People regularly use non-physical, cognitive spaces to navigate and think. These spaces are important to architects in the design and planning of physical buildings. Cognitive spaces inform design—often underlying principles of architectural composition. They include "spaces of privacy, territory and the space of memory and visual thought." They let us to map our environment, model or plan projects, even imagine places like Heaven or Hell.

Cyberspace is an electronic extension of this cognitive space. Designers of virtual environments already know the power these spaces have on the imagination. Computers are no longer just tools for projecting buildings. They change the very substance of design. Cyberspace is itself a subject for design. With computers architects can design space built for physical and non-physical media. A conscious integration of cognitive and physical space in architecture can affect construction and maintenance costs, and the impact on natural and urban environments.

This paper is about the convergence of physical and electronic space and its potential effects on architecture. The first part of the paper will define cognitive space and its relationship to cyberspace. The second part will relate cyberspace to the production of architecture. Finally, a recent project done at the University of Michigan Graduate School of Architecture will illustrate the integration of physical and cyberspaces.
spaces as media

Spatial constructs, or cognitive spaces, are the result of the mind composing an image of the world around it. These constructs allow one object to be related to another. They make comparison, relationship and evaluation possible and play a primary role in relational and qualitative judgment. Qualitative thought depends on information set in context via these constructs. This contextual understanding allows people to evaluate issues with respect to one another before taking action. This understanding helps us select a brand at the grocery store or size a window in a facade.

I will refer to the spatial construct of the outer world as the outer cognitive space, and inner cognitive space defined as the place of imagination, thought and memory. While these spaces represent different kinds of information, they are both the result of mental effort. However, they present different kinds of information. For instance, we can never quite place our internal thoughts into the outer world image because thought and perception operate in different parts of this cognitive space.

These spatial constructs are the basis of communication. The information comprising these constructs is not limited to visual stimulation. Language, sound, touch all inform these cognitive spaces, providing a complete and immersive sense of the world. We take information through the senses, pass it through a cultural/linguistic filter for interpretation and then store it in memory. Expression is the same process in reverse. Memory and thought are passed through the cultural/linguistic filter and perceived by the outside as voice and gesture. These expressions are in turn mediated through sound and light to enter recipients’ senses as information, and enter the recipients’ cognitive space.

This implies that we have no direct contact with the outside world except through this creation of cognitive spaces. Experience is characterized by information passing through our senses to our awareness, and its interpreted experience via cognitive space. While I cannot debate the philosophical issues here, I am not arguing against the existence of an external world. Instead I propose that the spatial construct is integral to our understanding of the world. I also believe that the construct is valid whether the information it portrays comes from real or symbolic sources. This validity becomes more important as virtual reality and simulation technology extend our cognitive space into interactive environments.

spatial thought

The concept of space as medium—leveling the status of physical and cognitive objects—is important to the design professions. This is particularly true of those vested in the design of the physical world. Space is a medium populated with artifacts of our own mental efforts. It is useful in the most basic efforts—say navigation or orientation—or on higher, symbolic levels of thought. While our prehistoric ancestors largely concerned themselves with objects of the natural world, we also deal with artifacts of language and culture. Not surprisingly, a large part of our language is devoted to spatial terms and metaphors. In this sense cultural artifacts and natural objects take on the same role as sources of data.

Other kinds of spaces result from our bodily presence in an environment. These include zones of privacy around the body and zones that range beyond our senses. These extended zones would be defined by angles of orientation, attention and local and national territories. We have to view space not only as a matter of data manipulation but one of identity for humans are spatial animals. We use space to define ourselves by the creation of peripheries and our physical dominance over territory. Space and information flow are related through this management and response to our environment.

Below is a diagram which illustrates information flow within a cognitive space model.
(Figure 1). The Objective World is the outer world of Data and unprocessed information. Through the process of Sensation this information passes through the Somatic Boundary via the senses and enters the Subjective World of the body. It then passes through a Cultural Language Boundary where it is processed and preliminarily interpreted. Here distinctions are made between words and sounds, images and illumination. The mind then places these sensory images within the Outer Cognitive Space where they are regarded. This space is where experiential information resides. Through the process of Personal Interpretation, prioritized information may be passed to the Inner Cognitive Space and manipulated symbolically or stored in Memory for future use. Expression passes information from the Inner Cognitive Space through the Cultural Language Boundary and through the Somatic Boundary through the organs of expression. Once the information enters the Objective World it may be retrieved by its creator or others as data.

In all cases above, space is used symbolically. The objects we sense are consolidated and represented as colors, textures or objects within the outer cognitive space. This information may be presented at various degrees of resolution within the cognitive spaces, but ultimately it originates in data. What we perceive as space and its contents is the result of construction influenced by culture and language.

Items in the inner cognitive space selectively enter our memory. Recollection is the process of passing a memory back to the inner cognitive space and regarding it. This space is the place of reflection and recognition where we remember the face of a friend or our childhood home. It is what guides the pencil as we draw a map of our neighborhood.

memory palaces

One of the most striking uses of internal cognitive space is that of memory palaces. Some excellent research has been done on these cognitive structures and I recommend readers to works by Frances Yates and Jonathan Spence. In short, memory palaces are mnemonic devices for housing memories. Taking the form of buildings or cities, these structures provide specific spaces for mnemonic objects. The builder of a memory palace can mentally move through this museum and recall memories by reflecting on various rooms’ contents.

In the culture of ancient Greece there were five art forms: sculpture, poetry, architecture, music and rhetoric. One of the expressions of rhetoric was the ability to recite from memory great quantities of information. Memory was highly valued not only for spontaneous oratory but because there were few ways to store information. The Greeks used ephemeral wax tablets, imported papyri and stone for recording information. None of these was well suited for the needs of an orator—especially someone who prided himself on a spontaneous access to facts.

It required great discipline to memorize this information in a way that was useful and flexible. While memorizing lists is basic to our thinking it is limited for purposes of quick recollection. Memorizing an intermediate structure—say the
layout of a building plan creates a mnemonic structure, a context for memories. By mentally strolling through it rooms and their contents come into view. This visual organization prods the memory by displaying metaphors for names or concepts.

Readers can take a moment to recollect their childhood home. By moving from room to room, objects can be recalled that might otherwise be forgotten. An angle of a wall, a chair placed just so by the window, the cat’s favorite hiding place ... each memory is housed in the larger mnemonic structure of the architecture. This is an example of how a memory palace would work.

The added benefit of this method of memorization is the fact that it is not linear. Recalling a fact doesn’t involve mental recitation of lists. Instead, the cognitive act takes the form of experientially moving at will among memories. This was apparently of great value to orators who could rely on this system for both accuracy and accessibility.

This, of course, is an ancient tradition and among its latest practitioners were the Jesuits during the Renaissance. As other means of recording information became available, the practice fell into disuse. The use of ink and parchment didn’t require the discipline of maintaining a memory palace, and soon superseded their construction. The added benefit of external media like paper and parchment is its non-proprietary nature. Memory palaces could not easily be passed from one generation to the next yet another reason for their extinction.

While information demands of earlier times could be met with pen and ink, today’s needs require higher levels of technology and automation. The memory palace could re-emerge as a model for future collective memory allowing users to navigate stored information in an intuitive, spatial manner. Cyberspace designers could create interactive memory palaces which could be used by others and passed from one generation to the next.

cyberspace

With the increasing spatialization of the Internet computers now can display networked information spatially. This is an important advance. The spatialization of cyberspace ties into our basic training as humans. We learn to think spatially from the moment of birth – our first days spent building a spatial matrix around us. While there is no assurance that this matrix is the same from one person to the next it is an attribute we share as humans and possibly with other creatures as well.

The spatial construct’s strength lies in its inclusivity. Going to a museum is a case in point. A museum communicates with us on a number of levels. Its architecture organizes the information it houses. The pamphlet you pick up at the entry uses symbols to orient you in the space and language to describe the exhibits. The paintings on the wall, though flat, present varying depths of represented space. These various media, architecture, literature and artwork, exist in the same space. We interpret their symbols differently, of course, but the inclusivity of space makes this mediation possible. Just as space can house a number of media, cyberspace can do the same.

Although graphically simple, windows, the Mac OS and others are examples of the spatial construct in computing. While there are other methods of organizing information, the spatial metaphor is likely to be used for some time to come. The increasingly spatial orientation of the networked computing indicates the value of imagery and the third dimension. Developments such as object-oriented programming rely on the spatial metaphor for constructing new computer programs.

The spatial metaphor in computing is successful because it taps into our spatial thinking – it allows us to manage information both cognitively and experientially. In this way computer space is an extension of cognitive space. This is a strong argument for reinforcing consis-
cy and clarity between cyberspace and the way in which we experience and use space in general.

architecture and cognitive space

In the course of the past few years I have studied the impact of information technology on architecture. My students and I have concerned ourselves with manifestations of cyberspace and the role of architecture in their development. Specifically we have addressed cyberspace as a deep spatial environment affected by social, organizational and aesthetic issues...not unlike architectural spaces. However comparisons between them must account for their differences.

There are four issues which relate physical space to cyberspace: 1) parity between physical and cyberspace via cognitive space; 2) the transformation of physical architecture in the light of this parity; 3) the anomalies of translating the spatial metaphor to 3d environments; 4) the possibility of creating hybrid schemes that exist both in physical and cyberspaces. The most recent project done at the University of Michigan addressed each of these issues in the course of developing a building design.

cyber reel parity

Humans perceive space as an assembly of data in a format that they understand and manage. Space is a format for the information they receive or generate. Its illusory quality does not undermine the fact that the data it is based on is real. So whether we regard a physical or symbolic space, they both the result of mental activity.

sublimation and reification

If we accept a cognitive parity between the physical and the symbolic we can question the need for physical construction as the sole purpose of architecture. The program for a building can be sublimated to reduce the physical space required by the project. The logical structure of a building might be replaced by a logical structure for an information base. This is particularly true in cases where the main purpose of the building hosts information rich activities such as libraries, schools, museums, auditoriums and office buildings. Even in factories, which seem intrinsically physical, portions of the buildings’ programs are dedicated to information work – offices, conference rooms, filing and administration areas. This form of sublimation could affect even the most earth-bound buildings.

The mirror image of sublimation is reification. There may be reasons for parts of cyberspace to be anchored in a physical entity. It may seem debatable that a building should reflect a cyberspace condition. However overlaps between cyberspace and physical space already exist in surveillance systems and electronic building management networks. Future buildings may accommodate this overlap, allowing the physical and cyberspaces to better serve the user.

misfits and anomalies

Misfits in architecture occur when the original function of a building changes without necessary modifications to the building. Architecture can’t – and perhaps shouldn’t – accommodate every momentary need of the user. The result is a misfit between the building and the purpose it serves. Misfits are not the fault of methodology or design strategy. They come from the fact that buildings are static in nature and require updating if their functions change. Misfits may involve size, configuration or even the location of a building in cases where a company has moved its operations elsewhere. The discipline of architecture is afflicted with examples of this kind.

I am basing this argument on a specific understanding of function. This underlies nearly all of my discussion. Aesthetics, questions of typology and other concerns play an important role in the design of buildings. However, viewing the matter through the lens of function and space allows us to evaluate spatial solutions on a verifiable basis of economy and efficiency.
The merits of this may be argued—architecture is much more than the result of functional decision-making. However, the decision of whether a solution should be physical is not made by architects alone. Clients ultimately decide one way or the other. The narrow scope of the functional critique highlights the issues surrounding the decision. As this study shows, the efficiency of a cyberspace solution could affect the need to build physically.

If physical space has misfits, cyberspace has anomalies. Anomalies are the paradoxes resulting from the relation of symbolic spaces to spaces in the physical world. These develop when the spatial illusion breaks down and cyberspace betrays its nature. Cyberspace—a purely symbolic space—often has no foundation in the physical. I have written elsewhere of spatial discontinuities which indicate the slippage between on-line text and the physical world it describes. In our research, my students and I investigated anomalies found in Multi-User Domains, wss, where the domain relies on the spatial metaphor. In spite of the reference to spatial organization, the activities and configuration of some wss defy any physical logic.

My students and I found this to be a pregnant area of research. It reveals the gap between the architectural understanding of the spatial metaphor and the illusory existence of cyberspace. Being symbolic, cyberspaces have the ability to do things that no physical structure could. They can transform, disappear overnight and be rebuilt the next day. My students found a number of anomalies in the course of their research and carefully documented them in drawings and models.

cybrids

If we accept a cognitive parity between physical and cyberspaces we can expect the development of constructs which straddle the two modes of existence. These constructs, here called “cybrids,” would be designs that benefit from on-line technology in the development of the building program by the use of surrogate spaces. My students and I took the cyberspace literally, inferring the spatial construct to be adjunct to the physically built environment.

A number of questions immediately come to mind. Why should architects concern themselves with cyberspaces? How would the sharing of physical and cyberspaces occur? What physical technology is necessary to effect the hybrid illusion? Some of these questions are being answered in laboratories around the world. Others were addressed in the design studio.

The architect has traditionally played the part of symbolic manipulator at the service of the client. In a service that ranges from interpreting clients’ needs into sketches to the production of documents and the administration of contracts, architects rarely if ever physically build the objects of those services. It is not in their scope of services—by contract. The six contracts for architectural service are clear on this matter.

In this light the architect can be indifferent as to whether his or her work should be consummated in physical or cyberreal construction. If the fee structure were not based on the cost of physical construction as it presently is, there would be no conflict of interest in recommending one kind of space over another. The question of why architects must be involved in this technology can be answered from the standpoint of economics.

economics

One of the virtues of cybrids are their cost-effectiveness. If some aspects of the building program can be met through hybrid technology, there could be substantial savings in the start-up costs of a project. If the building’s floor plan is reduced—and we have found that the reduction may vary greatly depending on the building type—a building’s energy consumption and maintenance costs would likewise be reduced. These form a good part of the operating costs of a
building. Since initial costs of development are reduced so too would be the financing costs for the project. There might be tax benefits in the form of rebates or the reduction of the built floor area.

On a larger scale there would be societal benefits as well. Because of the on-line nature of these cyberts the buildings’ utility becomes globalized, accessible to anyone who has the technology. The building no longer serves only the local community, but also serves remote “occupants.” This speaks for a real advantage in terms of overall costs. The client’s costs have been reduced while at the same time the benefit to the world has been increased. This surprising condition reveals the subtle influence this technology might have on the global community.

medication

Clients might also gain from having their environment mediated in this way. If the building is globally accessible, the building is globally present. That is to say the architecture becomes an instrument of persuasion—a form of promotion for the client. Architecture, which has a tradition in representing the client’s values, now might become part of an owner’s promotional arsenal.

access

If the building is accessible by other than physical means there would be simultaneously an increased use of the facility plus a reduced need to be physically present at that building. This is borne out in recent developments in telecommuting. In an increasing number of cases, the employee no longer has to drive in to work. It might be possible for an employee to be at work—sharing a symbolic workplace with colleagues—and not have to physically be there.

This is a well-publicized phenomenon and the benefits and burdens of telecommuting are still being sorted out. There are signs that certain businesses and employees stand to gain from this development. The employee is no longer place dependent. A choice of employer is not as dependent on place of residence as it once was. The employer has a greater number of options to select from in accommodating employees at the same time that the pool of potential employees increases.

Less well documented is that the host community stands to gain from the cybrid. The incremental load on the community’s infrastructure is lightened since many employees will not be using physical transportation. Power, utilities and maintenance supporting the building would be less than in a conventionally developed structure.

There are costs related to the maintenance and installation of the computer equipment used to support the cybrid structure. But in comparison to overall costs related to the maintenance of a physical building, these would be marginal. The cybrid’s support costs would depend on the degree to which the building’s program has been affected by the technology.

flexibility

Since cyberspace is symbolic and electronic it is very quick to respond to change. Flexibility is one of the key virtues of this kind of environment. My students found that entire sections of a wos would disappear overnight and others would appear just as quickly. The creation of a space is not nearly as complicated as building a physical one—users of wos learn how to build soon after joining a community. Compared to the effort of modifying a physical building, changes in wos are nearly instantaneous and cost-free. The mediated portions of cybrid structures would be analogous to wos, offering emulated spatial and social environments.

Clients’ needs can be met on an on-going basis as opposed to a one-time physical solution which constrains them. Not all aspects of a cybrid can be managed in this way. There are portions of the building which must be physical.
Figure 2. This schedule graphic developed for the Information Architecture Studio shows the concurrent development of physical and cyberspace strategies. The Definition/Analysis portion of the semester dealt with each separately. The Generation/Synthesis portion brought the two strategies together in one project.
These include restrooms, mechanical rooms and - at the very least - the computer room itself! Yet there are a number of areas of a building that could be affected by sublimation. Even if only the filing cabinets were to become an electronic database, there would be a floor area savings of 5 to 10 percent in each office.

But what kinds of space would take their place? Cyberspace should not merely mimic the spaces that might have been built physically. Dependence on the physical referent would deny the fluid, symbolic nature of cyberspace. Instead designers should aim for an emulation in which the space provides the orientation benefits of physical space yet surpasses it in amenity and flexibility. Design must not be limited to the reproduction of physical space. Cyberspace offers freedoms and benefits not found in the physical world.

**Information architecture**

To illustrate the issues surrounding cybrids, I will discuss work done in a recent graduate design studio I directed at the University of Michigan College of Architecture and Urban Planning. I will structure the discussion with reference to the preceding topics to present ways these issues can be managed in the design process.

**Cybernetic parity**

In the spring of 1997 my students worked on a project which related cognitive space - as exemplified by cyberspace - and the space of physical architecture. The theme of the project was Information Architecture and stressed the effect of information technologies on the design of space. The semester was divided into research and design phases. The research phase was a concurrent study of physical and on-line environments. It included an investigation of on-line communities and an analysis of four buildings on the campus. Represented among these buildings were a library, a museum, a school building and an auditorium. In the study, physical buildings were represented as information while the on-line entities, Multi-User Domains (MUDs), were resolved as physical objects. The reciprocity between the physical and cyberspace is indicated in the schedule chart.

(Figure 2)

The students were prepared for this research through reading material and a series of brief exercises in cognitive mapping. This was to introduce the concept of cognitive space as a design issue. The first assignment was conducted as a game. Pairs of students were separated by a screen. Each was given a set of colored blocks of varying shapes. One student put the blocks together in a composition. The other student tried to build the same composition by following verbal instructions given by the first.

In the second exercise, the students each walked to the building they were to analyze. Back in the classroom, they drew a cognitive map based on their memory of the walk. They then each telephoned a classmate and described their route to the building. The classmate was then to create a second-hand cognitive map. Each student built models of their cognitive maps. (Figures 3 and 4) As expected the compositions varied greatly, although the basic logical structure - landmarks and important intersections - remained consistent.

A major source of error, and mirth, was the linear communication of the information. Small initial errors often led to large consequences in the end. In several cases the students wished they had been able to communicate graphically. While this seems obvious in the context of an architecture studio, it is an important point in the in understanding cognitive space. The students were thinking spatially and communicating verbally. They felt that graphics better conveyed their thoughts than words. In addition, the non-linear nature of graphics would allow them to verify configurations within an overall image. They sensed a mismatch between the idea and the medium used to convey it.
sublimation and reflection
Following these efforts the students analyzed each of the four buildings. In teams of three, they documented each of the buildings, doing formal, functional and typological analyses of their organization. While this is standard procedure in many architecture schools, here the focus was on information and its influence on architecture. The students were transforming an existing physical building into manipulable information for future use in their own design. I will return to this transformation later.

As the teams analyzed the buildings, they also researched wums on the Internet. With one exception, Alphaworld, these domains were text-based social wums. wums are similar to chat rooms and mass (Bulletin Board Services) which serve as on-line meeting places. They are distinguished by their use of spatial metaphors to provide settings for dialog—the way a stage set enhances a play. Because both the spaces and their occupants are described rather than depicted, there is much ambiguity in using a wum.

Much has been written about the masquerade of identities played on-line. The text environment of most wums allows users to conceal their identities through the use of on-line character representations or avatars. The ambiguity of the text medium also holds true for the architecture of these spaces. The students considered the similarities and differences between physical and cyberspace using these wums as exemplars of mediated space.

The spatial illusion in a wum is enforced by descriptions of spaces and movement between rooms that make up its fabric. In most cases text is the only interface the user has with this environment. In graphic wums, like Alphaworld, the spaces perspective and movement is similar to that found in computer games like Doom or Quake. In text wums movement is done by typing a direction—N,E,S,W—or a destination. Instantaneous teleportation is possible by entering the address of a destination.

The students derived the logical structure of the wums by navigating them in groups and mapping them out according to cardinal directions. If a room was accessed using an “n” command, it was mapped as a cube situated north from the previous room. Rooms not accessed this way are mapped as spheres connected arbitrarily to the previous node. The resulting logic:

![Figure 1 and 4: These cognitive maps by Vandile Antalakal and Kristen Gibb were the result of phone conversations with other students. The buildings and site acted as landmarks in the dialog. Gibb’s map on the right presents these landmarks at relative locations. Note that there is no site in the model and that the objects apparently have relative to one another.](image)
The logical adjacency maps, LAMs, were built as physical, Plexiglas models to stress their presence as cognitive objects. Since the physical buildings were also mapped in this way, it was possible to compare the sublimated architecture and the reflected environment (Figures 5, 6, and 7).

LAMs of Meridian, a MUD. The model shows a regular, ordering organization since most spaces are located with cardinal directions. The map is a true line connection between "nations" in the MUD. Xing, Yip and Yoon, bananaWaani and Satansouwannana researched and built this model.

Text nodes are fairly specific in their directions since there is no space, per se, between rooms. If you leave a room you are instantaneously in another space. The relationship is easy to map as a LAM because the rooms can be represented as nodes in a lattice of connectors. However, the graphic MUD Alphaworld was surprisingly ambiguous. It was harder to map as a LAM because the "outdoor" space between buildings implicitly connected each destination to all others. A map of this would have had as many connections as the square of the number of nodes.

The students instead opted to map the larger structure of Alphaworld which is actually made up of several other "worlds". This structure resembled the LAMs of text MUDs because tele-transportation between worlds resembles the instantaneous motion in text environments. This relationship between the mapping of graphic and text environments bears further examination.

In the course of the MUD research the students located places where the spatial metaphor broke down, where the text described physically impossible situations. At the same time, they also critiqued the designs of the physical buildings for their functional misfits. The subject buildings were an auditorium, a library, a school of music, and an art museum.
The students located the anomalies, classified them and built physical models of the conditions. The were classified as Class A, B or C anomalies with Class A being conditions general to on-line activity, Class B being general to web activity and Class C occurring in specific MUDs. At times the line that separates one class from another is obscure although the students thought it useful to see the anomalies in categories.

Class A anomalies are familiar to users of the Internet. They include the instant teleportation from one Web page to another. Also the sense of being somewhere else—surfing—conveyed by the metaphor of cyberspace: Some of these anomalies are part of everyday culture. For instance, a newspaper or photograph can transport us as well as a computer screen. This illusionary motion occurs in our inner cognitive space.

Class B anomalies include many of the irregularities of web spaces. They include matters of space, identity and movement. Spatial descriptions of rooms may not fit the context. At LambdaMOO a closet can house hundreds of people. Jumping into a fountain can take users to remote parts of a web. Identity and society is an on-going masquerade as avatars—the users’ representations—often take genders and species not related to their own. Finally, motion is the result of text commands, not physical relocation. This can lead to paradoxes in space. Going west from a point and then going east may not return a user to the same spot. Black holes exist where users go and then cannot leave unless they teleport out or log off the system.

Class C anomalies are unique to specific MUDs. They include elaborate closed loops in which users can only move within a group of rooms but can’t leave the group without teleportation. One example is that of Aleutia in BayMOO uncovered by Nanilee Anantakul. (Figure 8) Users can enter it using conventional motion and move about the spaces there. But, appropriately, they can’t leave unless they teleport out. Another example is the pentagram of Alphaworld, discovered by Dang Nguyen and Christopher Kretovic, which is made of five empty rooms. Each has a teleportation terminal which allows users to go to four other rooms. Each of these four rooms in turn have terminals to four rooms. The user discovers that these are all the same five rooms, interconnected within a pyramid structure. In a lab these spaces map as a pentagram—five nodes connected to each other. There is no way out by using the teleportation devices. Users must use other means of teleportation. Some anomalies have resulted from careless programming or deliberate mischief. Regardless of their origins, they are entities which have no precedent in the physical world. Designers of cyberspaces may employ lessons learned from these and other anomalies in their future work.

**Hybrids**

Following the anomaly study the students developed programs for their own building design. In the functional analysis of the physical
buildings, the students had to derive the subject building's program—working backwards from its plans and sections. Now they had to take the existing building program and modify it in response to what they had learned while analyzing the two on-line.

There are many techniques for doing this. Among them are determining which spaces are information-oriented and candidates for being affected by the technology. These physical spaces might be mediated to become cyberspaces for on-line usage. This sublimation would reduce the overall scale of the physical building as outlined before. After the students developed their program they created designs that incorporated the cyberspace as part of an overall building scheme. There were several ways this could be done and can be explained by use of Venn diagrams. Figure 9. The two space types—physical and cyberspace—can be completely distinct, congruent or overlapping. Many examples exist of Distinct Physical and Cyberspaces. The logical construct of a computer network rarely has anything to do with the layout of the building that houses it. In many cases relationship between the two is not necessary since the focus is on data and file structures rather than the support of navigable information space.

Examples of congruency between cyberspace and physical space are seen in surveillance and monitoring systems. In these cases the building is mapped into a data base and linked to support technology through cameras and sensing devices. The one-to-one relationship of the cyberspace map to the building serves the panoptic needs of the surveillance party. The rigidity of the cyberspace model is the limitation of congruency. If physicality literally determines the behavior of the cyberspace, the on-line architecture cannot benefit from cyberspace's inherent fluidity.

The overlapping relationship is currently seen in analog and digital forms. For example, many teleconferencing and telepresence systems serve specific spaces in buildings. This is limited due to the expense and relative rarity of the technology. The space is perceived as a camera image and is usually not navigable by the viewer unless the camera is operated through remote control.

Digital examples include many where their initial programmers have used existing buildings or cities as the core configuration of their domain. Such cases usually indicate overlapping spaces since—in most instances—the space community actively builds the bulk of the space structure. The congruency between the two space and a physical space is usually limited to the initial construction. The administration of the space usually allows communal participation in the construction of the domain.

Despite the overlap, to my knowledge there is no interactive relationship between a space and its referent spaces. With the exception of users who happen to occupy the physical version of a cyberspace at the time they are playing the space, there seem to be few if any examples of interaction. In most cases the space version of a building or city is an unlinked simulacrum, a stage set that merely resembles the real thing. With the advent of Virtual Reality Modeling Language (VRML), RealVideo and other technologies a true dialog between on-line social environments and physical reality is possible. For example, a space player may come upon a room which has a link to physical counterpart. A camera in the physical space can send an image to its cyberspace twin which is in turn displayed to the space player. This linkage could conceivably be two-way, effecting an overlap between the physical and the cyberspaces.
The students were encouraged to explore potentially asynchronous use of the building as well as the decentralization of its program. Although few of the projects took on decentralized schemes, a number of them did question the temporal nature of a building’s operation. This was particularly true of auditorium projects where several students opted for continuous operation. Performances from around the world might be accessed at any time through Internet media.

Since the theme of the semester was Information Architecture, a number of students took the opportunity to explore the use of information technology to influence the actual form of the building. One student, Mark Mitchell, used the passage of light through his site to determine the configuration of his art museum. (Figures 10 and 11) This is a radical version of contextual design as the resulting geometry, though based on the local geometry of buildings, is surprisingly different from the surrounding architecture. Another, Christopher Kretovic, scanned historical photographs of the site and reduced their collages digitally to determine his museum’s structure and layout.

Another important aspect of this project was the bridging of the cyberspace and the physical through a metaphorical narrative linking the two spaces. By understanding the cyberspace from the physical, the user is oriented within the nonphysical space. In a rare book library project, Banah Hammash described the building as a book with the cyberspace being its pages released into the sunlight. While the physical books would be hidden from light, the cyberspace pages would be available for all to see—undermining the very notion of unity in books. This automatically evokes a number of images for the user, pre-orienting them within the cognitive space of the building.

Several schemes incorporated the mirror images in reflecting pools of water as allusions to the fields of vision. A nature of on-line experience. There were also attempts at constructing the shadows of the physical building to determine the cyberspace form.

The sustaining metaphor is important in uniting the fabric of the physical building with that of the conceptual space. The cognitive space of cyberspace is dictated by more than just the access to data. As these spaces develop socially they will create cultures to a degree independent of the instrumental aspects of computing. The mythology—the use of the narrative as a

Figures 10 and 11 This art museum by Mark Mitchell used various viewing angles on the existing site to determine its geometry. Vertical surfaces were created by reflecting the reflections from a pool through a hypothesized void. The cyberspace of the museum, shown on the right, extends the surfaces of the building beyond its perimeter. Cybernetic additions to physical art displays would be accessible by the building occupants as well as those entering the facility from the Internet.
conceptual framework is a way of organizing and correlating these radically different kinds of space.

The narrative lets the user anticipate the cyberspace from evidence provided by the physical building. Conversely, the on-line user may intuit the configuration and presence of the physical building through the cyberspace experience. The two conditions are understood to be related and the metaphor of space and the narrative provide the conceptual framework uniting them.

The cyberspaces designed by the students were typically less static than those found in conventional architectural schemes. The designers wanted to convey the impermanence and subjectivity of these kinds of space. I encouraged them to examine the principles underlying the physical architecture and then allow them to inform the cyberspace configuration. There would be a geometric, conceptual link back to the physical architecture. But this geometry would only be the organizational skeleton of the building. Fixed room configuration would only occur if the cyberspace overlapped the physical. This overlay would happen if occupants of the physical space needed to confer with occupants of the cyberspace or if surveillance of the physical building were an issue.

With these underlying principles it would be possible to have a number of evolving solutions. We felt this approach was appropriate since spatial cyberspace could configure itself into specific forms according to the needs of the user. Once those users have left the space it could reform itself for others. The designers felt that cyberspace might constantly evolve while the physical architecture maintained an anchoring role through its relative permanence.

The exercise emphasized the continuity of the spatial metaphor—from the analytical phase to the final stages of design. As they developed their building programs the students decided which components of the physical building could be sublimated by the technology. Once this decision was made, however, they were responsible for integrating the cyberspace conceptually into the spatial matrix of the scheme. The didactic intent here was to have the students explore the effects of the programming decisions and the continuity of the spatial strategy in physical and cognitive media.

In most cases the physical and cyberspaces overlapped in specific areas and the cyberspace developed from there according to underlying geometry of the physical scheme. As an instructor, I encouraged the students to derive principles from the site to develop their physical response to the problem. The building’s relationship to the site was analogous to the cyberspace’s relationship to the building. The analogy allowed the students to see how underlying principles derived from the physical could be employed at higher levels of abstraction. This method is familiar to most architects and is common in architectural education, although the design of cyberspace is a recent development.

In several cases the students based their cyberspaces on the principle underlying their physical solution. Ranah Hammash’s solution for a law office used the freeform geometry of her physical building to extend and orient the cyberspaces beyond it. Wainee Thunstron’s design for a law library was almost entirely a cyberspace with specific reference to the physical architecture of the existing building. (Figures 12 and 13) In an art museum by Christopher Kretovic the vaults of the gallery extended into the ground plane to create a rough cylinder for a cyberspace extension.

Students also examined the effect of cyberspace on the physical space—as a kind of feedback condition. Building designs often indicated invisible extensions or highlighted absences. These took various forms ranging from outdoor rooms to projections onto the surrounding terrain. The work the students did on anomalies in GCs also affected the schemes where the cyberspaces intersected the physical buildings.
Making the illogical events in cyberspace palpable was a great conceptual challenge as the students were forced to acknowledge the contradictions and resolve them spatially.

Although the cyberspaces referred to the architecture of the physical buildings, these spaces often did not take the shape of conventional rooms. Students took advantage of the disembodied nature of the space by stressing information display over containment. An example would be rooms which existed as shards of information which took on depth when viewed closely—the way space is seen when looking through a prism.

Containment strategies were often employed in the design of social environments of physical and cyberspaces. The embrasure of the user and other occupants helped to set the stage for social interaction. Whether these enclosures took on conventional form was up to the designer. More important was the provision of a defined place of interaction.

**self, society and space**

The principles of the architecture provide a grounding for non-physical space. They become referents and set the conditions of orientation. Cyberspace in this case is not a purely abstract space. Instead it is an extension of our present experience of the world. These structures help us to manage information. We are so immersed in this environment that we see it as our only reality. Instead it is a sophisticated and powerful illusion—one basic to our sense of self and place in the world.

In cyberspace this means that designers must employ a cognitive understanding of space and information. The cyberspaces created by designers and programmers should acknowledge the user as the starting point for any design development. Cyberspace is an extension of our cognitive space. Denial of this undermines the role of computing as a medium for human interaction. This denial is implicit in many current visual interpretations of cyberspace. Designers, reveling in the freedom from physical constraints, often produce results which are disorienting and confusing. These experiential environments—while often beautiful—may best serve entertainment or artistic functions. But as places of work they provide no reference points for organization. Information is presented as a blizzard of images and fragments. While these images may illustrate the deluge of information...
in our age, it doesn’t address the need to organize it in a coherent fashion.

Representational clues, like gravity and oriented light, are crucial to situating ourselves in space. We take these for granted, but they are vital to our engagement with the world. Even our imagined and dreamed spaces employ these devices as an unspoken connection to physicality. This understanding is fundamental to developing sensory cyberspaces. Readers may refer to the works of Susanne Bodker and Brenda Laurel for more information on these issues. Understanding the human factors of computing is essential to the prospective design of online environments.

Spatial structures analogous to architecture can provide localized contexts mediating between specific data and the expanse of the Internet. These structures may be connected into larger wholes and higher levels of organization. An examination of our and their effect on architecture anticipates the creation of useful cyberspaces— the seed structures of this larger organization.

Cyberspace is not a place of escape. We found many similarities to the physical world in the sense. Issues of territoriality, dominance, and various behavior modes are among the many things we encountered. These are all aspects of physical human culture. In the design of cyberspace, planners must acknowledge the foundation of physical and social realities in creation. For this reason cyberspace is likely to be an abstracted but not entirely abstract space. Computer users will still be able to recognize principles and features of physical reality in these spaces. Space is a host environment for handling data, a fact which explains the success of the spatial construct in computing. Other kinds of organizers including agency and search engines exist, but only the spatial metaphor allows users to browse in an undirected fashion. Its power is in information management as an environment for felicitous discovery.

Space makes engagement with the information possible. More, it makes engagement of users with each other possible. The advent of graphic cyberspaces demands spatial strategies to better serve our culture. This humanization of technology can be effected with the skills and training of architects. It benefits both our society and the profession that these matters are explored.

Cybrids can reduce the incremental lover on urban infrastructure, reduce our use of natural resources, maximize efficiency in the production in useful places of work and play. They exist at the boundaries of matter and media, fiction and fact. They can play a unique role in serving our information-based economy and culture.

The development of cybrids offers a challenge to architects—one they are well positioned to meet. The linkage of physical and cyberspaces must not threaten the profession. Instead, architects must see this as a new field of endeavor. While architects may not feel that they need the technology, the technology needs them. If spatial skills are needed for more effective communication, they should be provided by those already trained for the task. If architects and designers accept this challenge, they can enrich and humanize the technology. If not, the profession risks further marginalization as mediated alternatives to architecture continue to develop.

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