighting, or acoustics. (Mahalingam 1997)

4. Algorithmic and Genetic Design

Another approach uses computer agents assigned to building components that interact with one another, fighting for resources – fresh air, daylight, heat – until they reach a stable, optimal state. (Pohl, J. 1996) (Pohl, K. 1996) Yet another tool at the designers' disposal are genetic algorithms that let them breed a variety of solutions, optimizing different parameters whether functional or aesthetic. (Krause 1997) In assisting the team, the computer does not have the final word, it only provides options or makes suggestions through its agents. Ultimately, the team and client together determine which solutions to pursue.

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[4] Technologies: Usenet newsgroups, HTML.

[5] Technologies: CAD software and modeller, Virtual Reality Modeling Language (VRML), access and software to use satellite-supported global data system.

[6] Technologies: CAD modeler, VRML, CUSee-me video conferencing software, video-streaming support. 3D domain software such as Blaxxun.

5. Programmatic Assessment

In the course of design the architect and client determine which business functions need to be rendered physically and which might take form in cyberspace. (Anders 1997) These might, for example, manifest the business' intranet and virtual private networks, facilitating intra-office communication and alliances with remote companies and agencies.[7] Some physical functions may be partially replaced by cyberspaces, particularly information storage like files and libraries.[8]

As we saw in the Collegium project, some of these functions may be portrayed in cyberspace as ambient environments – others simply as graphic displays or placeholders for future use (see Table 11.1 Domain Data Display). Others are contiguous with, even overlapping, the cyberspace model of the proposed building. Some hover beyond the site's simulation while others are nested within one another, available by entering them or summoning them categorically into view.[9]

6. Project Promotion

The cyberspace of the design team is also a tool for the client. He may check in to see progress, attend meetings. With some preparation the cyberspace can be used for fund-raising activities, promoting the project with the interactive model and multi-user interface. Gatherings at different scales may be arranged live *on-site* or the event may continue throughout the preconstruction phase of the project under the auspices of an automated promotional agent that handles questions or relays messages.[10] All the while, the design team works without interruption since the promotional activity is invisible to them.

CONSTRUCTION AND DEPLOYMENT

7. Bidding Process

Once the design is set and the physical portions of the cybrid are established, the team conducts a directed, automated search for the specialties involved in the construction.[11] Contractors and subcontractors visit the physical and cybereal sites to meet with the architect and client. Contractors propose alternates to the design change the cyberspace

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[7] Technologies: Electronic Data Interchange - Value Added Networks (EDI-VAN), Virtual Private Networks (VPN), groupware, intranet software.

[8] Technologies: Database software actively linked to HTML files available through network.

[9] Technologies: VRML, HTML. This posits the linking capability of HTML be employed in creating interactive VRML models, a capability still in development.

[10] Technologies: Internet telephone software and support, streaming video, 3D MUD software, CUSeeMe teleconferencing software and support.

[11] Technologies: Agent-driven Internet search engines, ftp.

model to show the projected results. The computer support evaluates these proposals for fitness just as it did with the design team's work.

At the same time, contractors for the client's information technology systems offer proposals that refine the cyberspace component of the cybrid. Electronic Data Interchange, intra-extranets, virtual private networks and Internet commerce softwares are formatted within the spatial, symbolic domain of the cybrid. Cyberspaces for managing corporate databases attend the proprietary areas of the cyberspace and actual building. Multimedia spaces overlay physical meeting spaces and conference rooms.

8. Construction Team Meetings

Once all parties are in agreement, development of the cyberspaces extends the original work of the architect while the construction of the physical building begins. Meetings still happen in the cyberspace's domain, but they at times overlap discussions held on site within the contractor's temporary shed. The two parallel spaces connect with sound and image, each informing the other during the meeting. [12]

9. Model Update and As-Built Documentation

As the physical construction continues, the architect, contractor and consultants update the cyberspace model of the building. This keeps it up to date and ultimately provides an accurate account of what was finally built.[13] This extends the European practice of post-construction quantity surveying.

10. Owner Use of Domain

The client, in the meantime, has already begun to use the cybrid. The non-physical parts of the project are in place far in advance of the physical construction. Remote prospective employees are interviewed on-line. Databases are tailored for their final uses, plans for fixtures and furnishings are mapped into the cybrid's electronic model. Since the technical support – server and network – for the cyberspace may theoretically be anywhere, some businesses can already be conducted through the network months before the physical plant is completed.[14]

11. Sensor and Activator Deployment

Monitoring devices, sensors and activators (servo-mechanisms) are installed as the building proceeds. As sections are completed, the devices go on-line to their cyberspace equivalents. Feeding the cyberspace with updated information, they make it a valuable tool for the management of the physical environment. (Newman 1994) Communications, building systems maintenance and operation, fire prevention and security all benefit from the mutual support of the cybrid's components. Computer agents determine which portions of the building require cooling and control the dampers

[12] Technologies: VRML, 3D domain software, video conference software, data projection system.

[13] Technologies: CAD modeling software, VRML.

[14] Technologies: video conference software, EDI-VAN, Internet commerce software, HTML.

in the ventilation system.[15] Selective camera/display connections between the physical and cyberspaces lets remote visitors converse with the occupants of the building. A contractor sent to modify a portion of the electrical system sees through the ceiling using a head-mounted augmented reality display that merges electronic and material spaces. (Feiner, Webster, Krueger, MacIntyre, Keller 1995)

OCCUPATION AND USE

12. Transfer of Domain Use to Tenant

Upon completion of the project the cyberspace of the cybrid – no longer used by the design team – expands into a larger 3D digital world. This domain may have different uses and levels of privacy depending on the client's business.[16] It can serve as an intermediary workplace for telecommuting employees and sales contractors. Or it might become a public Internet storefront for the business. It may even become a place of production, capitalizing on its computer/media affordances. Design work done there – as before – may be experienced or sent to devices that render it physical.[17] Conceivably, any business that creates or processes information would benefit directly.

The cyberspace portion of the cybrid is present to the rest of the world. It is ubiquitous while the building is local. Because of this, the cybrid is a tool for the promotion and activity of the business – the way Web sites are currently used for advertising. It contains not only the configuration of the physical building, but also the non-physical components of the business – literature, advertising, communications. These, as with the database, manifest themselves in different ways – at times regenerating themselves uniquely for each visitor.

13. Building Documentation

The domain and its cyberspaces are constantly updated during their use, providing the owner with a complete record of activities that affect the cybrid. This domain is used to interface with the building systems in real time and to program future activity. This on-going documentation is currently being addressed by several architectural software companies under the term *Building Information Model.* (Laiserin 2003)

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[15] Recent research at XeroxPARC proposes the use of forensic agents in mechanical systems that "bid" for service to parts of a building. The higher bidding agents will receive power, heat, cooling according to need. This market model for building operation can reduce energy costs by up to twenty percent.

[16] Technologies: EDI-VAN, Internet fire-wall security, graphic object-oriented programming software such as Microsoft's Visio.

[17] Technologies: CAD modeler, stereolithography, rapid prototyping, computer-driven laser software and support, ftp.

14. Modifications and Additions

In ensuing years, the physical plant undergoes change. Plans derived from the cyberspace assist in the plans for additions and modifications.[18] With each change the cyberspace is updated – always preceding the physical construction. The cyberspace undergoes change as well, since users may influence its configuration or the functions of its information structure change. Only some of these are reflected in the physical structure, most being distinct and untethered. The cybrid's database may constantly evolve, changing from moment to moment according to the user's needs.[19]

PROJECT TERMINATION

15. Sales and Leasing Documentation

Finally, the building is no longer required by the original owner whose business has relocated or requires a new building altogether. The cyberspace component of the cybrid can be the source of data for sale of the structure to a new owner.

16, 17. Demolition and Reclamation

Conversely, the database can provide demolition plans for the building's removal. Further, with its database model of as-built conditions, it can provide information for the reclamation of materials for recycling.[20] In the end, all that remains of the cybrid is the ghost, the cyberspace that attended the construction, life, and death of the building.

18, 19. Reuse of Domain and Archiving

Yet it is a lively ghost. So long as a networked computer maintains the database and multi-user domain, the cyberspace remains active. In this form, it may still be the client's business space, regardless of where the company has moved. It might be an historic archive of the building it once supported, or it might even take on a life independent of the physical operation. For instance, a long-defunct nightclub could still host parties long after its physical demise. Just as buildings take on new owners, so too might cyberspaces take on new users.

Cybrid Typology vs. Utility

We have here speculated on a technologically-augmented architectural practice. However, cybrids challenge many conventions of practice. Although Table 11.1 was based on current building types, one could ask whether such typology would pertain to cybrids. Traditional

[18] Modifications to the facility will incorporate many of the cited technologies as though the changes were new work.

[19] Technology: Database software and support, HTML

[20] Technology: CAD, Database software, HTML

12. Conclusions

The claim of this thesis – that one could reconcile physical and cyberspaces within architecture – has here found evidence in the history of architectural computation, a survey of recent technological developments, and a demonstration involving the design of a mixed-reality project. Although this would appear to suffice in theory, the support for cybrids may ultimately be insufficient for the practice of architecture. The history of VR, and virtual architecture in particular, shows that whatever the merits of a proposal, its success in practice depends on its recognition among clients who will fund and benefit from such projects. Without familiarity with the product, promotion of its benefits, an established technology for fabrication, and a history of successful projects, clients may be as reluctant to employ cybrids as they were virtual architecture. Or they may accept cybrids not as architecture at all, but as a new mode of communication – one in which the home or office becomes an appliance for telepresence. The future, while unavoidable, is elusive; we can here only offer a procedural model for cybrids. The business and economic issues at stake in their development remain for further study.

Looking Forward

We can temper this forecast by observing the increasing familiarity with networked communications, digital games, and on-line environments among the young. Simulation and its realized imaginary spaces pervade television, cinema, gaming parlors, and other forms of recreation. (Eshaq, Rafi and Karboulonis 2000) The merging of material and simulated environments, the premise of cybrids, is already happening in our time. Anticipating the coming decade we can see the students of today employing simulation in their homes and places of work. What they and their children will take for granted will amaze us.

Although we have focused on architecture throughout this dissertation, the principles of cybrids may find other uses. Conceivably, any design discipline that uses inscriptions to guide fabrication could employ a cybrid strategy. For, as their processes become more computerized, the databases and their manifestations may be more intimately and permanently connected. This could apply to devices, appliances, instruments, art objects, or environments other than architecture. If such artifacts are worn, affixed or implanted, their cyberspaces or comprehensive spaces could effectively cybridize their users, letting them take their information spaces with them.

Perhaps the most challenging and, for me, the most exciting aspect of the cybrid proposal is its dependence on the observer's imagination. We noted this in our description of a *comprehensive space* or – in the eyes of designers – a *project space* that integrated cognitive, simulated and physical spaces within the experience of the user. We also recognized stage illusion as a precedent for merged realities, and observed the design of structures that employed similar techniques. Whether the ultimate solutions for cybrids will depend on Victorian techniques is not an issue. Scrims and mirrors may be replaced with holographic surfaces and novel projection, or some other yet-to-be-imagined technique.

Table H: Program Space Areas

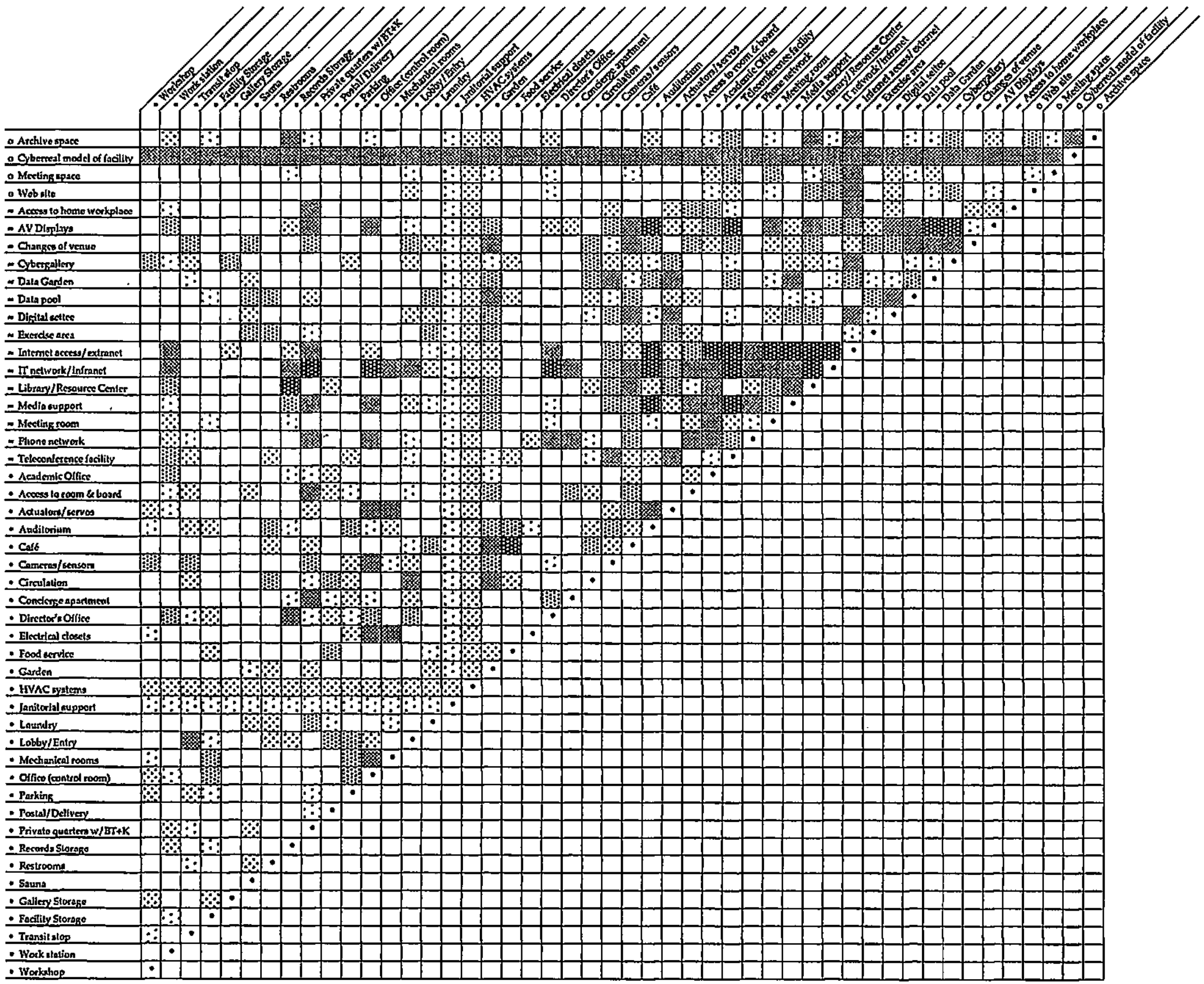
This table shows the various versions of all support/spaces described in Table IV.B. Shaded selections indicate support/spaces with the most demanding specifications. These will be the specs for the final design. Dark shading indicates refinements/additions to the specifications.

Resource & Ontology	Quantity	Population	Area/unit (sm)	Total area	Use Duration	Comments
Information Spaces						
o Archive space	1	NA	varies	varies	<1x/yr.	Variable size emulation - may be reconfigured by user/use.
o Archive space	1	for 21+ Board	varies	varies	FT	Variable size emulation - may be reconfigured by user/use.
o Archive space	1	for 21+	varies	varies	FT	Variable size emulation - may be reconfigured by user/use.
o Archive space	1	1	varies	varies	FT	Variable size emulation - may be reconfigured by user/use.
o Planning space	1	for 21+Board	varies	varies	FT	Variable size emulation - may be reconfigured by user/use.
o Cyberreal model of facility	1	varies	AN	AN	FT	Emulation of cybrid building and domain. Comprehensive project space.
o Meeting space	1	for 7	20	20	<1x/yr.	Emulate room of 20 s.m.
o Web site	1	varies	NA	NA	FT	Site may give access to Planetary Collegium hub emulation + extra/infranet.
Information Space Subtotal				20	varies	
Mixed Reality/Cybrid						
~ Access to home workplace	21+	varies	varies	varies	AN	Emulation varies according to size or use of home space.
~ Access to home workplace	21+	for 3	varies	varies	<1x/yr.	Emulation varies according to size or use of home space.
~ AV Displays	AN	for 3+	NA	NA	AN	Includes screens, speakers, HMDs, PDAs, cellular phones. Interface w/ cybrid.
~ Changes of venue	varies	for 21+	varies	varies	varies	Inclusive of all varied spaces used for congregation and dialog. Indoor and outdoor.
~ Cybergallery	1	varies	40	40	FT	Media art/regional art work on display, small gatherings.
~ Data Garden	1+	for 21+	120	120	FT	Interactive information display in tempered/natural environment.
~ Data pool	1	varies	60	60	AN	Provide changing area, proximate to rest rooms and café.
~ Digital settee	5	for 2-6	4 to 12	40	AN	Varies by population. Digitally augmented teleconferencing booths.
~ Exercise area	1	for 10	40	40	AN	Nautilus-style work-out environment augmented with dynamic displays.
~ Internet access/extranet	1	varies	AN	AN	AN	Provide computer room of 30 s.m. + necessary network closets.
~ Internet access/extranet	1	for 21+	AN	AN	AN	Provide computer room of 30 s.m. + necessary network closets.
~ Internet access/extranet	1	for 3	AN	AN	AN	Provide computer room of 30 s.m. + necessary network closets.
~ Internet access/extranet	1	for 3	AN	AN	AN	Provide computer room of 30 s.m. + necessary network closets.
~ Internet access/extranet	1	for 21+	AN	AN	AN	Provide computer room of 30 s.m. + necessary network closets.
~ IT network/Infranet	1	varies	30+	30	FT	Provide computer room of 30 s.m. + necessary network closets.
~ Library/Resource Center	1	for 21+	50	50	FT	Media, journals, book lending and sales - linked to shop.
~ Media support	1	for 21+	varies	varies	AN	Provide media support space to all teleconf. & meeting rooms
~ Meeting room	1	for 21+	50	50	<1x/yr.	May be part of or same as teleconferencing facility.
~ Meeting room	1	for 3	30	30	<1x/yr.	May be part of or same as teleconferencing facility.
~ Phone network	1	for 21+	15	15	FT	Provide 15 sm. Phone tech. Room. Proximate to computer room.
~ Teleconference facility	1	for 21+	50	50	<1x/yr.	Include area for media support.
~ Teleconference facility	1	for 21+	50	50	AN	Include area for media support.
~ Teleconference facility	1	for 3	6	6	AN	Include area for media support.
~ Teleconference facility	1	for 3	6	6	6x/yr.	Include area for media support.
Cybrid Subtotal				567	sm + varies	

Resource & Ontology	Quantity	Population	Area/unit (sm)	Total area	Use Duration	Comments
Physical Spaces						
• Academic Office	3	1	15	45	56x/yr.	Research advisor offices.
• Access to room & board	21	AN	varies	varies	<1x/yr.	Room and board may be on or off premises as needed.
• Access to room & board	21	1 to 3	20-60 sf	re: Priv. Quar	30x/yr	Varies according to occupant and duration of stay.
• Actuators/servos	AN	NA	NA	NA	AN	Embedded in building fabric, grounds, domains. May be accessed by researchers.
• Auditorium	1	for 200	400	400	AN	Provide media support, prox. to Breakout Area and café. Internet access.
• Auditorium	1	for 30	90	90	<3x/yr.	60 sm aud.+ 20 sm breakout space + 10 sm stage
• Café	1	for 21+	35	35	AN morning, noon	Informal dining. Provide small prep kitchen for catered service. Indoor/outdoor.
• Cameras/sensors	AN	NA	NA	NA	FT	Embedded in building fabric, grounds, domains. May be accessed by researchers.
• Circulation	AN	varies	~30% tot.	NA	FT	Corridors, hallways, walkways, waiting areas.
• Concierge apartment	1	1 to 4	100	100	FT	Full-time occupancy by Concierge/Director of Facilities.
• Director's Office	1	1	25	25	FT	Director + small conference area
• Electrical closets	AN	NA	10 ea.	AN	FT	Locate near mechanical room.
• Food service	1	for 21+	varies	varies	<1x/yr.	Food service may be on or off premises as needed, see Café
• Food service	1	for 21+	35	35	AN evening	Dining. Catered food service requires prep kitchen for dining. May be same as café.
• Garden	1	varies	AN	AN	FT	Including glades, copses, local vegetation for strolling and conversing.
• HVAC systems	1	NA	AN	AN	FT	Includes photovoltaics and natural systems.
• Janitorial support	AN	NA	15 ea.	AN	FT	Mop sink, storage.
• Laundry	1	varies	40	40	FT	Near café or other public amenities.
• Lobby/Entry	AN	varies	AN	AN	FT	Entry vestibules.
• Mechanical rooms	AN	NA	~10% tot.	~10% tot.	FT	Includes battery room for PVs.
• Office (control room)	1	NA	25	25	FT	Proximate to electrical, mechanical and leasing offices.
• Parking	80	NA	15	1200	FT	Photovoltaic array over parking area.
• Postal/Delivery	1	for 21+	15	15	FT	Mail boxes, proximate to facility offices.
• Private quarters w/BT+K	21+	1 to 3	20-60 sf	840	30x/yr	Varies according to occupant and duration of stay.
• Records Storage	1	NA	10	10	FT	File storage for operating leasing office. Secure storage.
• Restrooms	AN	NA	AN	AN	FT	Public restrooms proximate to public areas and circulation.
• Sauna	1	for 10	12	12	AN	Proximate to pool and changing rooms.
• Shop/Provisions	1	varies	25	25	AN	Small shop for supplies, sundries.
• Storage	1	NA	100	100	FT	Storage of equipment, materials. Proximate to Facility Admin.
• Storage	1	1	25	25	FT	Storage of artwork, materials. Proximate to gallery.
• Study Hall	1	21+	25	25	AN	Associated with the Library
• Transit stop	1	NA	AN	AN	FT	Bus shelter or subway stop.
• Work station	2	2	15	30	FT	Technician and Assistant to Director. Near to Facility Admin.
• Workshop	1	varies	40	40	FT	Custodial support, may be accessed by researchers
Physical Space Subtotal				3117	sm + varies	
Totals	Program Areas	(sum of subtotals)		3724	sm + varies	
	Circulation Factor	0.3		1117.2		
	Mechanical Factor	0.1		372.4		
	Total			5213.6	sm + varies	

Table I: Spatial Proximity

This table relates the program spaces in Table IV.H to one another. Their need for proximity is conveyed by the shading of the cells, with the darkest indicating the greatest need. The information from this table will be used in laying out the configuration of the Collegium hub. Note: Since the spaces in Table IV.H were not all physical, some pairings in this table – physical/emulated or physical/cybrid – produce a "second-order" cybrid. This shows the degree to which material and emulated entities are intertwined in the cybrid project.



Appendix 2

Documents cited in text

Table of Contents

THE PLANETARY COLLEGIUM

Part I
Overview

1. The Planetary Collegium is concerned with the development of advanced research in the trans-disciplinary space between the arts, technology, and the sciences. Consciousness research is an important component of its work. It sees its influence extending to new forms of creativity and learning at all levels and for all age groups in a variety of cultural settings.

2. It presents a dynamic alternative to the standard university form of doctoral and post doctoral research while producing, if not exceeding, outcomes of comparable rigour, innovation and depth. The Planetary Collegium is designed to produce new knowledge for the new millennium.

3. The Collegium is based on the successful experience of CAiiA-STAR in attracting doctoral and post-doctoral researchers of high calibre whose work transcends orthodox subject boundaries and whose practice is at the leading edge of their field. *CAiiA-STAR is fully described in the appendix to this paper.* Its strong, internationally recognised track record is the guarantee of realisable objectives and future achievement in planning the Planetary Collegium. The plan has been developed, tested and proven within the limits of the university framework and is now ready to move out into a world in which traditional forms and practices of higher education are becoming redundant.

4. <u>How was CAiiA-STAR originated?</u> Roy Ascott created the Center for Advanced Inquiry in the Interactive Arts in 1994 at the University of Wales College Newport, as a full professor of the University. In 1997 he was appointed to a further professorship at the University of Plymouth to extend CAiiA by creating a similar center in the university's School of Computing, to be known as the Science Technology and Art Research center (STAR). Led by Professor Ascott, CAiiA-STAR is an integrated platform for doctoral and postdoctoral research that draws on the intellectual and technological resources of both universities.

5. <u>What has CAiiA-STAR achieved?</u> It has drawn together into its advanced research community leading exponents of the interactive, digital, post-biological arts, who each represent, at the highest level, the principle generic strands in a new emerging field of transdisciplinary practice and theory. They are each highly regarded, the recipients of prizes and honours, frequently holding professorial positions in senior universities, academies and research centres.

6. <u>Why create a Planetary Collegium?</u> It is intended to be the projection of this successful university venture, CAiiA-STAR, into the post-institutional space of the 21st. century – a century in which the old academic orthodoxies have to be replaced by creative research organisms fitted to the telematic, post-biological society. It combines the necessary face-to-face transdisciplinary association of individuals with the nomadic, transcultural requirements of a networking community.

7. <u>How is the Collegium structured?</u> It is seen initially as being based in seven *nodes*, each strategically located across the planet. Each node will be based in a purpose-build residential seminar centre, whose architectural features creatively address the requirements and opportunities of an ecologically responsive, technologically informed environment. Each node will be embodied in architecture of unique distinction while contributing to a planetary research infrastructure of extreme sophistication and subtlety. The seven nodes will be networked within a regularly updated state-of-the-art communications environment.

8. <u>How is research accommodated?</u> Each node will be the base for eighteen research candidates, enabled by a group of three supervisors, making a research community of 126 researchers and 21 supervisors worldwide. Additionally, a worldwide online network of specialist mentors will emerge as individual and collective research trajectories develop. All research conducted within the Collegium will seek an integration of theory and practice, and a harmonisation of material and spiritual impulses in the technologically informed modes of inquiry. Each node would have a small onsite administrative/residential support team. The team would service composite sessions of its own specific group, while hosting composite sessions of groups from other nodes.

9. Supervisors will meet formally on a regular basis to share responsibility for the advancement of research within the Collegium as a whole. A Governing Board of the Collegium will be appointed to provide overall institutional and financial direction of the enterprise as a whole.

10. <u>How will research achievement be recognised?</u> At the successful completion of their research, and its acceptance by an international committee, candidates enrolled in the Collegium will be awarded a formal recognition commensurate with the PhD in traditional universities. The Collegium would guarantee the negotiable value of the award in this context.

11. <u>How will the Collegium evolve?</u> Initially we are creating the first layer of a three-layered structure. The first layer concerns the support and development of advanced practice and theory, which will constitute the generic strands of an emerging field of creativity. The next layer enables the preparation and research of those destined to act instrumentally, as advisors, consultants and planners, at high levels of governmental, regional and institutional organisation. The third level concerns learning and self-creation in a transdisciplinary post-biological context, within a matrix of concept, communication and construction.

12. <u>When did the idea of the Collegium originate?</u> It was first proposed in a paper given at the 5th International Symposium on Electronic Art in Helsinki, where it was described as being a fluid process, a self-expanding network, a set of emergent complex systems, rather than any kind of fixed institution or centralised establishment of bricks and mortar. It identifies the need for strategies to re-vivify art education (which seems to have entered a stalemate, a kind of cul-de-sac leading merely to training and technological dexterity), and to increase the connectivity between art and other fields of knowledge and practice. It places the problem within a holistic context, which embraces the rich diversity of cultural formations across the globe while focusing on the specific needs of our computer-based society.

13. <u>What questions does it ask?</u>
    - How might new technologies and the metaphors of science be employed in the education of the artist? And how might the insights of the artist contribute to the advancement of knowledge in science and to technological development?
    - How can the accrued wisdom of exotic or earlier cultures be allied to the search for meaning and values in a post-biological society?
    - How might the Net, in the fullness of its evolution, serve the needs of interactive, non-linear learning, and engender creative thought and constructive action?
    - How might new discourses be initiated which will bring critical, aesthetic and moral perspectives to bear on emergent fields of practice?

14. <u>What is meant by new *technologies*?</u> We mean not only electronic, telematic, and digital media - complex and challenging as they can be. We have in view also developments in biological research, artificial life, molecular engineering, neuro science, and nano technology. We include technologies that reframe our ideas of the mind and consciousness, no less than those that give us new visions of planetary society and life in outer space.

THE PLANETARY COLLEGIUM

Part II
Implementation of the nodes

As a transdisciplinary, multicultural organism seeking to work at the leading edge of artistic, technological, social and personal development, the Collegium will establish its nodes in areas marginalized by dominant cultural forces. For this reason invitations to invest in the establishment of a node are being made to regions considered to be at the interface of old and new structures of society, or geographically remote from the metropolis.

The Node as Cybrid

The Collegium will operate its nodes as mixed reality environments, here called a *cybrid*, which comprises both material and cyberspaces in the service of its institutional goals. Peter Anders who is the Associate Director - Planning for the Collegium has advanced the concept of the cybrid. With the advent of virtual reality many of the effects of buildings may be emulated. As technology has advanced so too has its realism and interactivity with the simulation. Emulating computer games, virtual reality walk-throughs provide satisfying alternatives to full-scale models and detailed renderings. So much so as to prompt the question: When do the simulation and the building itself compete – even become redundant? If, as we note, the architect sculpts the spatial/conscious experience of the occupant, the domain of architecture may reach beyond physical buildings to the technologies that mediate phenomena.

Virtual reality does not eliminate the need for building, but it can crucially alter the nature of what's built and why. Further, by integrating emulated and actual environments, a new hybrid experience can be formed in the minds of occupants. These new environments, here called cybrids, are practical and aesthetic implementations of augmented or mixed reality, a successor to virtual reality that situates illusions within a physical context.

The Planetary Collegium

Like its precursor CAiiA-STAR, the Collegium will couple face-to-face interdisciplinary dialog with the decentralized, nomadic affordances of an Internetworked community. However its operation will be quite different from its predecessor. Unlike CAiiA-STAR the Collegium will be free of a host university. To provide the localized infrastructure necessary to conduct business Ascott proposes the Collegium be a distributed presence, embodied in seven locations situated strategically around the globe. Each embodiment would be an infrastructural sub-center – or node – of the Collegium, replacing to varying degrees the amenities of a host institution.

Among the great challenges is how to design for a dispersed community while maintaining a holistic view of its operation. In designing for the Collegium, the authors have integrated a blend of buildings and spatial emulations as an architectural cybrid. The emulations employ telematic technologies to convey distal presence, embody information, and situate remote spaces co-locally in the present. The merging of "virtual" and "real" spaces is made possible both by technology (mixed reality, augmented reality, high-bandwidth computer networks, satellite links) and – more importantly – the consciousness and memory of its users.

The Collegium will integrate physical and cyberspaces into a technologically augmented mnemonic structure, an advance on the practices of situated memory and memory palaces. The project proposes a new learning environment that places the user in a coherent space, consistent throughout all modes of interaction. Screens, AV displays, Internet access, virtual reality headsets variously reinforce users' view of the cybrid, while conforming to the perceived structure of a global and local whole.

Planetary Collegium will be a centre of research within the international community of researchers, theoreticians and artists involved in emergent fields of practice. It will constitute an integrated platform for research in interactive media, robotics, artificial life, and the cognitive sciences, leading to Collegium awards commensurate with post-graduate and doctoral degrees. Research fellows and postgraduate students would be based both online and onsite, meeting several times a year in pursuit of their studies.

In practice the Collegium will extend beyond its constituent members to the public through periodic conferences, and presentation of its research in international and transdisciplinary venues. This outreach is

specific to its aims: to enrich human experience and extend public awareness of these new developments and their relevance to education, culture, industry and entertainment.

The Collegium and its nodes comprise a *comprehensive* environment, a unity of physical and cyberspaces integrated in the minds of its users. This cybrid aspect of the Collegium requires a close interaction between the participant and the environment as well as a tight coupling between material and emulated/simulated components. This integration will support the telematic interaction of the Collegium's researchers, its online community, and public performances.

The tight coupling of physical and cyberspaces is the charge of an integrated, responsive environment. At its largest scale this environment would detect user intention and respond appropriately across its global entirety. User intent would be detected by a variety of overlapping sensors (video, sound, free-body motion capture, ultrasound). Environmental responses would be conveyed mechanically, through projection and/or sound displays, or through co-present environments detected through wearable computing. These responses would overlap reciprocally, providing users with intermodal coherence regardless of their interface.

Many of the attributes associated with responsive environments apply to the Collegium's design. The technology underlying cybrids is called *augmented* – or *mixed* – reality. Mixed reality commonly applies to the design of objects and games, however in situating virtual reality with a physical context it offers a great deal to the development of augmented, responsive spaces. The contents of the cybrid's cyberspaces would include information display, personal/group telepresence, digital spaces and worlds, avatars, and monitors/controls for the physical environment.

Wearable computing is a sub-element of node design. To the greatest degree possible the cybrid reality will be available through unencumbering technologies so as to encourage easy interaction. However, as there is a need for private use – even creation of – cybrid spaces, the authors propose the use of head-mounted displays and wearable computing as an important interface with the cybrid. This is a natural outcome of pragmatic choice and experiment since the preliminary work on cybrids assumes an economic use of available technologies. Initially at least, wearable computing will be an important alternative to larger, more expensive public displays.

The Planetary Collegium in summary:

- crosses borders between artistic and technological sectors.
- involves co-authored creation processes from specialists from a number of different disciplines.
- can ultimately be used in a variety of formats – such as digital worlds, performance, websites, projections or telepresence.
- involves targeted communities, both within its structure and its mission.
- is based in telematics.
- is from (and serves) intercultural groupings
- allows the engagement of the public/audience as a creative user.

Production of the Nodes

The Planetary Collegium's development constitutes three phases, which will apply at all seven nodes:

1) Conceptual Design
2) Systems Design
3) Creation of Infrastructure.

Only Phase 1 is addressed in this document. The others depend on its successful execution. Phase 2 involves the selection and design of specific node sites of the Collegium. It entails final specification of both physical and cyberspace infrastructures and develops the Collegium's cyberspace components to a level necessary for the next phase. Phase 3 involves the material development of buildings and technologies as well as that of attendant cyberspaces and cybrids. It also brings the Planetary Collegium into full operation as an institution.

It is estimated that the three phases will be completed within a period of three to four years. Phase 1 will take one year and is expected to end in March 2003. The following timeline summarizes Phase 1's progress so far and projects its development.

2001	
September - November	Creation of Planetary Collegium design program
December	Determination of physical and cyberspace components
2002	
January – February	Preliminary design strategies for Collegium scope
March – May	Conceptual design for Collegium node This involves designed configuration of nodes in both material and projected cyberspaces. This stage leads to documentation for further development and future sponsors.
June – July	Documentation of Conceptual Design/Technology Research This stage prepares documentation in graphic, online, and digital formats for publication and seeking sponsorship from host communities/industries. It also involves preliminary research into the mixed reality technologies to be employed in cybrid development.

From this point the project proceeds on two parallel paths: Design Development, and the Sponsorship Search. The authors anticipate the Sponsorship Search to last the duration of Phase 1 and involve on-going communication/negotiation with prospective host communities and corporate sponsors. Concurrently, Design Development will proceed as follows:

August – November	Technology Research/Design Development Technology research will continue from the previous stage, refining selection of technologies and developing techniques for the creation of an overarching cyberspace network for the Collegium. Design development will conclude formal study of nodes pending future site selection. It will, however, proceed in delineating the cyberspaces of the project.
December – January '03	Technology Preliminary Specification/Web site development Specifications will outline the technologies and techniques for use in the Collegium. The design of the Collegium will reflect these decisions. A Web site will be prepared as a kernel for development of the Collegium network. It will be designed to support the selected technologies.
2003	
February – March	Design Development concludes/Kernel Web site operational

Roy Ascott Founding Director
Peter Anders Associate Director - Planning

APPENDIX

CAiiA-STAR

Centre for Advanced Inquiry in the Interactive Arts UWCN
Science Technology and Art Research Centre University of Plymouth

Introduction

Founded and directed by Professor Roy Ascott, CAiiA-STAR is a worldwide transdisciplinary research community whose innovative structure involves collaborative work and supervision both in cyberspace and at regular meetings around the world. It combines, as an integrated research platform, CAiiA, the *Centre for Advanced Inquiry in the Interactive Arts* established in 1994, at University of Wales College Newport, and STAR, the *Science Technology and Art Research* centre, established in 1997 at the University of Plymouth. CAiiA-STAR has the aim of creating new knowledge through research in the theory and practice of interactive art, and is recognised as a leading centre in this field. CAiiA-STAR has a transdisciplinary perspective, which seeks the integration of art, science, technology, and consciousness research within a post-biological culture, and is involved in advancing the parameters of this emergent field (e.g. telematics, immersive VR, Mixed Reality, Alife, architecture, hypermedia, telepresence and agent technology, transgenics, data imaging, intelligent environments, generative music, technoetics). It is a community of closely connected doctoral candidates and graduates, post-doctoral researchers, advisors, associates and supervisors. These high level professionals are committed, through collaboration and shared discourse, to pushing the boundaries of their art. For these reasons the level of research is extremely high and the methodologies employed are extensive and rigorous.

Research Sessions

For most candidates* research is conducted online and at three ten-day face-to-face *Composite Sessions* each year, each involving individual tutorials, research seminars, critical round tables, and a public conference. The Centre is regularly invited to hold its Composite Sessions at universities and media centres abroad. These sessions and conferences have been hosted by *Artspace Media Centre*, Dublin (1997); *La Beneficia Cultural Centre*, Valencia (1998); *CYPRES*, Marseilles (1999); *Federal University*, Rio de Janeiro (1999); *University of Arizona*, Tucson (2000); the *Ecole National Supérieure des Beaux-Arts*, Paris (2000), *Fondazione Fitzcaraldo*, Turin (2001), *Universitat Oberta de Catalunya*, Barcelona (2001). *University of California DARNet*, Santa Cruz and Los Angeles (2001). Additionally, CAiiA-STAR initiated and co-sponsored the international conference *Invenção* in Sao Paulo, Brazil (1999) in collaboration with the *ITAU Cultural Centre*, the *International Society for Electronic Arts* (ISEA), and the journal *Leonardo*. Its meetings during 2002 are scheduled for *University of Arizona*, Tucson; *Curtin University*, Perth; *IAMAS*, Ogaki, Japan.
*Onsite students are required to attend at least one Composite Session each year.

Research Reporting Procedures

In addition to reports to their supervisors, doctoral students are required to submit progress reports to the University Research Committee (UWCN or Plymouth according to their registration) at regular intervals. Principal amongst these reports, and additional to annual progress reviews, is the *Transfer Report* (3,000-5,000 words) which, accompanied by an External Assessor's Report, is presented to the University Research Committee, to support the transfer from MPhil to full PhD status. After a minimum of three year's full time research a candidate is eligible to submit a thesis for Final Examination, which includes a *viva voce* examination. The final submission may consist in either a written thesis of between 80,000 and 100,000 words, or a thesis consisting in two parts: a digital portfolio of practical work which has been initiated, researched and developed exclusively within the research period, and a *linked narrative* of no less than 35, 000 words. The Examining Board includes an External Examiner (appropriately qualified and experienced in the UK at the doctoral level), an expert from within the University, and an independent Chair. Full time students may be either *onsite* (permanently resident on campus for three academic years) or *online* (committing 30 hrs of research per week at their home base, and attending three *composite sessions* (see above) per annum over a three year period).

Research Supervision

Each candidate has a minimum of two supervisors, comprising a Director of Studies from within CAiiA-STAR, and a Second Supervisor, who may be either from the Universities of Wales or Plymouth, or an expert based in another university or research establishment of appropriate academic standing. An expert external Advisor may also be appointed.

Current Supervisors and Advisors include:

Professor Roy Ascott, (Director of Studies)
Professor Miranda Aldhouse-Green (Archaeology, University of Wales)
Dr.Guido Bugman (Robotics, University of Plymouth)
Dr.Andreas Broeckmann, (Media Art, Transmediale Berlin)
Dr.Angelo Cangelosi (Alife, University of Plymouth)
Professor John L. Casti (Complexity, Santa Fe Institute and Technical University, Vienna)
Dr. Ranolph Glanville (Architecture/Cybernetics, Cyberethics Research)
Professor Linda Henderson (Art History, University of Texas at Austin)
Dr.Peter Jagodzinski (HCI, University of Plymouth)
Dr. Carol Gigliotti (Art and Technology, Emily Carr School of Art & Design, Vancouver)
Dr. Roger Malina (Astrophysics, Laboratoire d'Astronomie Spatiale, Marseille)
Dr. Ryohei Nakatsu (Media Integration/Comms, ATR Kyoto)
Mr. Mike Phillips (Interactive Media, Deputy Director, STAR)
Dr. Michael Punt (Interactive Art/Film Theory, Deputy Director CAiiA)
Professor Tom Ray (Artificial Life, University of Oklahoma)
Professor Geoff Roberts (Mechatronics, University of Wales)
Professor Francis Rousseaux (Informatics, Université de Reims Champagne-Ardenne.
Mr. Chris Speed (Hypermedia, University of Plymouth)
Dr. Kristine Stiles (Art and Art History, Duke University, North Carolina)
Dr. Evan Thompson, (Philosophy, York University, Canada)
Dr.Simon Waters (Electroacoustic Music, University of East Anglia),

Current Online PhD candidates

Peter Anders (Independent Architect, Michigan),
Donna Cox (Professor, National Center for Supercomputing Applications, University of Illinois at Urbana-Champaign),
Char Davis (Immersence, Montreal),
Maia Engeli (Assistant Professor, Architecture and CAAD; Head, ETH World Center, ETH Zurich).
Elisa Giaccardi, (New Media Program Manager, Foundazione Fitzcarraldo, Turin)
Diane Gromala (Associate Professor, School of Literature, Communication, & Culture Georgia Tech, Atlanta)
Pamela Jennings (Assistant Professor, School of Art and Human Computer Interaction Institute, Carnegie Mellon University)
Eduardo Kac (Associate Professor, School of the Art Institute of Chicago)
Jim Laukes (Director, Consciousness Program, University of Arizona)
Laurent Mignonneau (Associate Professor, International Academy of Media Arts and Sciences, Gifu, & Artistic Director, ATR Media Integration and Communications Research Lab, Kyoto, Japan)
Marcos Novak (independent architect, Los Angeles),
Niranjan Rajah (Deputy Dean, Faculty of Applied and Creative Arts, University of Malaysia, Sarawak),
Gretchen Schiller (Professor, Université Paul Valéry, Montpellier III)
Thecla Schiphorst (Professor, Technical University of British Columbia)

Christa Sommerer (Associate Professors at the International Academy of Media Arts and Sciences, Gifu, and Artistic Director at the ATR Media Integration and Communications Research Lab, Kyoto, Japan)
Ron Wakkary (Dean of Academic Planning, Technical University of British Columbia)

Current Onsite PhD candidates
Geoff Cox (Senior Lecturer, School of Computing, University of Plymouth)
Dan Livingstone (Senior Lecturer, School of Computing, University of Plymouth
Kieran Lyons (Senior Lecturer, Interactive Arts, University of Wales)

PhD graduates
PhD degrees have been awarded to:
Jill Scott (Professor, Bauhaus-Universität, Weimar. Thesis: *Digital Body Automata*) 1998
Dew Harrison (Lecturer, University of West of England, Bristol. Thesis: *Hypermedia Systems: the creation and interpretation of concept-based art*) 1998
Bill Seaman (Professor, Dept. Design/Media arts, UCLA. Thesis: *Recombinant Poetics; Emergent Meaning as Examined and Explored within a specific Generative Virtual Environment*) 1999
Joseph Nechvatal (Visiting Lecturer, Visual Arts, New York. Thesis: *Immersive Ideals/Critical Distances*) 1999
Victoria Vesna (Professor and Chair, Design/Media Arts, UCLA. Thesis: *Networked Public Spaces: an investigation into Virtual Embodiment*) 2000
Miroslaw Rogala (Chicago. Thesis: *Strategies for Interactive Public Art: dynamic mapping with (v)user behaviour and multi-linked experience*) 2001.
Jon Bedworth (UWCN. Thesis: Music as Embodied Action, *Interfacing Autonomous Systems and Rhythmical Expression*) 2001.

Visiting Researchers in Residence
Prof. Katie Maciel, Federal University Rio de Janeiro (2001-2002); **Prof. Tania Fraga**, University of Brasilia (1999-2000); **Lucas Bambozzi**, São Paulo (2000); Carlos Fadon, Federal University São Paulo (1999); **Nigel Helyer**, Sydney College of the Arts 1997; **Teresa Picazo**, University of Barcelona (1996); **Barbara Rauch**, Independent Artist, Berlin (1996-97); **Alan Giddy**, New Zealand (1995-96)

UNESCO-Aschberg Lauriats
Lalia Krotoszynski, São Paulo, Brazil (2002); **Lenara Verde** , Porto Alegre, Brazil (2000); **Daniela Kutschat**, São Paulo (1999); **Maria Diaz**, Quito (1997)

CAiiA-STAR Conferences
The CAiiA-STAR International Research Conference *Consciousness Reframed: art and consciousness in the post-biological era*, has been held at the Caerleon Campus of the University of Wales College Newport in 1997, 1998, and 2000, on each occasion attracting over 100 presenters from more than 25 countries. In August 2002, *Consciousness Reframed* will be held in Western Australia, hosted by Curtin University, Perth. The Conferences may be seen to parallel, from the CAiiA-STAR perspective, the bi-annual *Towards a Science of Consciousness* conference at Tucson, to which CAiiA-STAR members regularly contribute. The CAiiA conferences have resulted in the publication of two books: Ascott, R. (ed). 2000. *Art Technology Consciousness*. Bristol: Intellect Books. 234 pp. ISBN 1-84150-041-0, and Ascott, R. (ed). 1999. Reframing Consciousness. Exeter: Intellect Books. 314 pp. ISBN 1-184150-013-5. Professor Ascott guest edited the Special Issue: Computers and Post-Biological Art, *Digital Creativity*, 9,1. 61pp., and with Dr. Punt published A Speculative Bibliography of Art and Consciousness in *Convergence*, 4, (3), pp. 116-134. The 1998 CAiiA conference in Valencia, Spain, resulted in a bi-lingual book of essays by CAiiA researchers: Molina. A & K. Landa. (eds), 2000. *Emergent Futures: Art, Interactivity and New Media/ Futuros Emergentes, Arte Interactividad y Nuevos Medios*. Valencia: Institució Alfons el Magnánim. pp.108. ISBN 84-7822-326-6.

PORTLAND SQUARE **CYBRID**:

FORM AND FUNCTION:
INTERFACE – CORE – PROJECTS – COMMISSIONS – GALLERY
SEPTEMBER 2001

Note to readers:

Peter Anders worked in an advisory capacity on this project at the request the University of Plymouth's STAR center. This report was authored by Michael Phillips. The project became operational in the summer of 2003.

"Virtual worlds should not be seen as an alternative to the real world or a substitute, but as an extra dimension which allows us an new freedom of movement in the natural world. In other words the transcendence of physicallity in the virtual world allows us to extend our mode of operation in the physical world. A new means of travel, a new form of communication, a new way of operating, a new medium of expression."

Frazer JH. 1995

"Four issues relate physical space to cyberspace: 1)parity between physical and cyberspace via cognitive space; 2)the resultant transformation of physical architecture;3)the anomalies of translating the spatial metaphor to 3D environments;4)the possibility of creating hybrid schemes -cybrids -that exist both in physical and cyberspaces."

Anders P.2000

Contents:

1: Introduction:

This proposal outlines the construction of a 'Cybrid' architecture for the Portland Square development. The construction essentially is a series of digital manifestations of the processes that are embodied in the building. The intention is to construct an interface to the buildings technological, communications and physical processes. This interface would allow data to be manipulated and displayed using a number of audiovisual presentations.

What is a Cybrid? A cybrid is the recognition that the time based, data and virtual aspects of a structure can be as tangible as the steel and glass that contains them. This includes the flow of human interactions with a structure. The Cybrid makes these aspects of a building tangible and produces a rich and dynamic set of opportunities for research, cultural activity and new kind of work environment.

At the core of this proposal is the notion of a virtual building that exists in data-form. The ideas outlined give an indication of the physical capabilities of the interface, but the most significant concept is that all of them are manifestations of a tangible relationship between the virtual and the real building. Screens become windows to the virtual construction, and access via the web provides virtual windows onto the real building.

This proposal takes the notion of a 'smart' or 'intelligent' building to a new level of sophistication that will produce a unique and significant technological, cultural and enterprise phenomena of international proportions. The Cybrid project proposes integration with the architecture, the buildings management systems, data, ICT and network technologies, and most significantly the human activities.

To our knowledge the building would be unique, a model for Twenty First Century architecture and smart technology. And most significantly the Cybrid is not a dead and lumpen artefact that will age and fall out of fashion, it is a living breathing dynamic entity that exists through change and innovation.

2: Context:

This proposal originates from two research groups located in the School of Computing: STAR (Science technology and Arts Research) (Mike Phillips, Chris Speed, George Grinstead and Peter Anders), and the Centre for Neural and Adaptive Systems (Guido Bugmann and Martin Beck). The groups have a history of cutting edge funded research within fields of Artificial intelligence, Interactive Media and Robotics.

STAR, through the CAiiA-STAR integrated research programme, has a network of world-recognised practitioners in the field of digital architecture, such as Marcus Novak, Stephen Perrella and Peter Anders, as well as international mid career artists such as Char Davies, Thecla Schiphorst, Bill Seaman and Eduardo Kac. STAR operates as a unique trans-disciplinary group, and has developed an international research profile. Reflecting these interrelationships STAR's main aims are: to define and establish new fields of practice through the creative and innovative use of interactive media, telematic systems and the cognitive and biological sciences; to develop theoretical discourses of emergent practice based upon the integration of science, technology and art. It is within this context, and through a rich collaboration with the CNAS group that the Cybrid concept has emerged.

The group have been involved in a number of architectural project such as the ongoing 'School Works' project, which integrates the design of virtual and actual architecture (DRMM Architects, organised by the Architecture Foundation and Design Council and funded by the DFEE, £7.5 million). STAR is also an element of the New Centre of Expertise, the Institute of Digital Art and technology (IDAT), which will be housed in the Block 'B' of the Portland Square development. IDAT has a vision which incorporates digital media industrial activity with a strong cultural identity, this is discussed latter in the document (Gallery section).

3: Elements:

The general theme is to produce a representation of the life of the building that would require access to data from the environment control system, the internet traffic in and out of the building and possibly additional data on people movements provided by additional sensors or existing ones (e.g. elevators).

- Movement of people and spaces occupancy can be translated into metaphorical representations such as flocks of birds, and many forms of natural phenomena: clouds, waves, buildings being constructed, viruses forming and collapsing.
- Temperature can be read and again translated into images and forms, and particularly into lighting systems that modify colour and ambience.
- New technologies such as flexible LCD screens offer an artillery of opportunities to reuse and present in many forms - sculptural, wearable, suspended and 'motor driven'.
- Displays through floor and wall mounted screens.
- Exploring 'Lift Zoning', we are able to develop interesting programming techniques that will make the lifts more intelligent, able to learn user habits and needs and provide a far more intelligent service to the standard dumb lift. (see 'Random' Lift button proposal).
- Social Navigation describes how the movement of people can modify environments. TeleSocial Navigation describes how the movement of people are modified by environments that are in responsive to the interests of the crowd (Social Navigation with a feedback loop!).

The Cybrid is being broken down into 4 sections:

[0] Interface: Construction of the internal media networks
[1] Core: Building Identity Data Manifestation.
[2] Project: elements feeding off the Core technologies
[3] Curated Projects / Programme

Each of these elements has different funding requirements, although it is anticipated that the many of the requirements of the Interface can be built into the buildings wiring infrastructure and have already been included in the current Mechanical and Electrical specifications. These are included in the appendix.

Once the Interface is in place the Core technologies can be laid over the top. These are mainly sensing and audio-visual projection systems to feed in and out live data. This will also require the most significant software requirements.

The Projects and Commissions then feed off the back of the Core technologies.

The figures and costings outlined in this document are very approximate and should be taken as guidelines rather than defining amounts. We have build in a generous guesstimate in each case. As we are dealing with a structure that is already under construction we are very aware of the need to work within considerable restrictions. However all of the proposals outlined below are low profile technologies that should overlap with existing systems with the minimum of disruption.

4: Interface:

The cost of wiring the building for the basic audio visual network will be provided by Buro Happold as part of the Mechanical and Electrical report. The Interface provides the data source for the Cybrid. These are gathered from the:

• Computer Network Systems and network traffic:
this will require access to the network system through a monitoring terminal, and a computer to process the data.
2x powerful networked computers @ £3K each
miscellaneous software
Software development
Cost: Approx £9,000

• Building Management systems
this will require access to the BMS network system through a monitoring terminal, and a computer to process the data. Essentially the same as the Computer networked system but would need to interface with whichever BMS is selected for the building. Discussions with Clifton Andrews have indicated that access to the BMS database would not be particularly problematic.
2x powerful networked computers @ £3K each
miscellaneous software
Software development
Cost: Approx £9,000

• External sensors
Temperature, wind and sunlight sensors were to be included on the roof of the building. A simple off the shelf system would be used.
Cost: Approx £500

• Internal sensors
These are simple vision systems being built in house and microphones for ambient sound. All other internal sensors would be taken from the BMS.

Cost: Approx £ 4000

All this data will be channeled through to the Core technologies, which will process and manifest them in a variety of digital forms for presentation.

5: Core:

The Core systems take these inputs, process them and feed them back out to the building though audio and visual displays and projections. The Core also provides access to the processed information through the web (streaming media and 3D representations), communications technologies (such as SMS text messaging and radio transmission).

The Core technologies are also the most costly as they will require the most significant development time.

•Visualisation and simulation:
This would be the main processing element of the data. It will require a range of multimedia computing resources and software development:
Visualization studio: Consisting of 2 workstations, audio and video capturing facilities an storage.
Cost: Approx £20,000

• Projection/Display systems:
This is the most vague area of this project. There is a description of the TIM system in the Proposals system, which while being very expensive allows a very dynamic and extensive display. We are also exploring video wall systems and plasma screens mounted on the balconies. At the time of writing a quote ha not been received.

• Audio system:
The audio system would be driven by a software application that connects using a standard TCP/IP Internet connection to a 'CASM' central server previously developed by a researcher who works for the Interactive Media Group, and a library of sounds which replicate the sounds playable in the atria and street. this system was previously used in an installation in the Clyde tunnel, developed using lottery funds. The sounds triggered can be positioned and moved up and down the building. This is the main function of the CASM system - to precisely control the panning position of a sound using a custom made digital audio mixer. Users can create a sound, position it, and define how the sound will travel through the building. The CASM server orchestrates all this on-site, and also makes sure that other users connected to the CASM server will get the same representation of the sound.
Cost: Approx: 20,000

• Web interface:
An internet representation(s) of the Cybrid through a website using streaming audio, shockwave, flash, VRML and similar dynamic and generative software technologies:
Cost: Approx £5,000

• Staffing:
We are expecting staff support from the bids we have submitted. Failure to achive these would make the production of the work problematic. We would request that at least one research assistant post be made available at a cost of around: £15,000-18,000 x2 years.

Total ball park cost of Interface and Core equipment: Approx: £72,000

NB: This does not include the nodes etc submitted to the M&E or the staff requirements.

6: Projects:

A list of project templates is provided in the Proposals section of this paper. They are all ideas by the Cybrid team and should be seen as extensions of the Core technologies of the building. Each project has been given a rough outline cost. It is not proposed that they are all built at the same time, but to give an indication of the nature of the work that could be included in the building. Some of these projects are simple extensions of the information systems, other require significant development, such as the robotics components, although in all cases these technologies are fundamental to the research work of the Cybrid team.

The projects should be seen as mechanisms for manifesting the Core technologies in a variety of different ways. It is proposed that the projects are prioritized and a role out programme is drawn up as part of the buildings curatorial policy for the gallery (see section 8).

In all cases these projects represent cutting edge technologies that will individually receive considerable publicity.

7: Commissions:

As well as the project proposals and 'in-house' activities bolted onto the buildings Core technologies described in the Proposals section, the building should have a strong commissioning activity that allows world class cultural practitioners to take advantage of this unique enterprise. In the first instance it is proposed that a 'symphony' is commissioned from a world-class composer / musician. The task would be to compose a set of sounds, algorithms etc which would be incorporated into the buildings audio stream. It is suggested in the 'Symphony' Project proposal (see Proposals section) would attract significant response from sponsors and a world wide audience. The corporate symphony is now a fairly popular concept for large international businesses. Brian Eno, who was given an honorary Doctorate from the faculty of Technology, composed the Windows 98 'Startup' sound. Eno's work has been particularly influential following his role in Roxy Music, work with David Bowie, Talking Heads, Philip Glass and U2. He would be the perfect candidate to compose a generative piece of music that would launch the building through the internal sound system.

The Cybrid would allow a significant commissioning activity to be undertaken along the lines of the ICA (Institute of Contemporary Arts) in London and other similar models discussed below. This would not only provide a much-needed cultural input for the region, it would also attract future sponsorship and funding opportunities.

8: Gallery:

The institute of Digital Art and Technology (IDAT), one of the new centres of expertise, will be housed in block 'B' as part of the School of Computing. IDAT wishes to run a digital 'gallery' taking advantage of the buildings Core systems and the display and dissemination opportunities presented by the Cybrid. The gallery would take responsibility for the curation of the digital art works, the commissioning of new work and the dissemination of public cultural activity. The gallery would seek public revenue funding from South West Arts. Traditionally in cultural institutions of this kind funding is a combination of public, private and self-generated income. For example:

• V2, Rotterdam – 65% public funding out of which 50% is covered by government (funding on a national level) and 50% is covered by the city (funding on a local level); 35% comes from project-based commercial sponsorship;

• Similarly, Ars Electronica Centre in Linz, Austria, where an annual turnover is 5,1 Mio ECU, secures its core funding from the city (local public funding governmental agencies support the biggest percentage), from the regional bodies and finally from the national government. Like V2, Ars Electronica Centre's core funding comes from public bodies (governmental agencies) on both local, regional and national level, which allows independent and ambitious programming, commissioning and production.

• Perhaps the most evident example of such policy is ZKM (Zentrum fur Kunst und Medientechnologie) in Karsruhe, Germany which, in principle, is almost a 100% publicly funded institution.

• The Lux Centre in London is an appropriate UK example. The Lux generates funding based on the similar principle – core funding being public (The Arts Council of England, London Arts Board, The National Lottery Through The Arts Council of England, British Film Institute and Foundation for Sport and The Arts. Additionally is it a project-based corporate sponsorship as well as self-generated funding from cinema ticket sale, catalogue and video sale, training and course and, finally, facilities rental. This however provides only a small percentage of funding.

The gallery will be managed from the IDAT administrative core. This working group will explore opportunities for funding sources. In the initial stages it is unreasonable to assume that self-generated funding mechanism would be in place. It is possible to imagine a scenario where funds are obtained form regional and national arts boards, the City of Plymouth, cross funding from core IDAT activities and top slicing from commercial contracts.

A typical structure of a new media centre: Gallery / Distribution / Training / Education / Production / Cinema with overall administrative and financial department. Building the gallery into the administrative mechanisms of IDAT and supporting it through the centres research and creative activities would allow significant and advantageous cross fertilisation of content. However there would be specific staffing issues for the gallery, including: • Gallery curator – programming, selecting and commissioning responsibilities; including contacts with artists, production and distribution of works, audience developing, fostering collaboration with other similar centres; • Gallery Assistant - providing an administrative and organisational support to a gallery curator
• In-house Technician

The curatorial policy for the IDAT gallery would be developed along ideas of fostering strategies for the creation and presentation of digital / networked work. Trans-disciplinary in nature, the space would integrate with IDAT' core focus and provide appropriate exhibition technologies as an extension of IDAT's publishing/ dissemination and research activities.

9: Funding:

Funding is being sought from a variety of public and private sector sources.

- An application has been made to the AHRB 'Innovation' fund for £50k, for developmental (Research Assistant) funding.
- An application is being developed for South West Arts Capital funding grants for £100k. this has been discussed and initially supported by David Drake head of SWA New Media and Publishing, who has expressed considerable enthusiasm for the project.
- Exploring sponsorship for elements, such as the commissioning of the 'symphony', from individual artists and funding partners such as South West Arts and the Arts Council of England.
- An application has been made to the AHRB (Arts humanities Research Board) for a research assistant to develop the audio systems for the project. £18000 for 3 years. AHRB Fellowships in the Creative and Performing Arts. Title: Sound Practice: creative explorations into sonic environments, real-time and interactive, electroacoustic music performance.
- An application has been submitted to the AHRB Research Centres for £800,000.00 for 5 years to support research which overlaps the project. MODEL is a proposal for a new research centre (AHRB Research Centre Proposal) which builds upon existing partnerships and joint projects currently in progress between STAR, inIVA (Institute for International Visual Arts) and REALL (Research in Education, Arts, Language and Learning) at Middlesex University. It is also a response to the perceived changing cultural terrain and the impact of emergent technologies. The centre defines itself as trans-disciplinary in its amalgamation of research centres across the fields of the Creative Arts, MODEL's distinctiveness would be its ability to exist beyond the limits of single institutions where outcomes tend to be produced in somewhat territorial isolation. A collegiate space supported outside fixed institutional frames would therefore enable the group to test product and process critically, and as the name MODEL suggests, to develop schematic descriptions of digital arts systems, theories and phenomenon that account for unknown properties and may be used for further study of its characteristics.

  Over the five-year period, Research will investigate A: *Invisible Architectures and Playful Pedagogies*, the study of virtual spaces, processes and objects. B: *Intelligent and Interactive Object* investigating the application of computer technologies to 'objects' both real and virtual, their cultural impact, and their many manifestations, especially within the context of children's experiences of interactive toys. This research will lead to the design and development of intelligent virtual and real objects, which when placed within a learning context can be articulated as the construction of an intelligent 'toy'.
- An application is being made to NESTA for funding, still in early stages.
- We are developing presentation material for the private sector to encourage sponsorship.
- It is extremely important that research support is given in the form of Research Assistants to develop custom software to interface and control the Cybrid systems.

10: Conclusion:

The Cost of the total Cybrid would be in the realm of £150,000 (not including the projection and display system). While this may seem excessive there is a possibility that £100,000 of this could come direct from South West Arts Capital grants, whilst some of the staffing costs could be obtained from existing grant applications. As the building grows it is obvious that the time frame is extremely tight. However the Cybrid project can be staggered over the next 3 years with stages outlined to produce a rolling programme of innovative projects. We feel strongly that this is an opportunity that will never repeat itself. Some form of Cybrid must emerge from this exercise. We can deliver variations on all these costings and systems and still produce a significant contribution to the cultural and scientific debates surrounding trans-disciplinary practice, emergent fields of human activity.

I would also like to point out that this report was written at a point in time when we have received very little real feedback from suppliers. Apologies for the lack of hard information and we would appreciate the opportunity to market the Cybrid idea to you using the visuals we have been working on.

11: Proposals:

The following templates hold specific projects that are being proposed by the Cybrid team. They are ideas for the application of the building core technologies and are primarily extensions of existing research by members of the CNAS and STAR research groups located in the School of Computing.

They are loosely broken up into three types of project:

1: Audio work: Projects 1 to 4. These projects are audio applications of the building Core technologies allowing the dynamic data to be represented through a range of sonic / audio broadcast technologies.

2: Installation work: Projects 5 to 14. These projects are specific applications of the building Core technologies and allow specific manifestations of the dynamic data.

3: Robotic work: Projects 15 to 19. These projects extend the robotics and intelligent systems research work being carried out within the School of Computing. They range from small clusters of robots to large slow moving elements of the architecture.

Where possible approximate costings are included, but unfortunately they are extremely vague and will depend on the availability of production staff and software developers. There is confusion between production time and the cost of purchasing the systems. Most of the projects described here can be constructed in house within the time frame given suitable resources, primarily for software development.

Apendix 1: Mechanical and Electrical Information for Buro Happold.

Information sent to Buro Happold for the next M&E specification report. The items in this list cover the 3 atria and the connecting walkway.

CYBRID INTERFACE REQUIRMENTENT
1) Control Centre: We have identified a two possible control centres for the installation. All the wiring below will need to terminate at these locations. The audio equipment, video, computer imaging systems, server and mixing facilities would be located at these points.

A) The original suggestion by the security desk.
B) The Interactive Media Group will be located in Block B in the studio space RB3.34. This would be an ideal monitoring and control point as it is central to the building and supervised by skilled staff.

2) Network: Server 1: In order to interface with the BMS and the buildings network we would need space for a server to be located in a secure place that attaches to BMS, CCTV & Network data.

Server 2: High Speed network link from server 1 to 2nd floor School of Computing Interactive Media studio RB3.34, to server 2 (that duplicates server 1 effectively as an interface to BMS, CCTV & Network data). (Use of old EDC server could be useful)

Network: High Speed network from Interactive Media studio throughout exhibition spaces to Networks nodes (see below).

3) Information Nodes: In order to connect and relocate installation equipment in a flexible way we have identified the need for connection 'nodes'. Each node consists of: 2 Mains sockets / 1 Ethernet sockets / 1 SVGA / 1 Svideo / 4 Phono(2 pairs)

The nodes would need to be located on...
A)4 corners of each atrium floor at each level (ie x 5)
2 mounted in the floor of the main atrium (Block A), towards the entrance and equidistance from the walls and each other.
1 mounted in the centre of the atria in Block B and C.
1 located centrally on ceiling of each atrium.
1 weatherproof node externally located on roof of each building.
1 over the entrance to block B and C.
2 over the entrance to block A equidistance from the walls and each other.

B) a node would need to be placed for each plasma screen located on rim of each floor overlooking the atria of each building.

C) 3 mounted evenly on the wall opposite the main windows of each block. These nodes would need to be located for each projection system. (see projection below, 8).

D) Nodes will need to be placed through the 'street':
10 nodes evenly spaced across the length of 'the street'.
However these would need to be embedded in the ceiling along with the speakers and the microphones.

4: Lift Management System: For connection to the lift management system we would need a network connection to the lifts (will need to negotiate with the lift contractors to diagnose and interrogate alternative systems for the management system.)

5: Mountings:
• A) It is difficult to specify the nature of the mounting points (they would need to support medium sized speakers, microphones, camcorder sized cameras, lights etc). These mounting would need to be fitted by each node. They would there fore be for suspension or fixing to the ground.
• B) Mountings for similar AV kit on roof of building.
• C) Mounting for AV kit over main entrance
• D) Hanging structures:
We would like to explore hanging a structure from the top of the atrium in Block A which would have projection equipment contained within it. This would require fixing points, and a small hoist? at the top of the atrium next to the central node.
• E) Mountings for Plasma Screens. The placement of plasma screens on each level has been discussed. Nodes would need to be located at each point. We are not sure about the pheasbility or desirability of this (See TIM, 9 below).

6: Audio: Recording... The simplest way of obtaining direct audio input for the system would be through shotgun mics mounted in the four corners of the atrium at an optimum point some where well above ground level. This would allow the collection of ambient sound from across the public space.

7: Playback...Slightly more complicated and awaiting clarification from suppliers, but the ambition would be for a dual speaker installation. A powerful surround sound system for Wagnerian experiences, such as the opening night, and a spot sound system that would allow directional and localised audio playback. This would be zoned to allow a balanced and targeted playback. These would be plugged directly into the nodes in the atria. The speaker system would run up height of each atrium allowing total 3D sound to be used.

This would require 2 speaker systems.
A) Those to be located next to the nodes in the corner of each floor in all atria,
B) network of small speakers dotted around the space of the atria, 4 feet of the ground evenly spaced every 2.5 meters (aprox).
These speakers would need to be embedded in the walls. Similar to those in the 'street' (3D, above).

The audio system would be driven by a software application which connects using a standard TCP/IP Internet connection to a 'CASM' central server previously developed by a researcher who works for the Interactive Media Group, and a library of sounds which replicate the sounds playable in the atria and street. this system was previously used in an installation in the Clyde tunnel, developed using lottery funds. The sounds triggered can be positioned and moved up and down the building. This is the main function of the CASM system - to precisely control the panning position of a sound using a custom made digital audio mixer. Users can create a sound, position it, and define how the sound will travel through the building. The CASM server orchestrates all this on-site, and also makes sure that other users connected to the CASM server will get the same representation of the sound.

The CASM system consists of: Hardware 1 x Redhat Linux 6.0 AMD K62 450MHz server / 1 x custom power/parallel data controller/audio input unit / 1 x custom audio mixing unit / 2 x Akai Professional S2000 digital audio samplers / 2 x external SCSI hard drives / 8 x custom digital mixer cards / 16 x audio input channels (phono) / 64 x audio output channels (phono) / 128 x 8-channel digitial mixer chips 1024 x audio channels: this system would interface directly to the nodes/speaker system.

8: Projection: The most attractive option discussed was the projection onto the larger atrium windows. In order to do this we would need to locate a suitable location for the projectors with the appropriate angle and throw. We are still working out the details but it would appear that we would need at least 2 projectors located opposite the large window. A node would need to be placed at these points.

9: T.I.M. We are discussing the possible inclusion of a large format transparent glass digital display system that is available form the USA from: http://provisionentertainment.com/Provision_home.html
This could be a perfect solution to the display systems for the atria. Further information will be available soon.

Apendix 2: Cybrid Website - www.cybrid.i-dat.org

A website to help coordinate the Cybrid project has been constructed at www.cybrid.i-dat.org
It is still in its infancy and under development, but it will contain a listserve for email communication and an archive for easy access to emails sent to the list.
A brief outline of the sections:

• concept | A description of the concept behind the project, expanded from the document circulated at the meeting...

• elements | This section contains the identified components or individual projects of the Cybrid project. This will change and evolve as more opportunities are identified and the project gets more focused,

• progress | This section contains identifiable achievements and a webcam view of the site (we are working on this in parallel, progress depends largely on the deployment of the new security cameras).

• timetable | This section will contain a timeline, which has agreed milestones etc for the project. Any access to your timelines would be appreciated.

• docs | A location for downloading document and spec for individual and collaborative elements, 3D models, image bank, etc. I can manage the posting of new documents until we have appropriate FTP access sorted.

• contact | contains contact information on the collaborators,

• comms | This will contain the listserve/email archive section.

Appendix 3

Related publications by author

We put thirty spokes together and call it a wheel;
But it is on the space where there is nothing that the utility of the wheel depends.

We turn clay to make a vessel;
But it is on the space where there is nothing that the utility of the vessel depends.

We pierce doors and windows to make a house;
And it is on these spaces where there is nothing that the utility of the house depends.

Therefore just as we take advantage of what is,
We should recognize the utility of what is not.

Lao Tsu

Tao Te Ching Chapter XI

Quotation from Arthur Waley's *The Way and Its Power*, London, 1934.

Envisioning Cyberspace

Designing 3D Electronic Spaces

Peter Anders

McGraw-Hill

New York San Francisco Washington, D.C. Auckland Bogotá
Caracas Lisbon London Madrid Mexico City Milan
Montreal New Delhi San Juan Singapore
Sydney Tokyo Toronto

Contents

Anthropic Cyberspace

Defining Electronic Space from First Principles

PETER ANDERS

ABSTRACT

This article proposes principles for the design of human-centered, anthropic cyberspaces. Starting with a brief examination of our cognitive use of space, it suggests that we address cyberspace as an extension of our mental space. The article proceeds to state 12 principles based on scientific and cultural observations regarding individual cognition and social interaction. These concepts are general—not specific to any culture or technology. In the accom-panying arguments, the author expands on these concepts, illustrating them with examples taken from conventional and electronic media, space and cyberspace. With these conjectures, the author hopes to begin a discussion on the anthropology of space and its emulation.

SPACE TO THINK

The field of cyberspace design is populated by those working at the boundaries of their professions as artists, designers, or engineers. Separating nascent principles of cyberspace design from those of its tributary disciplines is difficult, since cyberspace depends on the vision of its contributors—all working within their own fields. Consequently, it is more fruitful to address cyberspace at its root level, understanding cyberspace as an extension of our consciousness. Doing so lets us establish principles innate to the medium rather than prejudicing its development with those of pre-existing disciplines [1].

Such inquiry into first principles demands that we first understand what cyberspace is—how it supports human activity and aspirations. We may characterize cyberspace as the spatial reference used in electronic media, but that begs our need to define space itself, for what we experience as space is actually the product of complex mental processes.

The dimensionalized environment of thought and experience is a powerful tool for cognition. It is the array of sensation and thought in a matrix of our own making. Itself an artifact of cognition, our experience of space contains only the products of mental processes. Space may have no other existence—an argument that crops up in writings ranging from Zeno to Leibniz and Kant. More recently, Kevin O'Regan, a cognitive scientist, makes a compelling case for understanding space as an artifact of memory. Because of the mind's complicity in apprehending space, all objects of our awareness are imbued with meaning, whether through the deliberate signs of our culture or through the construction of mental images. Concrete objects undergo cultural and linguistic manipulations before we are even aware of them [2].

This process transforms all objects into subjects. Distinctions between physical and symbolic artifacts level out, as they assume the same cognitive status. Distinguishing a brick from its image is a matter of perception and cognition rather than a biased polarization of reality and simulation.

ANTHROPIC CYBERSPACE

This cognitive understanding of space is crucial to realizing cyberspace's potential. The human-based (anthropic) relationship between space and information grounds cyberspace as an information medium—rendering data into knowledge. This informs the design of cyberspaces that extend our innate abilities—anthropic cyberspaces.

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objects or spaces. The subject matter of the painting clearly supersedes its presence as a canvas stretched over a wooden frame.

What is true for objects is also true for the surfaces of architecture. The walls of buildings evaporate when moving images are projected onto them—the theater screen is no barrier once the film begins. For this reason, the defining role of architecture as a frame for social conduct is challenged—if not obviated—by the virtualization of its surfaces. Material presence is reduced to the point of virtuality as our attention slides from the surface into its apparent depths (Fig. 8).

CONCLUSIONS

In proposing these principles, I have deliberately avoided mentioning specific technologies and focused instead on the anthropological issues attending the design of cyberspace. I have done so for several reasons, the most important being to reassert the importance of human thought and behavior in creating cyberspace. Spatial experience is, after all, an entirely human construct.

Fictional space has long been a part of human culture, appearing in fairy-tales, myth, and art. Although we could say that cyberspace is merely another of its incarnations, cyberspace is radically different in its audience and scale. Symbolic spaces prior to electronics were limited to the minds of individuals. Heaven, Hell and the places of myth were internal spaces, traditionally shared in stories and art. The audience was culturally and regionally specific.

Cyberspace lets its users share the space, mentally occupying it simultaneously. It is an artifact independent of the minds of its users. Also, as an electronic artifact, it is shared by those who have access to it from around the world. It is a new collective, social space, culturally specific only in its technology, not for reasons of geography or social context.

Finally, cyberspace, unlike its precedents, is not passive. It is not a medium limited to specific use. Instead it is already host to a variety of activities ranging from commerce and entertainment to religion and social service. Unlike other fictional spaces it is active, constructed by the minute by millions of participants. It is this human and social role of cyberspace that holds its greatest promise.

REFERENCES

1. Peter Anders, *Envisioning Cyberspace* (New York: McGraw-Hill, 1999) pp. 108–110.

2. John H.R. Maunsell, "The Brain's Visual World: Representation of Visual Targets in Cerebral Cortex," *Science* 3, pp. 754–66 (November 1995).

3. Ray Oldenberg, *The Great Good Place: Cafés, Coffeeshops, Community Centers, Beauty Parlors, General Stores, Bars, Hangouts, and How They Get You through the Day* (New York: Paragon House, 1989).

4. Paul Harris, "The Child's Representation of Space," in G. Butterworth, ed., *The Child's Representation of Reality* (New York, NY: Plenum Press, 1977), p. 85.

5. Rudolph Arnheim, *Art and Visual Perception: A Psychology of the Creative Eye* (Berkeley, CA: Univ. of California Press, 1974), p. 259.

6. R. Ardrey, *The Territorial Imperative* (New York, NY: Atheneum, 1966), pp. 48–49.

7. Ibid. [1], p. 68.

8. Ibid. [1], pp. 48–49.

9. George Lakoff and Mark Johnson, *Metaphors We Live By* (Chicago, IL: Univ. of Chicago Press, 1980), pp. 17–18.

10. Ibid. [1], pp. 70–72.

BIBLIOGRAPHY

Altman, Irwin. *The Environment and Social Behavior* (New York: Irvington Publishers Inc., 1981).

Anders, Peter. "Cybrids: Integrating Cognitive and Physical Space in Architecture," in P. Jordan, B. Mehnert and A. Harfmann, eds., *Representation and Design*, proceedings of the ACADIA 1997 Conference (Cleveland, OH: Association for Computer Aided Design in Architecture, 1997) pp. 17–34.

Anders, Peter. "Envisioning Cyberspace: The Design of On-Line Communities," in P. McIntosh and F. Ozel, eds., *Design Computation: Collaboration, Reasoning, Pedagogy*, proceedings of the ACADIA 1996 Conference (Tucson, AZ: Association for Computer Aided Design in Architecture) pp. 55–67.

Bødker, Sussane. *A Human Activity Approach to User Interface Design* (Hillsdale, NJ: Lawrence Erlbaum, 1990).

Hall, Edward T. *The Hidden Dimension* (Garde City, NY: Doubleday and Company, 1966).

Johnson-Laird, P.N. "Mental Models in Cognitiv Science," in D.A. Norman, ed., *Perspectives on Cog nitive Science* (Hillsdale, NJ: Lawrence Erlbaum 1981).

Laurel, Brenda. "Interface Agents: Metaphors wit Character," in B. Laurel, ed., *The Art of Human Computer Interface Design* (Reading, MA: Addison Wesley, 1990).

Newman, Oscar. *Defensible Space* (New York Macmillan, 1973).

Norman, Donald A. *Things That Make Us Smar* (Reading, MA: Addison-Wesley, 1990).

Walker, John. "Through the Looking Glass," in B Laurel, ed., *The Art of Human-Computer Interfac Design* (Reading, MA: Addison-Wesley, 1990).

Whorf, Benjamin Lee. *Language, Thought, and Realit* (New York: The Technology Press and John Wile and Sons, 1956).

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CONJECTURES ON THE NATURE OF (CYBER)SPACE

Abstract:

In a series of conjectures this paper presents the experience of cyberspace as a subclass of space itsel treats space as an artifact of human perception and cognition while it presents the structure of cyberspace as a particular set of functional capabilities. It further explores ways in which the emula of space in electronic media masks the unique properties of cyberspace. The purpose of this paper is create working hypotheses regarding the interdependence of ideas about space and the functional characteristics of cyberspace. These hypotheses are to become tools for evaluating digital and electr media and understanding its social impact.

Introduction

We live in a time of dramatic technical, social, and environmental change. In a relatively short peri human beings have spread high-technology communication, destruction, and production systems ac the planet, thereby creating a highly interdependent global socioeconomic and political structure. T sea, air, and the earth itself have felt the effects of this explosion of human activity; an explosion enabled in recent times largely by computer systems interconnected into a shared cyberspace.

But what exactly is Œcyberspace1, and what is its relation to Œspace1 as we now know it? If we d understand the structure and organization of cyberspace, how can we hope to grasp the human significance of the ongoing and extensive migration of social and intellectual structure into cybersp Perhaps a good place to begin this discussion is by defining what we mean by Œspace1 and then fin the similarities and differences between our experience of space and that of its electronic emulation:

Space

Our experience of space is the byproduct of sophisticated, innate operations that integrate sensory/cognitive processes to produce a holistic image of our environment. This image– itself an artifact– seems transparent to us. Yet, though we take it for granted, this image is a highly-evolved information management tool, a map, a concept that helps us flexibly and effectively relate to each and to our world. The well-established conceptual character of space can be seen in the Oxford En Dictionary definitions of space as: denoting time or duration; denoting area or extension; and metaphorically, denoting continuous, unbounded, or unlimited extension in every direction . . . .

This is not to suggest that we are isolated from the physical environment. Our bodies leave the wal our presence in the world. We continuously interact with our environment to sustain ourselves physically by acquiring food and shelter and socially by communicating through language and the gestures of expression. However, in practice we interact with our environment primarily as a plac particular moment in time and particular part of space. The concept of space is what allows us to decouple ourselves from the uniqueness of our particular time and place. It enables us to flexibly p our specific experience into unknown new situations. Space is an idea which enables us to imagine adapt.

However, our concepts of space have evolved in relation to specific sets of circumstances. Our images of space are contingent upon the places, times, and cultures we live in. By extension, our concepts of space may not allow us to even recognize the unique characteristics of truly other' times, places, and spaces. We are not dolphins and may not be able to imagine the potential of a fluid space in which entire pictures of place and experience' are communicated instantaneously and holographically. We are not fleas and may not be able to envision the character of the dog space in which we live and leap for generations. Moreover, we are not computer programs and may not be able to readily conceive of an electro-linguistic space in which we share cycles with other recombinant objects so that they will help us synthesize fountains of replicating and evolving code.

But then what model of space should we apply to cyberspace? Can our existing concept of physical space, based upon millenia of experience, be adequately extended to the spatial experience of cyberspace? Are the two spaces so melded that we, eventually, cannot tell the difference? Or, instead, are there underlying principles of each whereby we will know one from the other? These questions are the subject in this paper.

The authors– perhaps optimistically – believe such principles exist. And that they may be revealed through tempered introspection and close observation of media in our society. However, because of the novelty of the digital electronic media it is hard to get objective data on their effect. Therefore, it may be useful to develop working hypotheses as frameworks for such evaluation. To this end, we have prepared the following conjectures on the nature space and its manifestations in electronic media. Each conjectures is followed by a brief statement elaborating upon and illustrating the principles at work.

Conjectures

1. PA: Space is a mental construct that conditions our relationship with the world.

Space is the means by which we distinguish and relate sensory and cognitive phenomena. Cyberspace is the spatial reference evoked in the use of electronic media. Electronic media extend us beyond our bodies and immediate, physical environment, changing our cognitive model of the world.

The electronic extension of our senses beyond our normal capacity requires us to graft these extensions onto a prior construct, our mental map of our situation and environment. The higher the dimensional quality of the extensions, the easier it is to assimilate them to our conventional understanding of space. We sense this from the engagement we feel with high resolution graphic images versus text or other low resolution media.

This ease of assimilation is one of the reasons that the concept of cyberspace has such appeal. Popular images of cyberspace treat it as a deep, dimensional environment that, though devoid of gravity and material consequence, contains entities arranged spatially. It is understood to be a space accessed through computer media, the technological equivalent of Alice1s looking glass.

Cyberspace, as defined above, actually predates computer graphics. The spatial effect of telephones gives its remote users the illusion of being in the same room, for instance. Cognitively there is a momentary collapse of the space separating them. Hanging up the receiver restores the space to its normal dimensions.

Whether space is evoked passively – as with the phone – or deliberately through constructed environments like multi-user domains, the users1 mutual involvement in the space has important social and psychological consequences. Social spaces, the traditional realm of architecture, affect the behaviors of their occupants.

We see this in the reciprocal relationship between architecture and the social functions it serves. Behavior appropriate in a bar, for instance, would be unacceptable in a church. Environments ter the actions of their occupants. For this reason we must see cyberspace not only as an extension o perceived space but as an expansion of our social environment beyond the physical setting. This already begun to affect cultural and social relationships in fundamental ways.

2. JS: A metaphor is a program for human beings which becomes real in cyberspace.

A metaphor is a "figure of speech in which a name or descriptive term is transferred to some obje different from, but analogous to, that to which it is properly applicable." Using metaphors allows human beings to analogize the known structure and relations characteristic of one situation or obj with another, usually unknown, situation or object. Not only are the objects analogized, but any processes or actions associated with the objects are equated.

A program is a series of instructions clearly describing how to do something. Metaphors are progı for human beings because, by equating situation A with situation B, they implicitly tell people wh actions to take in new situations. Metaphors tell people to do unto A as you would do unto B bas upon your learned experience with A.

Metaphors produce numerous real consequences. When metaphors are aptly chosen, they have re adaptive value by reducing the amount of learning, time, and effort required to deal with new obje and situations. On the other hand, by rigorously focusing upon the structure of a metaphor to pres action, human beings often ignore the recognizable structure of the new situation, thereby changin distorting the new situation in unexpected ways by their actions. Metaphors can obscure our view new structures to the point that our map becomes the terrain.

Furthermore, metaphors become independently real in cyberspace; they take on a life of their own the past metaphors were programs for human beings, now metaphors are used to organize comput programs which can act without human intervention. Metaphorized data objects have become components of real pieces of computer code which continue to grow and evolve. However, the evolution of new structural relationships between the data objects is constantly constrained by the structure of the original metaphor. The metaphor will lock the code's evolution until the structura possibilities of the new environment burst through.

The interaction between the life cycle of metaphors and the life cycle of the structures they inhabi existed for ages. However, the extreme speed of code evolution, the enormous scale of cyberspac the degree to which we are now essentially dependent upon computer programs, suggests that we should pay close attention to this relationship.

3. PA: All artifacts are vessels of meaning. The artifacts of cyberspace operate at a metaphoric le unique to that medium.

Owing to the fact that our experience of the world is a product of perception and cognition, it is inevitable that the objects we perceive bear the stamp of their making. Specifically, stimuli must p through filters of sense organs and the body prior to entering the brain. Light, sound and other sensations are converted to sensory signals. Once in the brain, the signals are sorted for personal, cultural and linguistic significance before we are even aware of the source of stimulation. The a p conditions of the mental image are that the image is a subject – a fabricated artifact –distinct from external stimulus. This artifact may be queried for meaning or stored for reference in ways that an object – or stimulus – may not.

Defined in this way, human artifacts range from the most concrete implement to the abstractions of words and concepts. Yet, artifacts necessarily occupy a position on this scale between the absolutes of materiality and abstraction. They depend on both for their substance. It is doubtful whether we, as humans, could actually recognize something at either extreme exclusively. For at one end even a brick represents the abstractions of process and proportion. Conversely, at the other extreme, language1s metaphors ferry meaning back and forth between the world of thought and that of matter.

Computers, and consequently cyberspace, are well-suited for similar symbolic operations. The metaphoric artifacts of software let us interact with computers. Icons, graphics and symbols abound in digital environments. They are low-dimensional references to much richer sources of data. This facilitates their manipulation for specific tasks.

However, computer metaphors are distinct from those of language. Though, like linguistic metaphors, they embody abstract concepts, their presentation may change depending on their use. A line of code, for instance, may be manifested as text, bits of data or a graphic. The metaphoric incarnation is limited only by the complexity of its supporting data. For this reason the artifacts of cyberspace are subjective, their meaning volatile.

4. JS : Everything is real, everything is virtual.

When discussing computers and cyberspace, people often make a distinction between real and virtual objects and events. This distinction between real and virtual objects, places, and spaces can be misleading. While the word virtual may be legitimately used as a simple synonym for computerized, it usually implies that somehow virtual objects are figments of our imaginations, somehow less real.

A more appropriate way to use these words might be to acknowledge that all things and situations have real and virtual aspects. In this context, as Ted Nelson suggested long ago, virtual means: seems to be. Virtuality is generated by the distance between the structure of the words and concepts used to describe a thing and the effective structure of the thing itself.

The virtual aspect of an object is: what does the object mean to human beings, how does the object or situation fit into the mental maps of human beings, and what is the metaphoric potential of the object? Of course, by this definition, all phenomena have a virtual aspect. On the other hand, to say something is real implies that it might not be. Again, the concept of reality is generated because there is always a loose coupling between the way we think about things and the effective structure of the things themselves. Reality may be better defined as cause and effect viewed from the point of view of the object or situation ignoring the virtual understanding of any viewer. Since all computerized and non-computerized objects and situations have effective structure, and since all objects and situations of any kind are virtualized by human beings in the process of assigning meaning, it would be appropriate to view virtuality and reality as two aspects of any situation. Maybe we can say that virtual is to watery as real is to wet.

5. PA: The use of electronic media requires the multiplication of its users into lower resolution images, proxies or avatars.

The virtues of electronic media are largely due to their speed and pervasiveness. Obviously sending a message physically, whether personally or by post, is slower than by fax or phone. However, what arrives through electronic media is not the original article. Instead the recipient gets a low-dimensional representation of the source. While the source remains at the message1s origin, its simulation materializes at the destination. In a phone call, for instance, the caller is duplicated as a tiny voice other end of the line. This voice, though analogous to the caller1s own, is actually a distinct artifac

The relationship between the source and its simulation depends in large part upon the interactivity medium. We may be reluctant to shout at the tiny voice on the phone, but we feel comparatively fi tear up a fax or delete an email. The fax and email are distinct from their sender, whereas the voic attenuated electronically – is still the sender1s own. It maintains a live connection to its origin.

This connection is strained in digital media. Artifacts of computers and networks – arbitrary preser and delays in response time – isolate the simulation, breaking the causal connection to the source. break also leaves the simulation to the mercies of the receiver who may modify, duplicate or other manipulate it. Significantly, the digital go-between changes the relationship between the two communicating parties. It paradoxically separates them at the same time that it connects them. Fo reason, avatars are often described as masks worn by correspondents in digital media. A conversa between two parties inevitably includes an additional two avatars.

The social consequence of this apparent user-multiplication is hard to predict because of the novelt digital media. Yet the distance between the user and the representation underlies many misunderstandings and frustrations on Internet IRCs and multi-user domains. We would expect th from any indirect communication except that cyberspace seems to magnify the effect owing to the intimacy of the medium.

6. JS: The current structure of cyberspace allows it to act as a cultural amplifier.

At this point in time, cyberspace is in essence a few huge cyberplaces; i.e., it is a group of enormo public, largely undifferentiated masses of computers and connections. Communication is virtually instant within and among these places with very little filtering of content taking place. In addition, traditional national, cultural, political, and economic boundaries between people present few obsta communications.. It is also important to recognize that the edge of cyberspace is a boundary zone much like a beach. As water and sand interpenetrate each other on a beach, so cyberspace extends normal space and vise versa.

Cyberspace is quickly extending into and transforming any and all traditional communications technologies; everything from letters, through newspapers, to radio, television, and the telephone s have been radically transformed by the existence of these immense interconnected, semi-intelligen computing environments As a result, distributed groups of people can behave like large, unified fl of birds, wheeling and diving at the slightest hint of food or danger. As in the flock, a single voic heard at just the right moment, can dramatically change the direction of the group1s thinking and Also, as in a flock, it can be very difficult to determine what triggered a particular group1s mover or actions. Accountability can become very diffuse in a place where things happen so quickly and many people are involved.

Furthermore, the programmable nature of cyberspace makes it possible for a single person to have enormous social effect. One individual can, in essence, clone himself in the form of a program or and act globally as the many computer viruses in circulation demonstrate. And, groups can also a their actions by creating programmed alter egos. Laws can now be enforced at an unprecedented of detail by dedicated code agents, and markets can be manipulated virtually automatically, often unintended social repercussions.

7. PA: It is the nature of electronic media to expand the effect of human gesture.

Human gestures include motions, utterances and the artifacts of expression. Any re-presention of a gesture 1) is a lower-dimensional image of its source and 2) propagates the original instance. Both result in the effective magnification of the gesture. Clearly the gesturels multiplication makes it accessible to more observers. But, paradoxically, the reduced dimensions can also magnify the source, forcing the observer to focus and interpolate – read between the lines. This is similar to the heightened awareness we might feel peering into a keyhole. Any movement seen through the aperture hints at much we cannot see. We are forced to expand upon our perceptions, filling in missing information as we go.

In electronic media, scale of effect is also a product of speed and distance. A live video transmissionls significance is enhanced by the distance it has to travel. If it came from the room next door, it is not likely to be as important as if it were transmitted from far away. Curiously, physical distance enhances the message, in effect validating the gesture it conveys. Transmission speed is directly related to effectiveness as it more tightly couples the message to its source. This is particularly true of analog transmissions where the two are directly related, the representation as true to its source as the medium will allow.

The apparent magnification of gesture has two divergent effects. It allows the individual to have a much greater effect than without electronic media. The scope of what would be normally isolated gestures is now limited only to their medium. This forces the receiver to distinguish the importance of the magnified, remote gesture from a more proximate, unmediated one. The resulting confusion of scales disrupts traditional relationships based on proximity and physical substance. It can also magnify details of human behavior to monstrous proportions, as is borne out by our increasing concern over privacy and public media.

8. PA: The radical re-scaling a gesture magnifies the realm of private activity to that of public scale.

Electronic mediation affects a message in ways that McLuhan could not have predicted. This is particularly true of digital media where any subject or gesture must first be represented as digitally prior to transmission. This digitization effectively levels all signals – images, sounds or text – to electronic pulses. For example, the digital representation of a mouse differs little from that of an elephant.

The first effect of digital media is to eliminate dimensional scale.

However, the scale of gesture must be restored at any scale to be perceived. As receivers of the information, we have to situate it contextually to derive its meaning. For instance, a digital signal representing microorganisms has to be presented as an image larger than the actual source. Of course, the opposite is also true. A full-scale image of the earth would be less useful than one, say, the size of this page.

But the scalar effect of digital media is not limited to the dimensions of its artifacts. Scaling is also measured in the replication of the source. One instance duplicated is likely to effect twice as many viewers as before. The increase in the availability of an instance via its images is directly related to the scale of its potential impact. This is regardless of the means of transmission or the quality of replication. Replication and – more important – repetition fundamentally alters the apparent scale of the source. Also the degree to which the signal successfully connects with the viewer is an important measure of impact. 5,000 televisions playing to empty living rooms as less effective than one TV playing to an engaged viewer.

But if those 5,000 televisions were being watched, their viewers would be a dispersed public. This makes the source instance – no matter the content -a public event. Further, the instance can be invoked repeatedly presenting it for review again and again. This multiple exposure produces a media artifact independent from the source material. The effect is that of magnification and decoupling of the from its context. It enlarges the original gesture -however intimate -to the public scale. At the sa time, the context attending the gesture is filtered out by digitization and -later -mediation. Paradoxically, this levels the status of intentionally public gestures to that of private sources. Th private life of the current U.S. president, for the example, has overwhelmed his professional life American media.

9 JS: Cyberspace is a place where language lives.

Cyberspace can be thought of as the spatialization of all the computer functionality in the world, especially the functionality of all the interconnected computers. It is all the gates, all the cycles, storage, all the links, all the bandwidth, all the code running, all the connected and controlled ele and electro-that systems, all the unintended side effects, and all the potential for computerized st and action. Therefore, much of the essence of cyberspace emanates from the nature of computer

Computers are fundamentally devices that perform functions by following sets of coded instruct programs. This is unlike a mechanical device which performs one function by virtue of its fixed structure. A computer is a 'virtual' machine, a device which takes its functional form primarily fi language models, from software, instead of hardware. In addition, these linguistic structures, the programs, can recursively operate on themselves, changing, growing, and evolving in the safe en of silicon and magnetic domains. Flexible, adaptable, and uncontrollable language lives in cyber

The language that resides in computers is different in one important respect from the language th hibernates in books. A recipe written in a book cannot cook a meal by itself. The recipe must be activated by a human being who cooks the meal. However, a recipe written as a program in a co can cook a meal quite easily, and it can cook endlessly. Given this fact, as human beings translat and more of there intellectual and social processes into computer code living in cyberspace, it is important that we be able to say precisely what we want. This is crucial, because when your talk computers, you will always get what you ask for, not necessarily what you want.

10. PA: The decoupling of information from its context affects fundamental notions of place an presence, of identity and community.

The effectiveness of an electronic medium depends on the specificity of the expression. A writte will translate more readily into email than verbal speech. This is because spoken communication attended by and inflections and emphasis, gestures and intonations that text lacks. Gestures that closely coupled with our bodies in this way differ from those that produce artifacts like faxes or i Much of our electronic media necessarily reduces bodily gestures to low band width images. Wh results is an artifact distinct from its source. This media artifact is merely a simulation -a crude d of the source.

Electronic media creates such replications in order to operate. We take for granted that the image see are the source itself, though, actually, they are devoid of context of materiality. This simulati without substance is merely a low-grade image when compared with the original. Yet, if it is acti linked to the source, the image is treated by viewers as if it were the source. If the connection bet the image and its source is maintained , and the individual is in dialogue with remote corresponde is less engaged with his physical milieu.

This focus of interaction – displaced from physical context -diminishes the individual's presence source while enhancing it at its destination. The form of conservation of presence is in effect whe using social, electronic media.

But this is not the case when the connection between source and destination is not live. Delays in media disconnect the two, leaving the image to the interpretation of the viewer, and the sender free to engage in his context. The attenuation between individuals and their images is also exacerbated by low resolution. One of the great challenges to the future of media and society is how those are images are mistaken for the source. Relationships founded on such electronic intermediaries would challenge the conventions of social conduct, and already producing unforeseen consequences.

11. JS: Dimensionality is fractal and is dependent upon the of point of view of the observer.

We live in a world of multiple non-integer dimensions where the particular character of any place-instant in space-time can be described using a non-integer dimensional map. Furthermore, our existence distorts both the situation and the map. The perceived differences between different cultures and places can be seen as generated by sometimes subtle differences in the relative importance or effectiveness of various dimensions. Subtle differences in dimensionality also define quality in many situations. Any measurable variable is a dimension in this sense, even when the variable is tightly coupled to other variables in a holistic situation.

Using the above definition, the dimensionality, and therefore the character of any place-instant, may differ significantly at spatially adjacent points when other dimensions change significantly, or the ratio of various dimensions changes, or the point of view of the observer changes. For example, what is the dimensionality of any point in a city? At a busy corner, at noon, in the financial district of a big city, using a dimensional scale of 0 to 1, a simplified dimensional map might read: X=.5, Y=.5, Z=1, rectilinearity=.8, noise (unwanted sound, image, etc.)=.7, level of mediation=.4, kinesthetic=.6, tactile=.5, olfactory=.4, social structural stability=.3, clustering reactiviy=.2. Just down the block in the same city, under the pedestrian overpass near the minipark at 3:30pm the simplified dimensional map might read: X=.1, Y=.1, Z=.1, rectilinearity=.1, noise (unwanted sound, image, etc.)=..5, level of mediation=.1, kinesthetic=.3, tactile=.2, olfactory=.8, social structural stability=.5, clustering reactiviy=.7.

This example points to place-instants which are equally real, equally virtual, yet quite different. The same analysis can be applied to cyberplaces and events which are equally real and virtual but which may have a quite different character. For example, what is the dimensional map describing the character of an experience created by a real-time, active-camera, eye-level video feed showing the busy corner at noon on a shared, human-scale display using multi-point sound with filtering coupled to shared, force feedback I/O driven by seismic and traffic light sensors in the host place? The dimensional map might read: X=.4, Y=.4, Z=.3, rectilinearity=.2, noise (unwanted sound, image, etc.)=..1, level of mediation=.8, kinesthetic=.1, tactile=.8, olfactory=.0, social structural stability=1, clustering reactiviy=.0.

Therefore, to properly understand the character of cyberspace, it is necessary to understand the dimensional structure of the specific kinds of place-instants which can exist in and around computers. Certainly, the character of cyberspace is effected by the structure of the metaphors used to organize the code for human consumption. However, in the long run, the character of cyberspace and of the human activities which grow in and around it will be determined more by the structural properties of computer languages, computer systems, and networks.

To understand what the new cyberspaces and places will mean to human beings, we should look at the particular dimensional mappings which are becoming possible. It may be important to understand which new configurations of space-time may have significant adaptive advantages or which may present particular hazards to life as we now know it.

12. PA: The ability to virtualize surfaces increases their dimensions.

This challenges social relationships to space and time.

Traditional architecture embraces the activities it houses physically. Walls surround us, roofs shel This containment protects us from the elements, but also -through the scale and presence- sets the for the contained activities themselves. Architecture, a frame for social interaction, also socially defines- even constraints-our daily affairs. Our behaviors are tempered by our physical environm

And just as architecture is formed by social forces, it also channels these energies through materia presence. We demand stability of our architecture to sustain our activities and to provide a consis social backdrop for our activities. The persistence of buildings in time manifests and reflects patte cultural behavior. The effectiveness of such framing depends on the demands placed on the viewe

For example, an elaborate picture frame ill serves a subtle painting by distracting the eye from the canvas what. Similarly, the distractions of ornament and detail compete for attention with focusec activities in architecture. For this reason house lights go down at the start a play. The activity on stage becomes the focus of our interest.

Electronic visual media also affect the status of objects by change of state. An unplugged televisi quite different from one conveying a program. While the former is a rough box of plastic and gla latter is effectively a hole in space. Its screen is a window onto another space entirely.

Placing symbols on an object challenges the presence of that object particularly if those symbols d another object or place. The subject matter of the painting clearly supersedes its presence as a can stretched over a wooden frame. What is true for objects is also true for the surfaces of our archite The definition and enclosure we associative with the mute walls of architecture are mitigated by tl moving images of video or film. The theater screen is no barrier once the film begins. For this re the defining role of architecture as a frame for social conduct is challenged-if not obviated- by the virtualization of its surfaces. Material presence-the persistence of form-are reduced by projection point that they themselves or virtualized as our attention shifts from the surface to its contents.

Conclusion

While we may not see direct evidence for the individual hypotheses presented above, taken togeth may help explain conditions we already face with contemporary media. To give just one example issues of re-scaling gesture from private to public scale and the replication of users as prevalent, lo resolution images has undoubtedly had an impact on commonly held notions of privacy. This is currently playing itself out in two contrasting ways. The first is displayed in public media where t most intimate personal details are confided to national television on day-time talk shows. The ins celebrity of the common individual – presaged by Warhol – seems to blur distinctions between pr and 3publicity2 in an ecstasy of exposure. It also reinforces the individuation of the public, dividi according to personality, special interests, and a nascent politics of difference.

In contrast, all aspects of the lives of public figures have been opened to view through the lens of electronic media. Recent evidence taken from the public media includes: the O.J. Simpson trial, impeachment of President Clinton, and the divorce then death of Princess Diana of Britain. What talk show celebrity with the aura of public figures is the negotiation and currency of the self imag While participants of the talk shows willingly give up their privacy in exchange for exposure, the privacy of public figures is wrested from them by journalists, scandal sheets and paparazzi. The replication of images in both cases increases their exposure to the public, yet, in so doing, levels distinctions between earned celebrity and that of self-promotion. It is hard to imagine such an economy of images happening prior to the advent of electronic media. Cyberspace, its digital manifestation, only magnifies this effect through its speed, pervasiveness, and odd combination of intimacy and impersonality.

With the foregoing conjectures we have described cyberspace on the basis of human experience. We hope with these hypotheses to frame the issues attending the design of cyberspace, and their application in different disciplines. We expect that such practical use of theory will validate or refute the hypotheses, and in turn, lead to further development of a nascent theory of electronic spaces.

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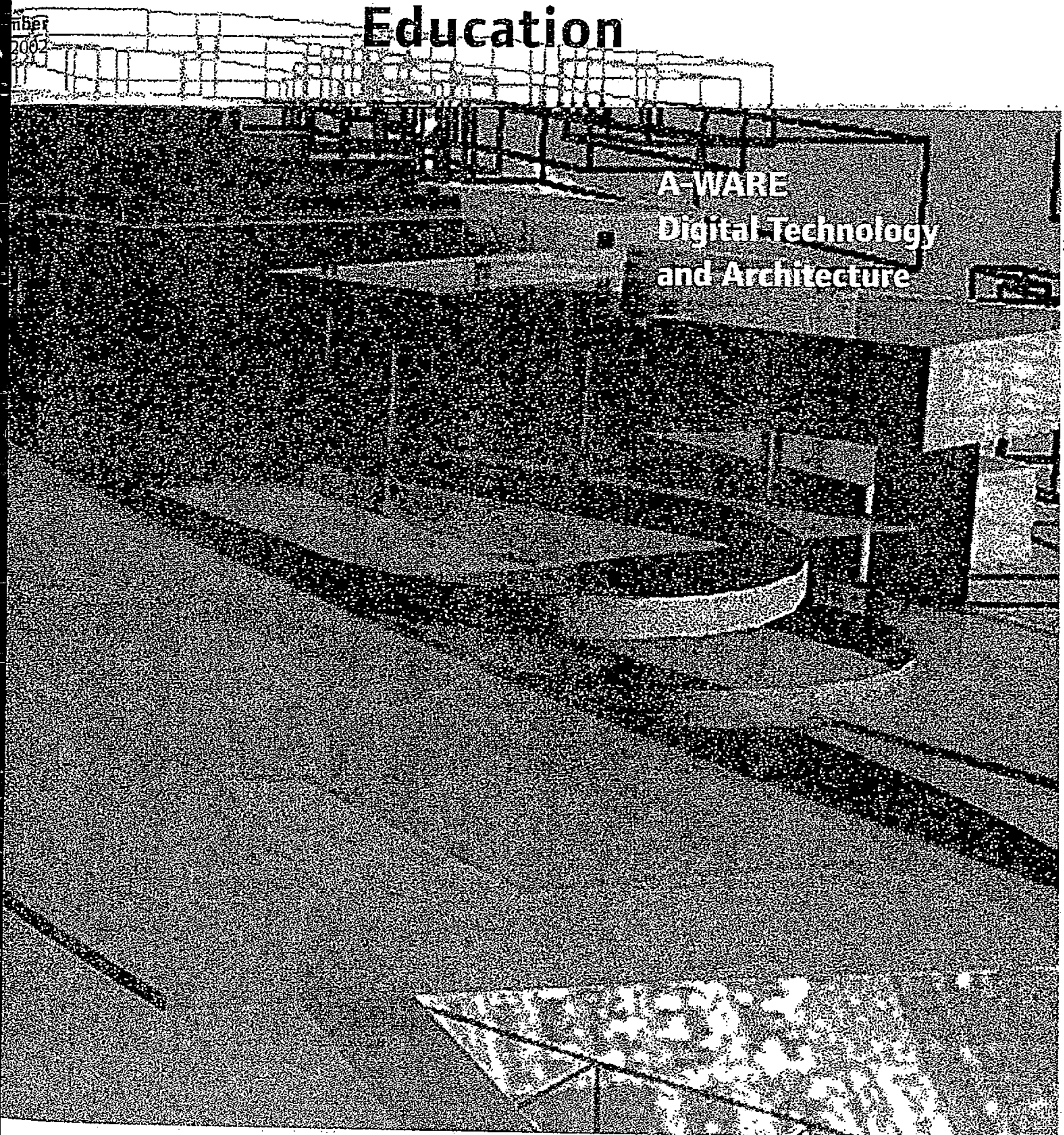

A-WARE
Digital Technology and Architecture

NOVEMBER 2002

Contents

The *Journal of Architectural Education* has been published since 1947 for the purpose of enhancing architectural design education, theory, and practice.

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Cover (detail): Switch Sites, a multi-departmental thesis proposal for Pittsburgh, Pennsylvania, by Emily Eastman, Rensselaer Polytechnic Institute, 2001. Three-dimensional rendering.

Inside cover (detail): Switch Sites, by Emily Eastman, 2001. Axonometric view.

JAE and its editors wish to thank Bentley Systems Inc. and Auto.Des.Sys for their generous support of the color images in this issue. Their contribution is greatly appreciated.

A-Ware \ Digital Technology and Architecture

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rigors of making things then involve translating, cheating, and generating error between these environments.

The work in this collection is a glimpse into the work of several colleagues for whom digital devices are simply a new set of interfaces and switches in the larger colloidal field of everything else, and so they are about the material within which they are embedded, our bodies, our larger marketplaces and networks, and our daily theaters of operation. Discussed as animations or activities, as verbs rather than nouns, these technologies, however invisible, calibrate huge spaces, spaces controlled by commerce, by the military, and by millions of other voices. They enter into and translate instrumentality between organizational protocols, between software and hardware, and between the extremes of wide worlds.

Dark Horse

ersity of Plymouth, UK

an twenty years since the com-
gates of architecture. Acclaimed
was a workhorse to replace the
ve manhours, speed production's
w, exhortations ranged from gush-
to outrage decrying the loss of
e rushed embrace and rejection
s grasp of computation. They pro-
and fears, nostalgias for either

he computer then, this horse
ws? Is it a television? A design
ilder? No, it's a fax, a phone . . .
hape changes in the fickle light of
shrouding its secrets in fading
metaphors that lull us into error

mputation ends up a footnote
istory, it will be in tribute to such
worse, intransigence. For rarely
been so compelled to reassess
but its values and purpose as well.
will trace the influence of compu-
ure and project it forward with a
effect.

A-WARE, our title, employs a suffix common to now pervasive tools of architecture. While the prefix connotes *architecture, artificial*, it also negates the instrumentality of *ware*, hinting at the positions taken in these pages. But, in its totality, A-WARE alerts us. It compels us to actions not taken despite the cries of revolution. With its long silence on the matter, *JAE* showed stoic reserve. Yes, computers were important tools, but did they affect architectural history, design, or theory? This skepticism prevailed during the technology's infancy, but computation now clearly affects all that this journal values. New techniques arise from new technologies. They inspire new thoughts, new forms, and so influence the course of events. Who would have thought this dark horse would stimulate a renaissance of expressionism, brow-furrowing tangles of theory, or anxieties over authorship and agency? The reigning welter of gesture and confusion compels *JAE* to stand back and consider. To provide a synoptic view of trends in design computation and their influence on the profession. To raise awareness.

In these fresh pages, we present an arc of computation's history, theory, and speculation. It begins and ends with historical surveys of architectural computation. These bracket articles on current trends: critiques of new formalism, autonomy of the design object, cybereal conflations in design, anthropomorphic reference, and a gallery of recent work by designers. This wide-eyed glimpse into the future is brought back to earth with a concluding, darker essay that bursts the bubbles of visionary hubris.

We begin with Alfredo Andia's survey of architectural computing. Anticipating Scott Johnson's closing piece, Andia distills a thirty-year evolution into a set of trends by which we can grasp the effect of technology. This taxonomy is handy for sorting out the varied product of design computation today. Conversely, Johnson's essay openly wonders whatever happened to the revolution. His sobering view of three decades of hype shows that not much has changed in practice. Apparently, the revolution was quelled; complacency won the first round.

But the pages between Andia and Johnson offer us new hope, unexpected breaches in the wall. Ted Krueger's "Eliminate the Interface" promotes a liberating view of the design object, one that acknowledges the role of cognition on the part of the designer and, significantly, that of the artifact

Journal of Architectural Education,
pp. 4–5 © 2002 ACSA, Inc.

l. His essay obliges us to reconsider architects' nsibility within the extended design process. ne artifact become a-ware?

Cognition is also at stake in Warren Wake and Levine's article, "Complementary Virtual Archi- e." Blurring distinctions between physical yberspaces, the authors describe architectural s — which I've called *cybrids* — that partake h worlds. Their article echoes current research gmented and mixed reality in cultural technol- Like Krueger's piece, it opens new vistas for ce and theory.

Brian Lonsway's piece is a sharp instrument itting formalist pretensions. His essay tar- he naive instrumentalization of computers ne errant use of metaphor in spatial represen- . He promotes a more robust (mature?) standing of computational effect by denying fectations of hyperbole and embracing la- out truly revolutionary aspects of computa-

Following this critique, a gallery opens onto ction of projects, providing a palliative to this discourse. Comparing the gallery's themes is instructive — note the emphasis on the body, for instance — as is viewing them in the critical light of this issue. Admittedly, there is much that has been left out of these pages, such as telepresence, rapid prototyping, online communities, and robotics. However, even in its limited scope, A-WARE offers tools for evaluating effect, distinguishing traits, and moving forward.

The digital revolution in architecture won't happen so long as computers remain misunderstood. Yes, "nothing is new, only the instruments have changed." But this instrument is of such nature that it calls into question the very use to which it is put. For what happens when the inscriptions of architecture — its symbols, models, and virtual realities — supplant the objects of their use? Are we prepared to face the truth of design's agency: that architecture is a medium, not a product? For the artifacts of architecture are cognitive tools: symbols, metaphors, simulations, text of all kinds. The products of architectural processes, buildings and the like, may in themselves be tools for awareness: libraries, schools, museums, pla worship. This consciousness, this augmented a ness thematically underlies our issue.

A-WARE refers to consciousness. It's not information technology per se, but about mem and cognition, human and cultural knowledge. It's about what information undergoes — mani tion, spatialization, appreciation — to become knowledge, experience. It is not about technol gies — computers, networks, or buildings — it's we use them to extend ourselves to our world one another.

No, the real revolution hasn't happened. disciplinary vigilance — for some, paranoia — is ranted. Technology threatens those dozing in t complacency: architecture's Trojans; those who fuse buildings for architecture, tools for techn those materialists of space blind to its cognitiv worth. It is they who must be alert, poised, aw for the horse has entered their gates and nigh

Keller Easterling and Peter Anders are coeditors of th special theme issue on digital technology and archite

Reframing Consciousness

Edited by
Roy Ascott

intellect™

The Cybrid Condition: Implementing Hybrids of Electronic and Physical Space

Peter Anders

Emergent Spaces

While many architects accept computers as extensions of existing practice, few accept that computers change the very foundations of their discipline. This is in the face of dramatic change in information technologies. For example, recent developments allow the creation of on-line work environments. These electronic spaces, called collaboratories, let researchers share technology to pursue common goals asynchronously, without the need for proximity.[1] Also, the US military has funded study of overlapping physical and cyberspaces to provide briefing facilities for its personnel.[2] Multi-user domains (MUDs) on the Internet are now viewed as promising social workplaces.[3,4] Since many MUDs now incorporate three-dimensional graphics and sound, we can foresee new and compelling uses for these on-line spaces.[5]

These spaces present clients with new means for achieving goals previously reserved to construction. Architects may find that portions of projects will no longer be implemented physically. Indeed, such developments may be hybrids of physical and cyberspaces. Designers may translate the information-rich components of a building programme into flexible, dynamic data-bases using spatial references for orientation and ease of use. To varying degrees, these spaces may be linked to the physical architecture of the project as they relate to the building's and business's activities. These hybrids, here called 'cybrids'[6], provide a model for responsive, physical and electronic spaces.

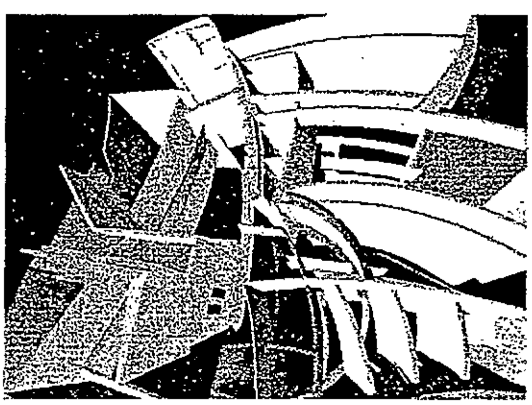

Figure 1. Library design by Ranah Hammash, graduate student at the University of Michigan School of Architecture, incorporating physical and electronic space

It is worth examining how cybrids may affect architectural practice and our environment. Some pragmatic questions need to be answered. For instance, what effect would cybrids have on the physical environment? How would such a strategy be implemented? What might be the interactions between the two spaces and their populations?

To answer some of these questions, let us consider a hypothetical deployment of a cybrid. Imagine that a client approaches an architect to plan a new facility. Assume it is the client's place of business, a business having informational as well as physical needs.

Planning/Design Stage

After initial correspondence, the architect contacts her consultants and engineers. Some are local but others are remote. The team agrees to meet regularly on neutral turf for progress updates. To this end, the architect contrives a site on the World Wide Web allowing many modes of interaction. Most importantly, the site is a multi-user domain that lets the team meet continuously either through use of avatars or by live video feeds from their workplaces.[7] Participants may also do so asynchronously by leaving messages in various formats, much in the way that email and Usenet newsgroups operate.[8]

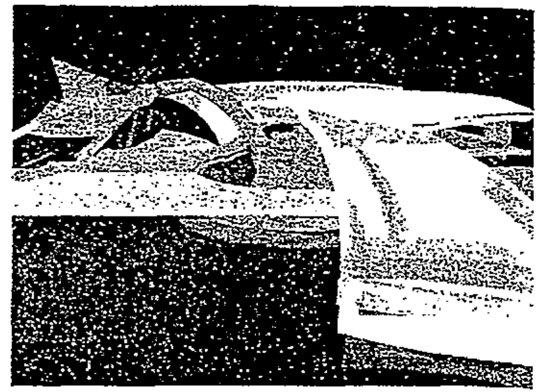

Figure 2. Cybrid library seen from ground

By modelling data taken from a satellite, the architect reconstructs the terrain of the physical site within the cyberspace. All pertinent information is included in this recreation: vegetation, power lines, water and sewer utilities, power, gas and media connections.[9] Significantly, she creates a platform in this model, the meeting space within the project's multi-user domain. When the team gathers, they do so in the presence of the site's simulation in cyberspace.[10]

One strategy involves a kind of game that encourages imagination and cooperation on the part of the team members. In a series of quick agent-assisted exercises the team produces a number of optional solutions that are manifested in alternative incarnations of the site.[11,12] The computer evaluates each schematic solution for fitness according to predetermined constraints such as cost, energy consumption, air flow, daylighting, acoustics.[13]

Another approach uses computer agents assigned to building components that interact with one another, fighting for resources-fresh air, daylight, heat-until they reach a stable, optimal state.[14] Yet another tool at the designers' disposal are genetic algorithms that let them breed a variety of solutions, optimising different parameters whether functional or aesthetic.[15]

The architect and client determine which functions need to be physical and which might take form in cyberspace.[16] These might manifest the business's computer networks, facilitating alliances with remote companies.[17] Some functions may be replaced by cyberspaces, particularly information storage facilities.[18]

Some of these functions are portrayed in cyberspace as ambient environments. Some are contiguous with the cyberspace model of the proposed building. Some hover beyond the site's simulation while others are nested within one another, available by entering them or summoning them categorically into view.[19]

The cyberspace of the team is also a tool for the client. He may check in to attend meetings. The cyberspace can be used for fund-raising activities with the interactive model and multi-user interface. Gatherings may be arranged live 'on-site' or the event may become a public Internet storefront for the business. It may even become a place of production, capitalising on its computer/media affordances. Design work done there-as before-may be experienced or sent to devices that render it physical.[28]

The cyberspace is ubiquitous while the building is local. Because of this the cybrid is a tool for the promotion of the business-the way Web sites are currently used for advertising. For it also contains the non-physical components of the business-literature, advertising, communications.

In ensuing years, the physical plant undergoes change. Plans derived from the cyberspace assist in planning additions and modifications.[29] The cyberspace changes as well, users influence its configuration or its information structure changes automatically. Only some of these changes are reflected in the physical structure, most being distinct and untethered. The cybrid's database may constantly evolve according to the users' needs.[30]

The Sweet Hereafter

Finally, the building is no longer required. The business has been relocated, new facilities are needed to meet business demands. The cybrid's cyberspace can supply data for sale of the structure to a new owner or provide demolition plans. Further, with its database model of as-built conditions, it can provide information for the reclamation of materials for recycling.[31] In the end, all that remains of the cybrid is the ghost, the cyberspace that attended the construction, life and death of the building.

And yet it is a lively ghost. So long as a networked computer maintains the database and multi-user domain, the cyberspace remains active. Indeed, it may still be the client's business space regardless of where he has moved. Or it might be an historic archive of the building it once supported. It might even take on a life independent of the physical operation. For instance, a long-defunct nightclub could still host parties long after its physical demise. Just as buildings take on new owners, so too might cyberspaces be recycled.[32]

Conclusion

In this scenario we have seen how the cybrid condition affects the built environment. Yet these observations are necessarily conditional and do not consider social and economic effects. However, cybrids already manifest themselves in local area networks as well as sited multi-user domains. Where they may evolve to next depends on social/economic forces and the imaginations of their developers.

Notes

1 Ross-Flanagan. pp. 52-9.

2 Downes-Martin et al. pp. 28-38.

3 Curtis et al

4 Bruckman et al

5 Anders 1966. pp.55-67.

6 Anders 1997. pp.17-34.

7 Technologies: groupware, file transfer protocol (ftp), telnet, email, 3D multi-user domain software (Chaco Systems World Gen software), HTML, virtual reality modelling language, modelling software, word processing

software, spreadsheet software, animation software, video streaming software, high-speed computer network with Internet connections, video projection, data and telephone connections.

8 Technologies: Usenet newsgroups, HTML.

9 Technologies: CAD software and modeller, Virtual Reality Modelling Language (VRML), access and software to use satellite-supported global data system.

10 Technologies: CAD modeler, VRML, CUSee-me video conferencing software, video-streaming support, 3D MUD software.

11 McCall et al. pp. 153-62.

12 Knapp et al. pp. 147-52.

13 Mahalingam. pp. 51-61.

14 Pohl. 1996.

15 Krause. pp. 63-72.

16 Anders, Peter. 1997. op.cit.

17 Technologies: Electronic Data Interchange-Value Added Networks (EDIVAN).
Virtual Private Networks (VPN), groupware, intranet software.

18 Technologies: Database software actively linked to HTML files available
through network.

19 Technologies: VRML, HTML. This posits the linking capability of HTML be employed in creating interactive VRML models, a capability not yet available.

20 Technologies: Internet telephone software and support, streaming video, 3D MUD software, CUSeeMe teleconferencing software and support.

21 Technologies: Agent-driven Internet search engines, ftp.

22 Technologies: VRML, 3D MUD software, video conference software, data projection system.

23 Technologies: CAD modeling software, VRML.

24 Technologies: video conference software, EDIVAN, Internet commerce software, HTML.

25 Recent research at XeroxPARC proposes the use of forensic agents in mechanical systems that 'bid' for service to parts of a building. The highest bidding agents will receive power, heat, cooling according to need. This market model for building operation can reduce energy costs by up to 20%.

26 Feiner et al. pp. 74-81.

27 Technologies: EDIVAN, Internet fire-wall security, graphic object-oriented programming software (Visio).

28 Technologies: CAD modeller, stereolithography, computer-driven laser software and support, ftp.

29 Modifications to the facility will incorporate many of the cited technologies as though the changes were new work.

30 Technology: Database software and support, HTML.

31 Technology: CAD, Database software, HTML.

32 'The Street finds its own uses for things-uses the manufacturers never imagined'..Gibson. p. 29.

Anders, Peter. 1996. 'Envisioning cyberspace: The design of on-line communities', in *Design Computation: Collaboration,reasoning,pedagogy*. McIntosh, P. and Ozel, F. eds., proc. ACADIA 1996 Conference, Tucson, Arizona. pp. 55-67.

Anders, Peter. 1997. 'Cybrids: Integrating cognitive and physical space in architecture', in *Representation and Design*. Jordan, P., Mehnert, B., Harfmann, A. eds., proc. ACADIA 1997 Conference, Cleveland, Ohio. pp. 17-34.

Breiteneder, C.J., Gibbs, S., Arapis, C. 1996. 'TELEPORT: An augmented reality teleconferencing environment', in

Virtual Environments and Scientific Visualization '95: proc. Eurographics workshops in Prague, Czech Republic 1996 and Monte Carlo. 1996. M. Göbel, ed. Vienna: Springer Verlag. pp. 41-9.

Bruckman, Amy and Resnick, Mitchel. 1995. 'The MediaMOO project: Constructionism and professional community'. *Convergence* 1(1).

Curtis, Pavel, and Nichols, David. 'MUDs grow up: Social virtual reality in the real world'. Austin, Texas: 1993.

Downes-Martin, S., Long, M., Alexander, J. 1992. 'Virtual reality as a tool for cross-cultural communication: An example from military team training', in *Visual data interpretation*: 10-11 Feb. 1992 San Jose, Cal./ Joanna R. Alexander, chair and director; sponsored by SPIE, The International Society for Optical Engineering, ISNT The Society for Imaging Science and Technology. Bellingham, Wash.: SPIE. pp. 28-38.

Feiner, S., MacIntyre, B., Höllerer, T., Webster, A. 1997. 'A touring machine: Prototyping 3D mobile augmented reality systems for exploring the urban environment', in proc. International Symposium on Wearable Computing 1997, Cambridge, MA. October 13-14, pp. 74-81.

Gibson, W. 1992. 'Academy Leader', in 'Cyberspace: First steps. Benedikt, M. ed. Cambridge, Mass: MIT Press. p. 29.

Knapp, R. W. and McCall, R. 1996. 'Phidias II: In support of collaborative design', in *Design Computation: Collaboration, reasoning, pedagogy*. McIntosh, P. and Ozel, F. eds., proc. ACADIA 1996 Conference, Tucson, Arizona. pp.147-52.

Krause, Jeffrey. 1997. 'Agent Generated Architecture', in *Representation and Design*. Jordan, P., Mehnert, B., Harfmann, A. eds., proc. ACADIA 1997 Conference, Cleveland, Ohio. pp.63-72.

Mahalingam, Ganapathy. 1997. 'Representing architectural design using virtual computers', in *Representation and Design*. Jordan, P., Mehnert, B., Harfmann, A. eds., proc. ACADIA 1997 Conference, Cleveland, Ohio. pp. 51-61.

McCall, R. and Johnson, E. 1996. 'Argumentative agents as catalysts of collaboration in design', in *Design Computation: Collaboration, reasoning, pedagogy*. McIntosh, P. and Ozel, F. eds., proc. ACADIA 1996 Conference, Tucson, Arizona. pp.153-62.

Pohl, Kym. 1996. 'KOALA: An object-oriented architectural design system'. Master's thesis, California Polytechnic State University, San Luis Obispo. unpubl.

Ross-Flanagan, Nancy. 1998. 'The virtues and vices of virtual colleagues' in MIT's Technology Review, Mar/Apr. pp. 52-9.

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Design Computation
Collaboration, Reasoning, Pedagogy

The Association for Computer Aided Design

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Technical Chairs and Proceedings Editors

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Arizona State University

Site Coordinators

Robert Dvorak, Warren Hampton, and Oscar Blazquez
University of Arizona

Envisioning Cyberspace: The Design of On-Line Communities

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ABSTRACT

The development of the World Wide Web into an active, visual social environment poses unique opportunities for the design professions. Multi-user Domains, social meeting places in cyberspace, are mostly text-based virtual realities which use spatial references to set the stage for social interaction. Over the past year design students at the New Jersey Institute of Technology School of Architecture have investigated several text-based domains. In the course of their work, they envisioned and graphically portrayed these environments as immersive virtual realities through the use of computer animation. Their studies addressed issues ranging from the nature of symbolic motion to social/political structures of these domains.

INTERNET AS SITE

Multi-user Domains (MUDs) are mediated social environments on the Internet. Originally intended for role playing games such as Dungeons and Dragons, they have since developed into elaborate social settings serving on-line social and professional communities. Despite the spatial qualities of MUDs, few of them are visual. Instead, they are text-based virtual realities which require the user to rely on descriptions of space and motion to create an image of the domain.

The use of text is dictated by the MUD software. Currently there are a variety of MUD types which differ largely in their programming code. MOOs (MUDs Object Oriented), MUSHes (Multi-User Shared Hallucination), MUSEs (Multi-User Simulated Environment) are among the many hundred MUDs currently operating on the Internet. The acronyms can be whimsical. The investigators of a MUCK were told that it stood for Many Unemployed College Kids. It actually stands for Multi-user Collective Kingdom. "MUD" and "domain" are here used to generically refer to these types.

The text interface is an efficient medium. It limits memory requirements for the computers and speeds up real-time interaction. It can also conjure an image with a well-crafted description. As a result, MUD users often prefer the verbal environment, arguing that it allows them freedom of interpretation. Some users insist that the introduction of graphics will reduce, rather than enhance, the MUDding experience.

Use of MUDs involves logging on to a computer server, often using Telnet or Gopher programs. Once on, the user types responses to text on the screen, say, the description of room they have "entered". The user might type "N" to leave the room by going north. The scene then changes as a new space description is offered. Users move from place to place by using sequential commands or by teleporting directly to their destination.

Conversation on MUDs is formatted to simulate dialog in a book. If a user, Fred, types "Hey, there!. the computer configures this to read as "Fred says. 'Hey, there!'" The result is that the user appears engaged in both the reading and creation of a novel. As users become more familiar with the commands, they gain a greater range of expression and action within the MUD.

For example, the following is taken from a session held by researcher Mike Buldo on his subject MUD, HoloMUCK. Naima and Des are the avatar names of other MUD citizens. "You" refers to Mike and is used only on the machine he is logged onto. Other MUDders' screens see the name of his avatar, Kilian. Spelling errors often reflect the speed of interaction since dialog happens in real time.

2) Naima pages: "They arrived! Well wonders never cease. "
Time> Tue Oct 31 19:53:04 1995
page naima= we d got them on Monay!!, tkanx alot
You page, "we got them on Monday!!, thanks alot" to Naima.
w
You head west...
Main Street (800W)
This once-desolate section of Main Street is looking busier these days.
To the north, at 800 W. Main St., stands the Red Dragon Inn.
[Obvious exits: north, w, e]
page dex= are u free tommorow between 8Your pager vibrates slightly. and 10..am?? You page. "are u free tommorow between 8 and 10.. am ??" to Dex.
...
3) Dex pages: "no, not till tomorrow night"
Time> Tue Oct 31 19:54:33 1995
page dex=awww...the people comming in to review tha e project will be on wanna let you meet them...would y i might be round tommorw night..n[Sjade] Give a man a fish and he'll eat for a day. Teach him how to fish and he'll eat forever.

page dex=awww...the people comming in to review the project will be on wanna let you meet them...i might be round tommorw night..dunno
You page, "awww...the people comming in to review the project will be on wanna let you meet them...i might be round tommorw night..dunno" to Dex.
You head west...
Main Street (900V~/ Ohio Avenue You are at the intersection of Main Street and Ohio Avenue, very near the western border of Tanstaafl County. This region is very hilly, and covered with a variety of trees—oaks. maples, and especially pines. Reality still holds sway in this region, but just to the west, the darkened West Tunnel burrows through a hill and into the unknown regions beyond...

Graphic MUDs are still a technical novelty and their success is mixed. Preliminary efforts (the Palace, World Chat and Alphaworld) are disappointing. The schematic quality of the contents and their graphics lack the poetry found in text MUDs. The ephemerality of MUDs also argues for spaces which are dynamic, responsive to their social and subjective nature. While text-based environments have an implicit, logical structure, their image as architecture is highly subject to the user. Current graphic MUDs, on the other hand, lose this depth by literally illustrating architectural environments. In many cases their illustration comes at the expense of poetry.

MUD ARCHEOLOGIES

In the spring and fall semester of 1995, my graduate and undergraduate students at the New Jersey Institute of Technology's School of Architecture surveyed ten MUDs on the Internet. This work was partially funded by an NJIT SBR grant for cyberspace research. The study was largely conducted in a CAD supported design studio and was carried out as a semester-long design assignment.

The MUDs selected were social domains not overtly used for role-playing games. Many MUDs operate as gaming environments, following the example set by Dungeons and Dragons in the early '8Os. The appeal of these games lies in their setting and participant role-playing. They act as a form of theater, or masque, in which MUDders may take on one or many identities in the course of play. Brenda Laurel and Sherry Turkle have written extensively on the psychological and social implications of this activity. The students' selection was limited to text-based MUDs to maximize the students' design opportunities.

The students, in teams of two, became citizens of their selected MUDs and explored the spaces described by the text. The team members and their selected MUDs are listed below.

MUD	*Web Address*	*Investigators*
Spring 1995		
Cyberion City	*ai.chezmoto.mit.edu 4201*	*Sean Edwards and Tom Mesuk*

Diversity University		*Kevin Spink and Tom Mesuk*
Jay's House		*Keelin Fritz*
Fall 1995		
BayMOO	*baymoo.sfsu.edu 8888*	*Susan Sealer and Thomas Vollaro*
DreaMOO	*fiinix.metronet.com 8888*	*Melanie Pakingan and Ian Dorn*
HoloMUCH	*collatz.mcrcim.mcgill.edu 5757*	*Mike Buldo and Robert Zappulla*
MediaMOO	*purple-crayon.media.mit.edu 8888*	*Michael Lisowski & George Paschalis*
Meridian	*sky.bellcore.com 7777*	*Dana Napurano and Keith Kemery*
The Chatting Zone	*reliant.lasermoon.co.uk 8342*	*Eric Syto and George Wharton III*
University of MOO	*132.207.192.76 7777*	*Raymond McCarthy and Brian Booth*

Typically, the team would divide the work between a navigator and cartographer. One operated the machine, "moving" from place to place within the MUD. The other charted locations of the places they visited. As the domains were mapped, these diagrams grew increasingly complex. This information was carefully, documented to produce a log/sketchbook and a 3D logical adjacency model of the MUD (Figs. 1, 2).

These models, perhaps the first spatial documents of these MUDs, formed a schematic diagram of the domains' spaces. Their coding was intentionally simple. Cubes represented spaces which were accessed directionally, using N, E, S, W or Up and Down commands. Spheres indicated spaces accessible by teleporting or by invoking their names. Points of MUD entry were colored red. Spaces were linked with simple rod connections appropriate to the directions indicated. Other symbols varied from model to model depending on the specifics of the MUD.

The final results were surprising in their complexity. Resembling extremely large molecular models, they documented hundreds of spaces. In many cases the models had to remain unfinished since the MUDs contained many more spaces beyond their main structure. Since MUD structure is dynamic, many of them grew and evolved throughout the study.

Most MUDs mapped easily as flow-chart diagrams. Some, however, had spatial anomalies. A room in DreaMOO described as being west of another, was entered by going east from that room. The nested arrangement of the Chatting Zone spaces would not translate easily to a ball and stick model. The rigorous structure of HoloMUCK forced the creation of pseudo-spaces just to allow movement through it.

DOMAIN STRUCTURE

The logical adjacency model of each MUD has a distinct form, like a fingerprint. Often MUDs begin as a verbal diagram of a neighborhood (Jay's House), an existing town (The Chatting Zone) or even the Earth (Meridian). Once in place, citizens of the MUDs are invited to build their own rooms and buildings. Over time the configuration of the domain changes to the point that not even its operators. the wizards (Note the reference to Dungeons and Dragons!), know the current shape of the community.

It is a participatory architecture, a kind of *architecture without architects*. Here we have the electronic equivalent of earlier cultures whose buildings inspired Bernard Rudofsky's study by this name. There are constraints on building, however. The degree of freedom that builders have depends on the wizards. Some MUDs, like HoloMUCK or Jay's House, have stringent codes enforcing the "realism" of proposed additions. The ability to build rooms also is dictated by the wizards.

In most MUDs, particularly MOOs, all objects are descendants of other objects. It is a result of object oriented programing which allows replication of code modules for editing and reconfiguration. All objects in a MUD have this characteristic whether it is a room, flower pot or wind-up toy. Even the avatars which represent MUD citizens fail into the category of object. They are all related in this curiously genetic way.

Each citizen is allotted an amount of memory to build objects. This increases with the status of the citizen. Getting memory or status in MUDs is a symbolic and social issue, often a result of "who you know". In the study, some researchers achieved high-ranking builder status and eventually became wizards themselves.

Some domains were clearly based on physical models, often based on the hometowns of the administrating wizards. For example, The Chatting Zone is a cyberspace mapping of Ipswich, Ireland, hometown of the MUD's founder. While Meridian maps the entire planet, its point of entry is in Norway, home of its wizard. Oddly, Meridian's server is in Morristown, NJ!

build their own rooms once they have citizenship. These rooms are often independent of the main logical structure, hovering outside the domain. In DreaMOO, for instance, linking new construction to the main structure requires permission. Not only must the builder petition the wizards, but the creators of connecting spaces. It is a complicated affair, and none our investigators were able to link their work to the main structures.

This results in constructions which have non-directional connections to the main MUD. Most private spaces, often quite elaborate, can only be accessed by teleporting. Guests may enter these spaces only if they are invited by the owner. As a result, many of the private spaces of the MUDs remained unmappable because of access problems. Often the addresses for teleport access were simply unavailable. This points up one of the advantages of graphic MUDs. Navigation is difficult if one needs to memorize specific addresses. Browsing and discovery are facilitated by visual, non-textual spaces.

The freedom allowed by wizards directly affects the MUD's structure. BayMOO, a San Francisco based MUD, has a laissez-faire approach and over time has evolved into a free-form branching structure. Its logical mapping reflects its incremental and unplanned growth. In contrast, Jay's Place has such severe "reality" requirements that descriptions of nearby cliffs had to be rewritten to reflect the actual rock composition.

Generally, MUDs in which the wizards exert the most control are more rigorously geometrical and easier to map. The looser structure of more participatory communities, like MediaMOO, make them initially more difficult to navigate. In MediaMOO, organizing spaces like Curtis Commons were later added to provide orientation for the users.

HoloMUCK illustrates the extremes of control. Its server is located at McGill University, in Canada. HoloMUCK's predecessor was called Flux. Originally, its wizards had developed an open MUD, placing minimal restrictions on building proposals. As the MUD developed, the configuration became more and more complex. The founding wizards felt that the illogical nature of the spaces made the MUD unusable. As a result, navigation depended more and more on teleporting and the illusion of the larger MUD structure was lost.

HoloMUCK was recreated using geometry clearly derived from a generic Canadian small town. Two main roads intersect to provide orientation and a river runs through it. The wizards have created one of the most controlled MUD environments found in the study. As in Jay's Place, HoloMUCK's planning stresses the realism of the domain. If a closet were opened to reveal an aircraft hangar, the wizards would not allow its construction in the main MUD structure.

If the failure of the original HoloMUCK was due to its spontaneity, the new MUD suffers from its stifling control. HoloMUCK's wizards have tried to resolve this by letting builders do what they like outside the "city limits". Lying outside the main structure is a free-zone in which spaces may follow any or no logic at all. As a result, most new construction lies outside the rigorous and isolated core, TANSTAAFL. TANSTAAFL is an acronym for "There ain't no such thing as a free-lunch", possibly an ironic reference to the surrender of freedom in the name of the MUD community.

"REALITY" CHECKS

The failure of some MUDs is due to problems other than politics. MUD size is largely determined by the number of spaces and objects programmed by the citizens. The number of rooms vastly outnumbers the users - especially the number logged on at one time. A paradoxical result is that MUDs with the greatest number of builders seem to have the lowest density population. This explains the apparent vacancy of many MUDs. While there are pockets of activity, large portions of the MUD often remain unused and rarely visited.

An example of this is MediaMOO. This MUD at the Massachusetts Institute of Technology was developed as a learning tool. Its many spaces and student experiments extend far beyond its original configuration. As a result, the investigators often found it largely vacant when they visited. This does not necessarily reflect on the success of the MUD. MediaMOO's spaces are largely navigable with conventional commands. Problems arise when the bulk of a MUD is invisible to its users and only accessible via teleportation, as in University of MOO and portions of BayMOO.

Unsuccessful rooms are like unsuccessful Web homepages. Once built they are rarely modified. Visitors may "hit" on a space once or twice, but without novelty or companionship to engage them, they rarely return. Our researchers found that few fellow MUDders knew the domains as well as they. Many citizens had not explored the main structure since their first few visits.

MUD activity centers on the entry, where users begin their sessions. In the MUD it often appears as a lobby, a town square or visitor center. In LambdaMOO, it is a closet. The area immediately around the entry is also populated but occupancy drops off sharply thereafter. MUDders often prefer teleporting to their destinations rather than sequentially moving through the labyrinth of rooms.

The problem is exacerbated by privatization. As mentioned, private spaces are often not spatially linked to the main MUD structure. The Chatting Zone and the University of MOO apparently have a great number of rooms in which private socializing occurs. Many citizens enter the MUD only to teleport directly to their rooms. In some MUDs citizens enter directly into their rooms, often staying there to monitor the MUD. This depletes the activity in the public portions of the MUD. There usually aren't enough users logged on to support this stratification.

This polarization between entry and private rooms results from poor spatialization and design. Real cities don't have single points of entry. Their periphery is open to the traffic of commerce and the population. Even the most private spaces in a city are part of its spatial structure. MUDs, while seemingly based on reality, ignore some fundamental truths of community planning. Teleportation is a symptom of the problem, but not its cause. HoloMUCK forbids teleportation because its wizards feel teleporting destroys the sense of physical community. This solution is misconceived. Teleportation is merely a user's way around a problem of design.

The graphic representation of a domain offers solutions to these problems. If visitors can "see" the extent of the MUD, they might be more inclined to explore it. Presently, the text medium blinds users to distant spaces and blinkers their experience. It limits their exploration to sequential plodding from space to space. They are only aware of the rooms immediately adjacent to themselves. The experience of motion is often like moving through a series of underground chambers. The creation of rooms is often referred to as "digging" a space. This combined with the acronym MUD makes MUDding curiously earthbound. (In fact, the opacity of the Internet for many users belies the term "cyberspace").

Teleportation is preferred to this movement once destinations are known and citizens are familiar with their domains. However, social activity diminishes as teleporting increases. Teleportation does not allow for the chance encounters and discoveries offered by the illusion of actual movement.

Possible resolutions would include incorporating the private spaces into the main structures of the MUDs. Limiting access to these spaces to spatial motion may also improve activity in the main structure. However, the burden of access should be lightened by providing more access points to the MUD. This would shorten the distance to a destination. If more than one entry is used, each will serve as a node of activity, creating the equivalents of neighborhood pubs and hangouts.

Random entry at these points would also stimulate exploration and interaction. Once the main entry has a critical mass of occupants, additional visitors could be let in elsewhere to spread activity to the lesser frequented areas. It could revitalize the MUD community.

ENVISIONING CYBERSPACE

The next phase of the study was to create two visions of the MUDs: one from a consensus of the subject MUD community; the other a personal interpretation by each investigator. In both cases the ambiguities of the text were used to spark the design process.

After the creation of the logical adjacency models, the investigators interviewed several of their fellow MUD citizens. This came naturally from the mapping phase. Many friendships had been made in the course of charting the domains. Other MUDders were curious about the project and would periodically check on its progress. The wizards were impressed, at times flattered, by the dedication of the researchers to their domains. The citizens were generally enthusiastic about helping with the study.

The results of the interviews were mixed and initially disappointing. The original aim of this phase was to arrive at a consensus vision of what the MUD would be like as a three-dimensional environment. By having the MUDders elaborate on their domains, it was hoped that enough detail would be generated to visualize the spaces. This proved difficult at best.

In only a few cases did respondents provide useful information. When asked to elaborate on a series of spaces, one woman faxed sketches she had made to illustrate what she imagined them to be. This was an exception to the rule. Largely, the responses, though well-meaning, generated no more than the descriptions already provided by the MUD itself. The MUDders were not prepared to embellish these texts and were bemused by the researchers asking such "obvious" questions.

This phase of the study contrasted the researchers' interests with those of their fellow MUDders. The project had been created with the aim of envisioning these cyberspace communities. Most MUDders don't question the use of text, treating it as a given while logged onto the domains. Some feared losing the richness of text to the newer graphical MUDs. To them the MUD is about social interaction, not the setting.

While there is no denying the effectiveness of text, graphic online environments can have their own poetry. If we accept MUDs as "virtual theater", we have to acknowledge the importance of the set. Actors use the set and props to convey subtle information. Leaning on a wall has different implications than facing it, for instance. Sets and props are distinguished by their evocative potential. Visualizing them would allow a subtler manipulation of these devices, "broadening the bandwidth" of the theater.

Many MUD citizens value the subjectivity of the text and bridle at the definition of the MUD space with a fixed design. Anarchitecture seemed preferred over an architecture. This became a theme many of the researchers incorporated into their own designs. Some projects merged text with graphics to provide a hybridized environment, others developed methods to allow MUDders to customize their image of the domains.

In the final phase of the project, the researchers were to individually generate a vision of their MUDs. They were to incorporate anything they might have learned in the course of the study, but were not bound by the information generated in the interviews. Each student was asked to use this opportunity to express a unique quality of being online. This was an effort to define the qualities of cybereal architecture.

Cybereal architecture here refers to virtual objects within the computer's illusive space. Unlike CAD drawings or models, they are not part of a design process which culminates in a physical presence. Instead, they operate autonomously within cyberspace to define information content. Common examples of cybereal objects would be computer icons and windows. They act as symbols of information structures (files, directories). Once spatialized these objects could define meaningful space for location of information much as architecture is used to define institutions, organize contents and orient the users within.

The sequence of spaces encountered by the students in the rendition had to match the layout of the logical adjacency model. The models became the focus of much debate since the illusion of space and motion had not been challenged to that point. The logic of the MUD structure (orientation, connection and location) is verifiable, but the nature of the spaces and connections is subject to debate.

POETRY IN MOTION

Motion in a MUD is an illusion created by the text sequence. MUDders issue directional commands to get from place to place. If no directional options are available, they can use the name of the destination to get there. However, teleporting differs little from conventional MUD movement. Both result in a space description with options for exits.

Other means of motion are available. Many MUDs like Purple Crayon and Meridian have modes of public transportation, such as trains or boats, which take MUDders on preselected routes. Some MUDs offer planes or taxis which use teleportation since the destination, once known, can be called out. The experience is sequential and textual, as described before, with the same result. These vehicles are a camouflage for the paradox of bodiless movement.

Motion by the user is entirely symbolic. The symbolism of motion is crucial to the MUD experience. It implies that the user is situated and complicit within the MUD environment. Movement brings the user into the MUD psychologically. It is integral to the MUD's immersive nature.

The investigators were encouraged to view this motion critically, seeing themselves as stage managers in a play. This manager has a unique position in a production. Unlike the actors or audience, the manager is not immersed in the environment. He is charged with realizing the illusion. The students were to create the illusion of motion without necessarily mimicking it.

Several students explored motion in their visualizations. In all cases, the work was presented as computer animations rendered with AutoDesk's 3D Studio. While CAD animations are still a novelty in architecture schools, the dynamic, ephemeral qualities of MUDs demanded the medium. Fades, pans, animation, change of viewing angles, morphing and other cinematic methods became common practice by the end of the study.

These techniques were specifically used to address the illusion of motion. For example, fading into another scene is similar to the experience of reading the description of a space. Entering into an unknown space was also presented as motion seen through the back of the head - like a video camera pointed out the back of a car. The viewer doesn't know where he or she is until the room has already been entered.

Some investigators interpreted motion relativistically. Rather than the viewer moving around the space, the space would move around the viewer. This reflected the actual user sitting in a chair while manipulating the MUD environment. This was demonstrated in animations where, although the viewer changed direction, only the setting moved while the "sky" did not.

In other cases morphing techniques were used to transform distant buildings into closer buildings, providing a dreamlike quality to the motion. One project by George Wharton III proposed that the MUD was always the same space and that the viewer was fixed. The illusion of motion was provided by a continual morphing of the MUD envelope. "Architectural" ripples in the envelope internally created the illusion of passing buildings.

Morphing can create motion effects in other ways. If rooms transform themselves into a user's destination, a non-spatial movement is effected. One researcher, Susan Sealer, devised buildings which changed shape at the user's whim. Going from one space to another was equated with reshaping the point of departure. In another experiment she changed the focal length of the software cameras. By dynamically reducing the focal length, the original scene was reduced to a point. The succeeding scene seemed to engulf it as it came into view, ultimately replacing the preceding space.

Another investigator, Tom Vollaro, presented his MUD as empty space filled with flying shards of matter[Fig. 3, 4, 5]. When the user wanted to enter a space, the shards would collect around him as though drawn by a magnet until the space was formed. This resulted in a graceful ballet of fragments shattering and reforming as the user "moved" through the MUD.

SOCIETY AND SELF

The user's identity while online is represented by a character called an avatar. Avatars often do not have the same name as their owner sometimes disguising the user's identity. The result is a masque which retains the role-playing character of the earlier MUDs. Much has been written on the subject of identity and its effect on MUD communities. Work by Brenda Laurel, Allucquere Stone and Sherry Turkle stand out as compelling investigations of this issue.

Several researchers focused their work on the avatar's presence in the MUD. As with motion, presence can be viewed relativistically. Presence is a subtle interaction between the self and the environment and several avatars were designed to manifest this relationship.

One investigator, Dana Napurano, associated light with this issue. When moving from place to place in a text-based MUD, the user activates the descriptions of the rooms. That space is "illuminated" by reading the text. This illumination would remain constant until one avatar met another and engaged in conversation. At that point the light emanating from one avatar focused upon the other, casting the rest of the space into shadow. Attention and forgetting were both illustrated by this simple gesture.

While many avatars in the study were humanoid in shape, there were significant exceptions. In an independent project by one student. The setting of the MUD was invisible and avatars were abstract, illuminated forms [Fig. 6]. When an avatar entered a new space, its color changed. Groups of avatars in a space formed constellations of light, intensifying their color while in dialog. Cyberspace was envisioned as a universe of human constellations.

In another case an investigator created a user interface for MUDding. One side of the screen offered a menu of masks. the other showed a nightclub scene [Fig. 7, 8, 9]. The scene was populated with floating masks of various colors. By selecting a mask from the menu, the user could take on the point of view of any of the avatars in the night club. The user could theoretically maintain a dialog with himself by shifting between masks. The same researcher presented other interface screens for navigation purposes [Fig. 10, 11, 12].

Despite the personal mediation of the avatar, MUDs can be surprisingly affecting. Communication seems intimate because of its unearned familiarity. Typing messages alone in a room to another online is similar to a phone conversation. As a result the researchers made a number of friends and acquaintances on MUDs throughout the study period. Some continue to maintain contact.

On a larger scale, these bonds can create subgroups within a larger MUD. These can operate as special interest groups and develop political power. For example in the University of MOO, the wizards' capricious pranks were causing the MUD citizens to call for their removal. Some were even planning to create a new MOO in protest. In other MUDs, social harmony can create enduring loyalties.

The researchers of DreaMOO discovered that a number of their compatriots online were refugees from the now-defunct Metaverse MUD. Metaverse, a fairly elaborate MUD charged its members a fee for use. Apparently, it

SUGGESTED READING

Anders, Peter. 1994. Architecture in Cyberspace. *Progressive Architecture.* October 1994, p. 71.

Benedikt, Michael (ed.). 1991. *Cyberspace: First Steps*. MIT Press. Cambridge, MA.

Bruckman, Amy. 1996. Finding One's Own Space in Cyberspace. *MIT Technology Review*. January 1996, p. 50.

Gelernter, David. 1991. *Mirror Worlds*. Oxford University Press. New York, NY.

Laurel, Brenda. 1991. *Computers as Theater*. Addison Wesley. Reading. MA.

McCorduck, Pamela. 1996. Sex, Lies and Avatars. *Wired Magazine*. April 1996, p. 106.

Mitchell, William. 1995. *City of Bits*. MIT Press. Cambridge. MA. Web site http://www-mitpress.mit.edu/city-of-bits.

Rheingold, Howard. 1993. *The Virtual Community: Homesteading on the Electronic Frontier.* Addison Wesley, Reading. MA.

Stone, Allucquere Rosanne. 1993. *The War Between Desire and Technology at the Close of the Mechanical Age.* MIT Press. Cambridge. MA.

Turkle, Sherry. 1995. *Life on the Screen: Identity in the Age of the Internet.* Simon & Schuster, New York, NY.

Consciousness Reframed III : art and consciousness in the post-biological era

Proceedings of the Third International Research Conference convened at the Centre for Advanced Inquiry in the Interactive Arts, University of Wales College, Newport

Executive Editor Roy Ascott
Editor Michael Punt

Thanks guys!

Consciousness Reframed III

Places of Mind:
Implications of narrative space for the architecture of information environments

Peter Anders

Virtual reality and cyberspace are extended spaces of the mind different from, yet related to, the spaces of fiction and ancient myth. These earlier spaces reveal how electronic media, too, may come to define our selves and our culture. Indeed, a better understanding of how we use space to think can lead to the design of better information environments. This paper will describe a range of traditional narrative spaces, revealing their varied relationships with the physical world. It will demonstrate the purposes of such spaces and how their function changes with their level of abstraction. A concluding review of current technologies will show how electronic environments carry on the traditions of these spaces in serving our cultural and psychological needs.

Keywords: cyberspace, narrative, space, Anthropic Cyberspace, cybrids

Narrative Space: Methodology for evaluation

In analyzing traditional narrative spaces I will use a methodology employed in my book *Envisioning Cyberspace*, Anders (1999),which presents artifacts and spaces in terms of a scale of abstraction (fig.1). This scale ranges from the most concrete to the most abstract, appealing to our senses and intellect respectively. Our scale also ranges from perception to cognition, our ways of appreciating the concrete and abstract. We use this in the knowledge that the categories discussed are provisional, and that current or future examples may conflict with their definition. However the risk is worth taking. The methodology helps us distinguish important features of traditional narrative space and gives us a framework for evaluating electronic spatial simulation.

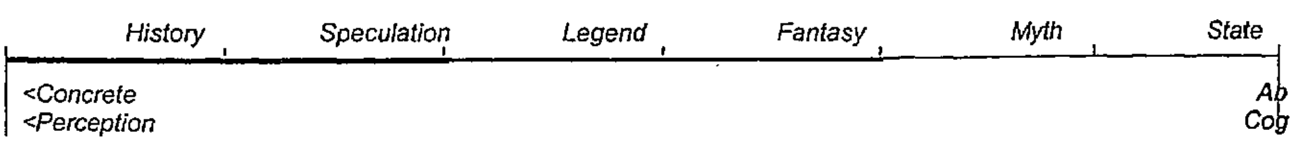

Figure 1. Scale of abstration for narrative space

The Space of History

Of all the extended spaces that of history – the systematic, verifiable account of events – is most concrete. Events in historical space refer to specific people, places and times, all parts of our everyday experience. History is relayed dynamically, events are described in sequence of occurrance.Accepted as nonfiction, it is valued by empirical cultures and is the foundation for Western societies.

Speculation Space

Speculation ranges from rumor to plans of action. Such projections, while beholden to the world of experience, are hybrids of fact and fiction. The plan for a building addition relies on historical, current facts, although it is an hypothetical space. While speculation is not entirely factual its fiction is grounded and believable. The building addition cannot float on air, for instance. To do so would require a move up the scale of abstraction away from concrete reality.

Legend Space

Legend describes historical people in fictional places or, conversely, fictional characters in actual settings. It keeps at least one foot on the ground. Like speculation legend may be hard to distinguish from history, for it is shared by the average citizen, its authorship unknown. But unlike speculation the fictional component of a legend may be fantastic. This magical component distinguishes legend from the more concrete categories of narrative space.

Fantasy Space

As we rise above legend to the levels of fantasy and fairy tales we increasingly encounter magic and the uncanny. These stories rely less upon material actuality than on symbols for cognitive and psychological states. Changes brought about by symbols are described in a magical way though the symbols themselves refer to the concrete world.

Fairy tales and folktales, in addition to defining a culture may also be didactic. They use fiction to relay psychological and cultural truths to children in fairy tales, Bettelheim (1977), and to adults through folk tales and parables. Magic often draws attention to important moments of the tale, marking it in the readers mind.

Authorship of the original fairy tales is often hard to determine as they are a part of popular culture similar to legend. Yet unlike legend the space of fairy tales and fable is stylized and general: a forest, a castle, the sea. They are not as specific as legendary places that may be cited by name. Likewise the characters that populate fairy tales are stylized, often drawn as types rather than defined as individuals.

Mythic Space

Myth, like folk tales and fables can be used for instruction but its purpose is to offer spiritual guidance. Its characters are archetypal ideals, deities. This is reflected in the surroundings they inhabit which may symbolize aspiration (the heavens) or death (the underworld) more than actual locations. Actions take place in no-time – eternity – or, in origin myths, are so far removed from the present that the rules of reality do not prevail.

Myths situate us in the world of man and nature. While fictitious, they are psychologically true, Campbell (1959). The entities and actions presented may be magical but their emotional structure is rooted in our everyday experience. Lust, jealousy, and anger among the gods engage the reader, however magical their actions may appear. Myth promulgates faith, provides spiritual guidance and assures the longevity of cultural institutions. It is used by spiritual leaders to convey meaning and cultural value, while legend and folk tales are a part of common culture.

State Space

At the highest level of our scale we find the conceptual spaces of religious and philosophical tradition. These are metaphors for states of mind. Heaven and Hell belong to this category as does the void of Nirvana. Such spaces are absolutes – resting places of the soul. Tellingly, they are rarely scenes of action in myth, for nothing really happens there. They are terminals to the road of life - beyond them lies nothing.

Even in this brief summary we can see trends that follow the ascent to abstraction. As we rise, we note a change of audience from the commoner to a select, sometimes religious elite. Use changes from conveying facts to values. And the subject itself changes: the concrete extreme is specific to time and place while idealized beings populate eternity at the other end. Heroes and gods occupy our minds more than they do places on earth.

Cyberspace: The space of electronic media

In the ensuing discussion we will review the fictional spaces of electronic media with respect to the present scale. Electronic media space is distinct from its precursors. Unlike text or painting electronic media is active and so resembles more the oral traditions of narration and theater. Also, unlike the traditional spaces of narrative, cyberspace is inhabited by users through their interaction within it.

Electronic media conveys spaces that appear incidental to the content. A telephone call gives the illusion of intimacy even though the topic of discussion may be impersonal. The story told by a talk-show guest occurs in a space distinct from the television studio seen by the viewers. The space influences, but is not dependent upon, the content. This media space differs from the conventional text or image as traditional media artifacts are confronted directly. Choices for engagement are limited to the illusion offered vs. the physical artifact, painting or book. There is no tacit intermediate space as with electronic media. It is this space that we will now relate to the illusory spaces of fiction. I will present the spaces by comparing them to the categories discussed earlier: history, speculation, legend, fantasy, myth, and state (fig.2).

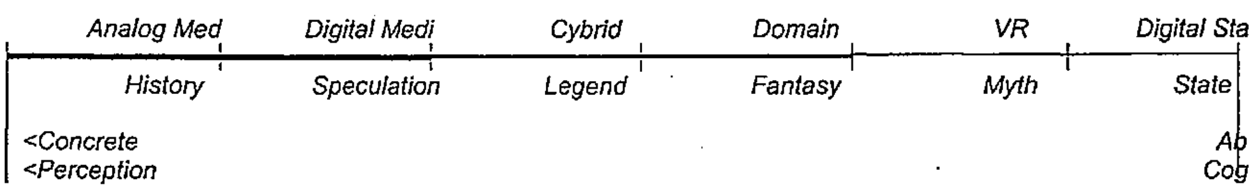

Figure 2. Scale of abstraction for electronic media space (top) compared with narrative space (below)

Analog Media

History, the category that relies most upon perception of the world is already well-documented by conventional broadcast media, radio and television. Electronic, analog media can be used for immediate, live coverage of events. The space between events and viewer collapses. Returning to our earlier example, the studios space of the talk-show is directly apparent to us. The space of analog media warps our own, collapsing remoteness into immediacy. These media are nearly ideal for uses served by history, journalism, and direct narrative.

Digital Space

Analog media have little separating events from the viewer. The processing of digital media, however, involves translational steps to turn input into digital information, then reverse the process to generate output. Two translations more than analog media, two more chances for error and manipulation to slip in. Digital media for this reason is attended by doubt. Doubt makes everything a potential fiction.

Digital media, particularly digital text and graphics used "realistically", hold a position similar to that of speculation. We see this in the gossip of BBS chat rooms, and plans generated using computer-aided design. Both contain fictional elements but even these fictions are grounded in reality, differing only in medium from their mundane equivalents.

Domain Space

It's no coincidence that fairy tale and fantasy themes are already popular in multi-user domains and digital Worlds. These online, role-playing environments require users to assume an identity – or avatar – for participation. Many users capitalize on the masking effect of the avatar to hide their real identities, Turkle (1984). These digital environments – while referring to the concrete world – are not subject to its laws. Magical actions are as common in these spaces as they are in fairy tales, Anders (1996). For this reason the space of online domains may be considered at a level of abstraction comparable to folk and fairytales. They share many attributes, 1) they are used to foster communities 2) their authorship is often unclear since many participate in their creation 3) they serve a dual purpose for entertaining users and serving as a learning environment for role-playing, 4) they contain fact-based characters (avatar) and fanciful beings (agents and bots), 5) they are popular and accessible to the average user.

Narrative Space	*History*	*Speculation*	*Legend*	*Fantasy& Fiction*	*Myth*	*State*
Audience	Popular	Popular	Popular	Popular	Select,Popular	Select
Author	Known	Known/Anon.	Unknown	Unknown	Unknown	Unknown
Occupant	Real people, Leaders, Public figures	Real people, Celebrities, Public figures	Heroes, Historic figures, Ghosts	Heroes,Royalty, Magicians, Man Monsters	Deities, Heroes,Man, Creatures	Deities, Spirits, Souls
Environment	Local, Specific, Actual	Local,Specific, Actual and/or hypothetical	Local, Identifiable	'Far away', Animate, Generalized	Primordial void or chaos, Heavens,Earth	No-where, Idealized
Time	Specific, Dynamic, Extended Past	Specific, Dynamic,Imm. past & future	Specific, Episodic	'Long ago', 'Happily ever after', Episodic	Timeless, Episodic	Eternal, Static
Traits	Empirical, Systematic, Verifiable, 'Factual'	Believed to be likely, Current, Conjectural	Believed to be historical, Magic,Fiction anch fact	Magical beings and Flight, S Diappearance	Ostensibly historical, Idealized, Symbolic	Non-narrative End state, Cognitive
Examples	Historical accounts, Journalism	Plans, Agendas, Gossip	Sleepy Hollow, Lorelei, Ghost stories	Fairy tales, Folk tales, Parables, Fables	Creation stories, Classic myth	Nirvana, Heaven, Hell, Cabala
Purpose	Shared account o Basis for future a	Planning, Projecting future, Specul. on present	Entertainment, Defines a local culture	Entertainment Didactic, Defines regional culture	Spiritual g Explanatory, Cultural Defin.	Establish goals,Spirit. guidance, Philosophy
Conventional Media	Oral,Text Image	Oral, Text Image	Oral,Text Image, Film	Oral, Text Image, Theater Film	Oral, Text Image, Ritual Theater	Oral Text

Electronic Spac	*Analog*	*Digital*	*Cybrid*	*Domain*	*VR*	*Digital State*
Electronic	Mass Media	CAD Digital Video	Augmented Reality, Telepresenc	Virtual Reality, MUDs,	Virtual Reality	Data Transla Display,

Media		Web Sites	Ambient Comp.	Digital Worlds		Internet
Examples	Telephone, Radio, TV	AOL, Autodesk	Kac, MacIntyre	Damer, Birrell	Davies,	Novak

Table 3. Characteristics of Narrative and Electronic Media Spaces

VR Space

While the domains just discussed are technically virtual realities they emphasize user representation and social interaction often at the expense of experiential quality. However, virtual reality (VR) changes character once this quality is improved – the user and use change as well. Owing to expense and accessibility this level of VR is limited to those who can work with its technology. Recent work by artists in this medium contain features that recall, sometimes deliberately, the spaces of mythology. Like mythology the space of VR is often autonomous, free from geographical locale. Some of its authors, like Char Davies, use it to convey meaning and values which, while not necessarily religious, are often philosophical.

As in mythic space the actions within VR are sometimes magical despite the ground planes, fixed light sources, recognizable objects and behaviors that relate to the material world. Unlike experience in domain space the user is unlikely to encounter someone else in VR. This changes the nature of VR space from being social to theatrical. The user is conscious of artifice despite the apparent freedom of interaction within it. This, too, recalls the space of myth as theater where players enact the ancient tales of culture.

Digital state space

At the extreme of abstract space – that occupied by metaphysical poles like Heaven and Hell – are electronic spaces that present states of being. Unlike VR and mythic space these are free of overt physical reference. Instead, they are often manifest processes innate to computing. As a result the space of artists working at this level is often disorienting as it makes few concessions to anthropic parameters of display. Without orientation down and up do not matter, all ordinates, scales and dimensions are arbitrary. Each user's experience is unique, the spaces self-sufficient, closed to outside reference. Changes in such states are meaningless to the user. Effectively, as in comparable spaces of narrative, nothing changes there. Ironically, the lack of reference in state space means its contents are not symbols, but simply traces as concrete as the natural markings on stone. At this level abstract and concrete begin to merge.

Cybrid space

Suspended between these ideal states and mundane, historical space – midway down our scale – is legend, the unique blend of fiction and verifiable fact. Cybrids – the products of Augmented Reality and Ambient Computing, Anders (1999)– occupy this position on our scale and comprise integral yet distinct physical and cyberspaces. Augmented reality allows objects that only exist within the computer to be grafted onto the physical environment. Ambient – or distributed – computing makes the physical environment responsive to changes brought about through users or other agencies. Taken to its extreme the environment appears animate, equivalent to the magic, responsive world of our childhood. Similarly, Augmented Reality recalls tales of the paranormal, of mysterious places annexed to our world.

Like myth, legend is used to define a group of people with common customs. But unlike myth legend has a greater fidelity to actual details people and places. Objects, buildings, and features of the landscape offer a mnemonic structure lacing together cultural narratives. Seeing a mountain or an abandoned house triggers memories, tales otherwise forgotten. The physical recalls the invisible. In turn, the invisible holds truths latent in our perceived world.

The model that legend offers cybrids' technologies, augmented reality and ambient computing, is that of a communal memory palace, Yates (1966), the structures of which are seen in the features of mundane reality. Legend acknowledges that consciousness is only partly empirical, that psychology and culture play an equal

Bibliography

Anders, Peter. 1996. "Envisioning cyberspace: The design of on-line communities," in Design computation: Collaboration, reasoning, pedagogy. McIntosh, P. and F, Ozel, eds. Proceedings of ACADIA 1996 Conference, Tucson, Arizona. pp.55-67

Anders, Peter. 1999. Envisioning Cyberspace. New York: McGraw-Hill, pp. 47-50

Bettelheim, Bruno. 1977. The uses of enchantment: The meaning and importance of fairy tales. New York: Vintage Books, pp. 111-116

Campbell, Joseph. 1959. The masks of God: Primitive mythology. New York: Viking Penguin Inc. p. 48

Turkle, Sherry. 1984. The second self: Computers and the human spirit. New York: Simon and Shuster, p. 82

Yates, Frances. 1966. The art of memory. Chicago: The University of Chicago Press, pp. 27-49

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His work has been featured in professional journals and he has presented his research on the architecture of cyberspace in several venues including The New York Architectural League, Xerox PARC, ISEA, CAiiA, Cyberconf, ACADIA, AEC, ACM-Multimedia, InterSymp and the World Future Society.

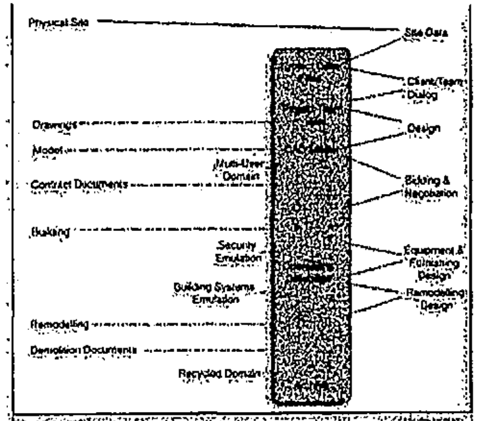


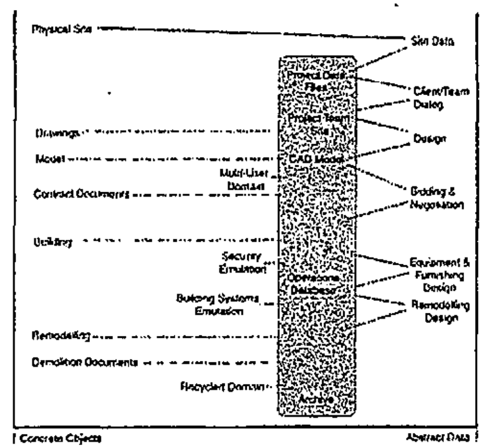
Figure 6: This diagram shows the oscillation between data/concepts and physical artefacts produced during the course of a design project.

Instead, let's look at the project itself as an information environment, one that is manifested discretely on a range of dimensions and scales. This changes the project from being aimed teleologically at building, to one encompassing all participants, information and artefacts throughout its duration.

Consider the artefacts of computation. A computer-aided design, or CAD, file is a record of design decisions. Changes and updates are registered; previous information stored. The database can be represented in a variety of ways: as lines on a screen, a rendered video-projection, an animation, or as printouts in two or three dimensions. A line – or more properly the data from a line – drawn at the earliest stage of a project may persist throughout the project's duration. The line is part of the conceptual computer model, part of the project's cyberspace, that may be manifested at will before, during, and after the project is materialised as a building.

This may appear to be a self-evident attribute of CAD software. Yet, seen in the light of the foregoing discussion on perception, cognition and technology, the role of the line can be emulated by the project space itself. By 'project space' I mean the project's comprehensive environment: the totality of its physical site, the media spaces used in its development, the environments used for meeting, planning and production and spatial resolution of the client's needs. All printouts from this comprehensive information space are derived, lower-dimensional renditions of the project space: paper, models, videos, virtual reality walk-throughs, or buildings. Yet, given the reduced need for physical manifestation, the oscillation between material and concept characteristic of the design process is dampened. Its products, less distinctly material, may themselves possess highly abstract informational qualities.

Figure 7: This diagram shows the dampening of the swing between concept and manifestation due to artefacts of computing.



This would matter little if the project were the design of a bicycle shed. But with complex projects – like an office building – the information space of the project team can live on to be reused in the space occupied by the project's tenant. A three-dimensional multi-user environment used to host design-team meetings can be re-utilised as a conferencing facility by the cybrid owners. The reuse, remodelling and retrofitting of such spaces is nearly cost-free compared with the physical alternative. The media and digital spaces created early in the project (like the CAD line) may persist throughout and outline any of the project's future manifestations.

Architects and designers – specialists in spatial design – can extend their services once they grasp the power of the symbols they use. Symbols embodied in the computer take on a validity of their own independent of their referential role. Hovering at the boundary separating information from the physical world, their increasing role in projects dampens the swing between abstraction and materiality.

This dampening results in faster execution of the project, savings to the client and the designer, more versatility in communications and flexibility.[11] Such a change in process can radically affect its products. For example, the physical model of a building could be augmented with alternatives that, while apparently part of the model, are not physical. The project space is discretely manifested in the material world – at any scale.

Take another example: conventionally an architect creates a master plan, say a ten year plan for the development of a campus. The unbuilt structures exist, but only in the minds of the planners. In a cybrid project, however, the master plan has an autonomy, its buildings may be used long before they are materialised.

In some cases they may never be built – yet still be useful as on-line meeting places, work areas and archives. In this sense the construction of a cyberspace may preclude the need for actual construction. It remains coupled, conceptually, with any manifestation of the project, yet remains symbolic – accessed and manipulated only through our extensions and the internet.

This can have a profound effect on the ethical practice of architecture. If we accept the role of an architect as a designer of space, and that the symbols used in the architectural process have their own validity, where does the architect best spent his time? Designing material buildings that serve a limited, local population? Or designing spaces that are equally useful, yet can be used by the world – connected through the internet? Is his time best put to depleting limited resources, encumbering the environment, crowding our cities? Or harnessing our spatial imaginations through technology?

Conclusion

Speculating on the long-term impact of such an approach is beyond the scope of this paper. Yet it is clear that cybrids offer an alternative to conventional architectural practice that points to less materialistic solutions to client's needs. We have outlined here a provisional philosophy for this emergent form of design, showing its epistemological, ontological and ethical consequences. Although the discussion has stressed architecture, it clearly affects any discipline whose products are symbolic and spatial and may extend to engineering and fine arts equally well.

We have seen the role of technology in this comprehensive space, it is only a servant to our minds. Space exists without technology. Its complicity in our mental processes and can make us question whether it is external to us at all. We are conditioned, since childhood, to understand the world as both material and magical – the domains of body and mind.[12] Our myths, legends, history and dreams all merge perception with imagination to constitute our sense of being. Cybrids are also such a blend, although mediated through technology. They are a new development in hybrids of fact and fiction, intertwining our immediate reality with a more abstract one of concepts and values. A re-defined architecture can produce such rich spaces and help to restore our psychic and physical bond with the world.

Notes

1. W. Mitchell, *City of Bits: Space, Place, and the Infobahn* (Cambridge, Mass: The MIT Press, 1995) pp. 43-44.
2. J. Blau, *Architects and Firms: A Sociological Perspective on Architectural Practice.* (Cambridge, Mass: The MIT Press, 1984) pp. 10-11.
3. '...there (is) no such thing as Architecture; there (is) the spirit but no presence whatsoever. What does have presence is a work of architecture, which at best must be considered as an offering to Architecture itself....' Louis Kahn, lecture at the Aspen Design Conference, 1973. Published in A+U Monographs.
4. I. Kant, *Prolegomena* (Chicago: Open Court Press, 1996) pp. 99-138.
5. T. Norretranders, *The User Illusion: Cutting Consciousness Down to Size* (New York: Viking, 1991) pp. 213-250.
6. S. Kosslyn, *Image and Brain* (Cambridge, Mass: The MIT Press, 1996).
7. S. Kosslyn, O. Koenig, *Wet Mind: The New Cognitive Neuroscience* (New York: Free Press, 1992) pp. 130-145.
8. Edward T. Hall, *The Silent Language* (Garden City, NY: Doubleday and Company, 1959) p. 168.
9. P. Anders, 'Cybrids: Integrating cognitive and physical space in architecture', *Convergence* 4, no. 1 (Spring 1998) pp. 85-105.
10. D. Norman, *Things That Make Us Smart: Defending Human Attributes in the Age of the Machine* (Reading, Mass: Addison-Wesley, 1993) pp. 51-52.
11. P. Anders, 'Integrating cyberspace and buildings: Trends and projections', presentation at Facilities Forum '99, Conference and exhibition, Santa Clara, CA, USA, 29-31 March 1999. Paper published in proceedings Red Bank, New Jersey: Group C Communications 1999, pp. 386-401.
12. P. Anders, 'Places of mind: Implications of narrative space for the architecture of information environments', presented at Consciousness Reframed III: Art and consciousness in the post-biological era, CaiiA, University of Wales College at Newport, UK, August 2000. Paper published in the proceedings edited by M. Punt (Newport, Wales: University of Wales College, 2000) pp. 5-13.

Erratum

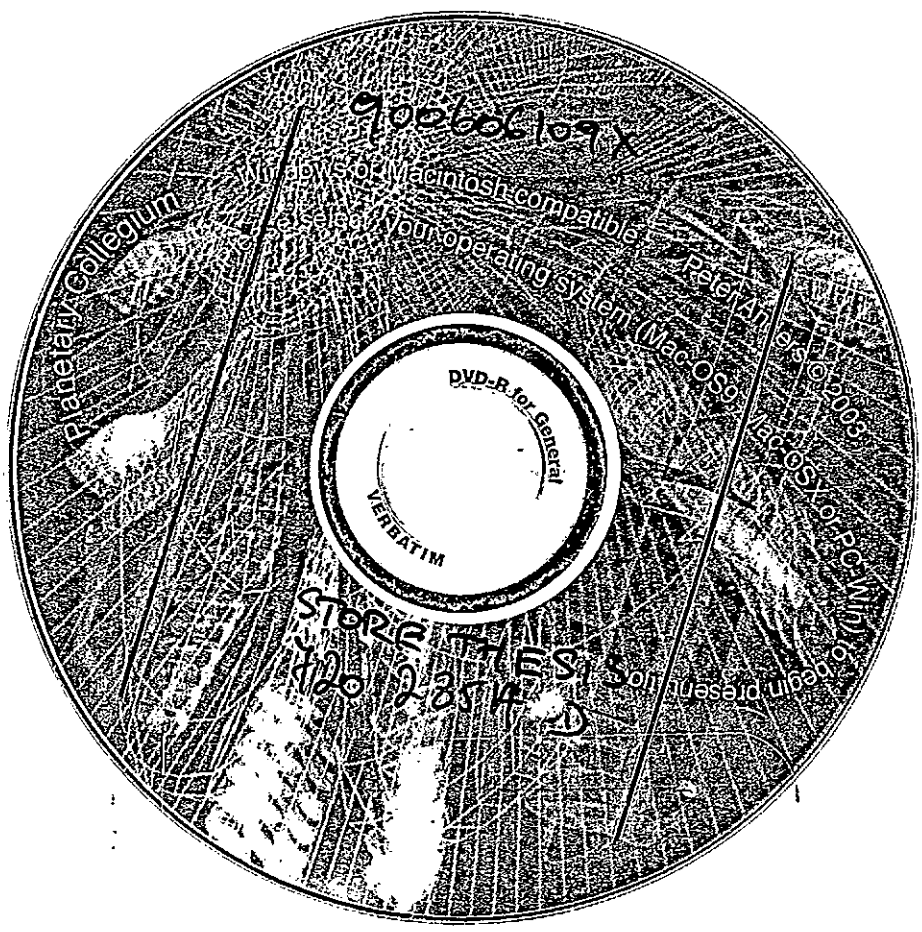
1. Paragraph 3 of page 13 shall read: "The Fun Palace, Price's project co-designed with cyberneticist Gordon Pask, was among the first to propose an environment that responded instantly to its occupants with moving walls, floors and ceilings, fog dispersal plants, and warm air currents. The inclusion of Pask, whose own work was greatly influenced by Norbert Weiner's concepts of cybernetics, was important in describing the responsive behavior of the building. . ."

2. Line 3, paragraph 2 of page 72 shall read: "Corroboration is important to the user's understanding of cybrids as compositions rather than mere. . ."

3. The following references shall be included in the bibliography:

Argyle, Michael. 1994. The psychology of interpersonal behavior. New York: Penguin Books.
Bricken, Meredith. 1991. Virtual worlds: No interface to design. In Cyberspace: First steps, ed. M. Benedikt, pp. 363-382. Cambridge, Mass.: MIT Press.
Cook, Peter. 1999. Archigram. Princeton, New Jersey: Princeton Architectural Press.
Cook, Robert L., Loren Carpenter, Edwin Catmull. 1987. The Reyes image rendering architecture. Computer Graphics: Proceedings of SIGGRAPH '87, July, 95-102.
Fetter, William A. 1966. Computer graphics in communication. New York: McGraw-Hill.
Fuchs, H., J. Poulton, J. Eyles, T. Greer, J. Goldfeather, D. Ellsworth, S. Molnar, G. Turk, B. Tebbs and L. Israel. 1989. A heterogeneous multiprocessor graphics system using processor-enhanced memories. Computer Graphics: Proceedings of SIGGRAPH '89. April, 79-88.
Fuller, Buckminster. 1963. Ideas and integrities. New York: Collier Books.
Goldstein K. and M. Scheerer. 1941. Abstract and Concrete Behavior - An Experimental Study With Special Tests. Psychological Monographs 53 (2).
Greenberg, Donald P. 1977. Computer graphics: Back to the electronic drawing board. The Cornell Engineer 42(4): 4.
Ishii, H. and Tangible Media Group. 2000. Tangible bits: Towards seamless interface between people,bits, and atoms. Tokyo: N1T Publishing Co., Ltd.
Ivas, Ivan. 1988. Michael Argyle: Bodily communication. London: Methuen & Co.
Johansen, John M. 1996. John M. Johansen: A life in the continuum of modern architecture. Milan: L' Arcaedizione. Krueger, Ted. 2003. Eliminate the interface. Journal of Architectural Education 56(2): 14-17.
Lynn, Gregory. 1998. Animate form. Princeton, New Jersey: Princeton Press.
Newell, M. E., R. G. Newell, T. L. Sancha. 1972. A solution to the hidden surface problem. In proceedings of ACM annual conference: SIGGRAPH 1, pp. 443-450, New York: ACM Press.
O'Neill, R. and E. Muir. 2003. Creating 3D worlds for the Web. New York: Wiley Publishers.
Maslow, Abraham. 1971. The Farthest Reaches of HumanNature. New York: Viking Press. Muir, Eden and Rory O'Neill. 1995. The architecture of digital space. Downloaded on 5.7.03 from http://www .arch.columbia.edu/DDL/research/ddl.human.html
Naimark, Michael. 1998. Place runs deep: Virtuality, place and indigeousness. Downloaded 4.15.03 from httl2:/ /www .naimark.net/writing/salzberg.html
Pask, Gordon. 1969. The architectural relevance of cybernetics. Architectural Design, September, 495.

Pask, Gordon. 1968. A comment, a case history and a plan: Musicolour machine. In Cybernetic serendipity, ed. J. Reinhardt, pp. 76-91. London: Studio International.
Pask, Gordon. 1975. Artificial intelligence: a preface and a theory. Preface to chapter on Machine Intelligence, in Soft Architecture Machines, ed., N. Negroponte. Cambridge, Mass.: MIT Press.
Perrella, Stephen. 1999. Electronic Baroque. Architectural Design 69(9-10): 5-7.
Perrella, Stephen. 1999. Commercial value and hypersurface. Architectural Design 69(9-10): 38-47.
Piano, Renzo. 1997. Logbook. New York: Monacelli Press.
Price, Cedric. 1984. Cedric Price: Works II. London: Architectural Association.
Richardson, S. S. 1995. Haus-Rucker-Company: Giinther Zamp Kelp, Laurids Ortner, Manfred Ortner. Monticello, Illinois: Vance Bibliographies.
Shaw, Jeffrey and Peter Weibel. 2003. Future cinema: The cinematic imaginary after film. Cambridge, Mass.: MIT Press. Terzides, Constantine. 2001. Teaching sensor and Internet technologies for responsive building designs. In proceedings of ACADIA 2001, 11-14 October, Buffalo, New York, ed. Wassim Jabi. pp. 356-362.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