Extensions: Some implications of cyberspace for the practice of architecture

Peter Anders
Director of MindSpace.net, USA

This white-paper builds upon previous research to present hybrids of electronic and physical spaces as extensions of current design practice. It poses an hypothetical project - a hybrid of physical and cyberspaces - to be developed through an extrapolation of current architectural practice by fully exploiting new information technologies. The hybrid's attributes not only affect the scope of development but the very activities of the design team and client during - and after - deployment. The entire life cycle of the project is affected by its dual material and media presence.

The paper concludes by discussing the effect the hybrid - here called a "cybrid" - on the occupant, and its local and global communities. It reviews the economics, administration, marketing, operation, flexibility, and extension of the project to assess its effects on these scales. The conclusions are provisional owing to the youth of the technologies. However, in laying out these issues, the author hopes to begin a discussion on effects computation will have on our built environment.

Emergent spaces

While many architects accept computers as extensions of existing practice - email is like telefax, data files are like drawings and models - few accept that computers change the very foundations of their discipline. This is in the face of dramatic change in culture and information technologies. For example, recent developments allow the creation of on-line work environments. These electronic spaces, called collaboratories, let remote researchers and colleagues share technology to pursue common goals asynchronously.[1] Over the past decade they have been successfully deployed at research centers, universities and multi-national corporations. Also, the U.S. military has funded study of overlapping physical and cyberspaces to provide remote briefing facilities for its personnel.[2] Multi-user domains (MUDs) and computer games on the Internet, popular among the young, 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]

The emergence of these spaces presents architectural clients with new means for achieving goals previously reserved to construction. Emulating space, these cyberspaces offer alternatives to material workplaces. Architects may find that portions of projects are no longer implemented physically for reasons of economy, flexibility or strategy. Instead, future developments may be spatial continua, hybrids of physical and cyberspaces. Designers may translate the information-rich components of a traditional building program into flexible, dynamic databases using a spatial reference 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' activities. These hybrids, here called "cybrids"[6], provide a model for responsive, physical and electronic spaces that can radically affect the design professions and the clients they serve.

Yet, this said, it's worth examining how cybrids may affect architectural practice and our environment. Some pragmatic questions - beyond the ablation of buildings into cyberspace - 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? How would the design and architecture of such spaces change with regard to current practice? Only by trying to answer these questions can we foresee what problems and opportunities attend the future development of cybrids in our built world.

Recognizing the cybrid as a class of artifact gives us a handle on its nature, but not its eventual use. The cybrid changes irrevocably the activity it serves. This is especially true of social structures related to the activity. The introduction of the telephone into corporations allowed the later separation of management from the factory floor, changing forever the relationship between administration and labor. Similarly, commercial electronic media such as television and radio have fundamentally changed our economy and value systems over the past fifty years.

Notes on assumptions and methods

This paper is a trend projection on the future of the production of buildings and supporting facilities. It forms a picture from many current technologies often seen in isolation yet seldom appreciated for their cumulative impact on architectural practice. I will pose an image of future practice that ties together many current trends and evaluate their likely impact. For this reason, though I mention current technologies in notes, these are meant more to demonstrate their application in the scenario rather than to make specific claims against them. These citations help to ground the scenario without distracting from its larger scope.

The subject of this paper is the transformation of architecture due not merely to technology itself, but its underlying suppositions and entailments. The theoretical perspective is very pragmatic. It is based on a principle of economy which favors the most efficient use of resources to accomplish a task. The point of view taken does not intend to favor any party or discipline, architecture, engineering or even client.

The following scenario suggests benefits to all participants. For example the design team meets via on-line teleconferencing just as the client uses e-commerce to support his operations - both cases benefit from efficient and economic use of the Internet. Rather than focus on particular parties in this analysis we will expand the scope to include local and international communities. Also the process and product will be described as a project rather than a building. This offers new opportunities, merging physical and electronic space, for service to the client and community.

This analysis - necessarily speculative - invites further development. The economic and social impact of cybrid technology is unpredictable owing to the novelty of the technologies and the subtle ways they may affect a culture. But if we can't predict future, we can at least ask questions. How, for instance, would an architectural cybrid affect its tenant? Would the very nature of the cybrid change the development of projects? What applications are better suited for cybrids? What are the costs and benefits of a cybrid strategy?

Cybrid implementation

To help us answer these questions, let's consider the 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. It could be an office building, a school, a library, a factory - any number of building types. Table 1 breaks down the following phases according to different building types/uses. The table is provisional, only a rough guide to the projected effectiveness of the strategy at each stage. The following scenario also includes notes that describe the technologies and potential products involved in each stage of the project. Note also that the term project applies to all aspects of a process that includes inception, development, use and termination of a spatial environment, building or otherwise.

Design phase

1. Team site (Please refer to Table 1)

After initial meetings and correspondence, the architect contacts her consultants and engineers. Some may be local but others are in remote places and time zones. The team agrees to meet regularly on neutral turf for progress updates. To facilitate this the architect contrives 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 multi-user domain that lets the team meet continuously either through use of avatars or by live video feeds from their workplaces.[7] Participants who are in different time zones may participate asynchronously by leaving messages, entering comments in a thread of published dialog, or video clips much in the way that email and Usenet newsgroups operate.[8]

2. Virtual reality site model

The site is an information space, rendered three-dimensionally by the architect. By modeling data taken from a satellite, she 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. 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.[9]

Significantly, she creates a platform on this model that symbolizes the meeting space within the project's multi-user 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 in this symbolic space, referring to graphics, text and other displays as they develop the scheme.[10]

ybrid Deployment

Effects on Development Process and Applicability to Building Uses

Key:

1 Negligible benefit to process/product	*a Owing to programmatic complexity*	*d Dep*
2 Possible benefit to process/product	*b Owing to technical complexity*	*e Dep*
3 Likely benefit to process/product	*c Owing to scale*	*• App*

ents	Service Office Buildings Administration	Manufacturing Factories Utilities	Cultural Libraries, Museums	Commercial Merchandising, Stores	Hospitality Hotels, Resorts	Health Hospitals, Clinics	Learning/Research Schools, laboratories	Resid Apartr Comm
g								
1. Team Site (MUD)	3 a c d	2 b	2 d	2 d	3 a c	3 a b c	3 a b c	2
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
3. Heuristic Gaming	2 d	3 b	2 e	1 d e	2 a c e	3 a b c	2 a e	1
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
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	•	•	•
6. Project Promotion	2 e	3 e	3	3 e	3	3	3	2
ubtotals	15	14	14	11	18	18	16	10
ct on phase	3	4	4	5	2	1	2	6
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
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 c
ase Subtotals	21	16	21	17	20	20	21	14
ct on phase	1	4	1	3	2	2	1	5

s . mindspace.net

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	55	46	58	61	60	42
Ranking re: effect on project	3	6	5	7	4	1	2	8

3. Heuristic gaming

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 alternate 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] - even feng shui.

4. Algorithmic 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.[14] 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.[15] 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.

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.[16] These might, for example, manifest the business' intranet and virtual private networks, facilitating intra-office communication and alliances with remote companies and agencies.[17] Some physical functions may be partially replaced by cyberspaces, particularly information storage like files and libraries.[18]

Some of these functions are portrayed in cyberspace as ambient environments - others simply as graphic displays or place-holders for future use (see Table 1 Domain Data Display). Some 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.[19]

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.[20] 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.[21] Contractors and subcontractors visit the physical and cybereal sites to meet with the architect and client. Contractors proposing alternates to the design change the cyberspace 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.[22]

9. Model update and as-built documentation

As the physical construction continues, the architect, contractor and consultants update the cybereal model of the building. This keeps it up to date and ultimately provides an accurate account of what was finally built.[23] This extends the current 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.[24]

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. 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 in the ventilation system.[25] 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.[26]

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 multi-user domain. This MUD may have different uses and levels of privacy depending on the client's business.[27] 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.[28] 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 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.

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.[29] 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.[30]

Project termination

15. Sales and leasing documentation

Finally, the building is no longer required. The owner's business has been relocated or a new building needs to be constructed to meet business demands. 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

Or it 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.[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.

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. 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 cyberspace themselves be recycled.

Cybrid typology vs. utility

In the foregoing discussion, I have described a technologically-augmented extension of current architectural practice. However, cybrids bend many premises of practice to the breaking point. For instance, Table 1 was based on current building types. One could ask whether such typology would pertain to all future uses. The use of the building doesn't necessarily determine the use of the cybrid. Rather, the use of the cybrid determines the behaviors of the user. Cybrids are best suited to extending a local condition outward. Populations isolated by geography or other constraints benefit most from such extension. But localization may also result from intentional separation from the surrounding environments. Examples include prison environments, space-station environments, even isolating ourselves to watch the television set. All of these are similar in that the localized situation is not desirable at various points and time. An extension outward through electronic means is a viable alternative to physical localization.

Seen in this way cybrid's are not necessarily just a substitution for physical environments but, instead, are actually extensions of local conditions. This can affect parameters of architectural programs. For example, senior citizens housing which is defined by a population that is less mobile than the average population would benefit from a cybrid strategy. This vies against the preliminary analysis in Table 1 which indicates that residential populations are least likely to benefit from cybridization. Clearly, in this case, individual occupants' use of the environment is unique, and qualifies any typological analysis. User parameters supersede those of general building types.

Evaluation and critique

Readers may note that nearly all the components of the proposed scenario are either already in use or possible with today's technology. But despite this familiarity, the creation of cybrids poses surprising challenges as well as opportunities. It's clearly dangerous to generalize the outcome of a cybrid strategy. Each case would have to be assessed on its own merits. For instance the consequences of using the strategy for an urban office building would be quite different from those of a suburban library. Still it's useful to point out the issues affected. Who benefits? Who suffers? At what scales are the consequences felt? Do the benefits of the owner, for instance, outweigh the burden borne by the community?

While it's tempting to imagine each cybrid attended by a spreadsheet totting up the pluses and minuses of implementation, such information is hard to come by. This is partially because cybrids are too new a phenomenon to have accurate information. Also, as we know, the impact of such strategies is hard to foresee. Take the example of typical computer networks in a company. What was installed originally as an accounting system over time helps with intra-office communication, even advertising and sales on the Internet. People tend to use technology in ways that it was not originally intended. William Gibson, inventor of the concept of cyberspace, says that the street finds its own uses for technology.[32]

Even so, the question of impact is too tempting to ignore. Although we can't put a dollar value to the issues, it is at least worthwhile listing what they are - or what we guess them to be. We can be safe in saying that benefits at one scale may prove elusive at another. For instance, the reduction in air pollution resulting from telecommuting to cybrids would be a direct benefit to the community. However, the proprietor of the cybrid may only benefit indirectly - the environmental issue having a lower priority among those influencing his decision to build a cybrid. For such reasons I will describe the effects of cybridization on three scales: the owner; the local community; the world. Cybrids will have critical implications - positive and negative - in each arena.

The owner/occupant

The owner's primary benefit is choice, since not all solutions - spatial or otherwise - need to be built. In the early stages of the design the owner and architect determine the physical and symbolic components of the cybrid. It's ultimately the owner's choice how much of the facility is physical. There may be a number of factors that influence his decision - available resources, tax advantages, business strategy. A welcome reduction in real estate taxes may result from a smaller building - or because a large portion of the cybrid may be a product of fixture expenses rather than construction.

The smaller building resulting from the cybrid approach requires less investment and reduces the initial capitalization of the project. Although there will be the added expense of the supporting computer network, it's highly unlikely that these costs will be of the same order of magnitude as the construction and maintenance of comparable physical space. Particularly if we consider future modifications or reorganization. Still, we have to bear in mind the obsolescence of computer-related equipment as part of the on-going maintenance costs of the cybrid. Even if these costs go down with the increasing capacity of the technology, they cannot be ignored.

Another benefit of the strategy is that the operation of the cybrid begins earlier than a conventional building project. Since the cyberspace component of the project is likely to function far in advance of its physical counterpart, it may already be a site for doing business. If the client were concerned about generating revenue from his investment, the on-line component of the project is likely to pay back sooner than the physical plant.

Not only can the cost of construction be reduced but costs of maintenance and upkeep as well. This is facilitated by a reduced area of building as well as the on-going automated monitoring of building systems. Conceivably, such an active vigilance over the building could affect other costs as well, including insurance premiums and building security expenses.

The substitution of cyberspaces for buildings is not the aim of cybrids, instead they are a spatial continuum that takes selective advantage of physical and emulated space. The primary advantages to the proprietor are not in cost savings engendered by "cheap" cyberspace. For, in using a cybrid strategy, the entire way of doing business changes. The real benefit to the owner is a careful allocation of resources, time and effort to effect a transformation of his operations, extending and accelerating them in ways not previously possible.

Such mediation of a business' facilities is appropriate - even necessary - in the current business climate. On-line commerce, extranets, collaboratories and ever changing business alliances point to a need for flexibility and choice. Even close to home, an employer's flexibility in time and place may help him get better qualified employees, wherever they may be. What flex-time is to a commuter, flex-space is to the telecommuter.

But what are the costs to the proprietor of the cybrid? First off, the cyberspace component of the cybrid is not physical space. There are as many differences between material and emulated spaces as there are similarities. Identity, propriety and territory in cyberspace are subjects of intense scrutiny for this reason. We can expect that interaction in cyberspaces will be attended by ambiguity and a degree of uncertainty for the foreseeable future. Cybrids blur the distinctions between the physical and symbolic, the real and fantastic. Designers of cyberspaces must take care that the metaphor of physicality doesn't mislead them - or their clients.

The abstraction of the workplace could also have a deleterious effect on its culture. For example, there is possibly a reduced mutual commitment between an employer and a telecommuting employee. Whether this results in less job security for the employee is debatable since telecommuting workers require less overhead than those physically on site. Also, it is difficult to predict how telecommuting will be qualitatively improved with cybrid implementation. Once again, each application of the strategy depends on the nature of the client, the purpose served by the cybrid and the culture of the organization.

The community

Though the advantages appear stacked in favor of the owner, we should also look at the effect a cybrid implementation might have on the local community. As before, this is contingent on the nature of the business and the degree of implementation. The negative effects of cybridization might be offset by bringing new businesses into town via the Internet, for instance. However, the net effect on the community is harder to assess than for the limited entity of the business. Some effects will be decidedly negative.

By reducing the size of the physical plant, the client affects long-term revenues of the host community. Smaller buildings reduce the need for construction and affect the associated market for materials and labor. In the course of operation, the cybrid's maintenance and operation costs are also less than for a conventional building. This reduces the need for support services supplied by the host community. Since many properties are assessed for taxation on the basis of their size, the tax revenue generated by a cybrid would likely be less than otherwise possible. Also, since the proprietor of a cybrid will be more likely to employ telecommuters, many of his employees will not be paying the same rate of local taxes as their resident counterparts.

Service businesses benefiting from commuter traffic will also suffer. If telecommuting and outsourcing are an important part of the cybrid proprietor's business, the local telephone company may be the only local business that stands to gain. Toll booths, parking structures, coffee shops, newspaper stands, delicatessens, shops, restaurants and theaters would all feel some effect from the reduced traffic. Indeed, without having accurate numbers to evaluate, it seems that of the three - proprietor, local community and world - the local community would be hit hardest by cybridization.

And yet even here there are advantages. Cybrids are a high technology answer to many ecological and urban problems. Clearly, reduced commuter traffic - even mass transportation - curtails the release of pollutants and toxins into the environment. The health of the community would no longer be a cost of doing business. Also, the reduction of tax revenues due to cybridization may be offset by reduction in infrastructural expense. The cost of maintaining roads, bridges and utilities that serve commuters would wane since workers may opt to work from home.

Net losses due to cybridization and telecommuting are hard to assess because many parts of communities are affected differently. We are confronted with apples-to-oranges comparisons. How can we compare loss in commuter-generated revenues to increased efficiency in doing business? After all, the hand that taketh away also giveth. Local citizens may suffer from increased job competition from telecommuters, but at the same time, their scope of potential employers also increases to include businesses in other parts of the country. Likewise, local businesses can now reach a remote clientele.

The stability of local economies might be a longer-term benefit of cybridization. For cybrids are not limited to new projects alone. Cybrid extensions may be business' alternative to leaving a community to find more space, for instance. Also, since starting a business with a cybrid may require less time and capital, the local business community might sponsor cybrids as a way to generate new economic growth.

A last point regarding telecommuting addresses the scope of the community. Are we only talking about the community local to the physical plant of the cybrid? Or the aggregate community of all the workers who contribute to the business? So far we have focused only on the former. But if it's the latter, the benefits of the cybrid strategy are much clearer. The telecommuter who works at home still has to eat, shop and support his own operation. The business lost to the city to which he would have commuted is now gained by his home community.

Before leaving our discussion on the community, we must consider who is participating in this process. Clearly those literate and aware of the technology. Cybrid operators and Internet commuters are obviously beneficiaries. The benefits of cybridization on the local communities is debatable - as we have seen. However, there are signs of polarization between the technology haves and have-nots. The advantages of cybridization to a poor kid in the Bronx are much less than to a computer-trained job applicant in Manhattan. And the stratification doesn't end with computer literacy. For electronic and computer networked businesses acquire a culture of their own - the ways of operating in it are sufficiently abstract to require training beyond operating a machine. As a result, there are less employment opportunities for the uninitiated. This, apart from social, economic or ethnic issues, drives yet another wedge dividing our communities. William Mitchell, dean of MIT's School of Architecture, has worked with colleagues and community groups to mitigate against this effect in the Boston area. Yet it remains a challenge to our education systems and local governments to close this gap.

The world

The advent of cybrids can also have world-wide effects. Among the liabilities I have listed for local communities is the potential for social stratification. Even at the scale of proprietorship, the telecommuting employee has a different status from those present at the job. The have/have-not problem of communities might only be exacerbated globally. For example, the benefits of cybridization are much more palpable to a western European country than to, say, an agrarian Third World nation. We could argue a net benefit to the world, but it's hard to validate - and small consolation for the have-not countries.

While this cloud hangs over the advance of global technologies, its edges gleam with potential. The same technology makes possible friendships and alliances without regard to time or place. It makes the needs of those far away as real as those that attend us locally. And if we are aware of each other's needs, we are tacitly responsible to them. This may not be the force that changes the world - for any technology is subject to misuse - but anything that potentially brings us closer together can't be all bad.

On a pragmatic level, cybrid's availability on world-wide networks is a global amenity. Given current examples of collaboratories that share equipment and remote observation stations, cybrids offer a new way to distribute facilities. A school that might otherwise not be able to afford tools for research can tap into a university cybrid developed expressly for that purpose. A hospital lacking advisory staff or data facilities might access them through a cybrid based at a regional medical center. A small business might be able to take on a larger international clientele by linking up with a global company through its cybrid extensions. The combined potential for international alliances and shared resources is another clear, if unquantifiable, advantage of the cybrid strategy.

What the long-term effects of this might be is hard to say. Cybrids are, after all, a special case of cyberspace, one that stresses the continuity of the spatial medium. In this scenario we have seen how the cybrid condition affects different scales of society. Yet these observations are necessarily conditional. 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.

Conclusion

Current interest in "intelligent" buildings resembles that surrounding "smart" buildings in the '80s. As before, the focus is on artifacts of construction rather than their development: decisions on what needs building or the project beyond initial occupancy. In literature on the subject we read about hardware: sensors, activators, smart materials and building-specific LANs. Still wanting is justification for their use. Does the "intelligence" of such building merely elaborate the functions buildings currently serve? Or can it serve new purposes beyond shelter and substance, serving cybrid occupants beyond the locality of construction?

If a building is the body of a cybrid, the domain is its soul. The cybrid comprises both. As we have seen the domain of a project is "living information" manifested in printouts, notes and buildings. Its generative and sustaining effect on buildings is direct and - to date - underutilized. This entity, a potential social space, is much more than an archive of building data. More, in fact, than electronic fluctuations in "intelligent" buildings. The emphasis of the cybrid is on its domain, its cyberspace, whose use is not limited to the production and operation of buidings.

This shift of emphasis challenges many assumptions about the architectural product. Are such products merely automated buildings or a new duality like hardware/software or body/soul? The model for this is nothing new - it has been with us since Plato's theory of forms. But when architects argue for "intelligent" buildings they stress physical attributes rather than the promise of higher abstraction. With the advent of dimensional, social cyberspaces, such abstraction becomes tangible, an artifact in itself. And the economies arguing for its use are inescapable. The challenge to architects is to view the totality of the project - its artifacts and extended scope - to find its natural grain of grace and economy. If the new reality of cyberspace is lost on design professionals, it will not be on their clients.

Notes

[1]. Ross-Flanagan, Nancy. 1998. "The virtues and vices of virtual colleagues". in MIT's Technology Review, Mar/Apr. pp. 52-59.

[2]. Downes-Martin, S. Long, M., Alexander, J. 1992. "Virtual reality as a tool for cross-cultural communication: An example from military team training". 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.

[3]. Curtis, Pavel, and David Nichols. "MUDs grow up: Social virtual reality in the real world" (Austin, TX: 1993)

[4]. Bruckman, Amy and Mitchel Resnick. 1995. "The MediaMOO project:
Constructionism and professional community". Convergence 1(1).

[5]. 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.

[6]. 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, Cincinnatti, Ohio. 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 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.

8. Technologies: Usenet newsgroups, HTML.

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

10. Technologies: CAD modeler, VRML, CUSeeme video conferencing software, video-streaming support. 3D MUD software.

11. McCall, R. and Johnson, E. "Argumentative agents as catalysts of collaboration in design". in Design Computation: Collaboration, reasoning, pedagogy. McIntosh, P. andOzel, F. eds., proc. ACADIA 1996 Conference, Tucson, Arizona. pp.153-162.

12. 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.147-152.

13. Mahalingam, Ganapathy. 1997. "Representing architectural design using virtual computers". in Representation and Design. Jordan, P., Mehnert, B., Harfmann, A. eds., proc. ACADIA 1997 Conference, Cincinnatti, Ohio. pp.51-61.

14. Pohl, Kym. 1996. "KOALA: An object-oriented architectural design system". Master's thesis, California Polytechnic State University, San Luis Obispo. unpubl. and Pohl, Jens 1996. "Agents and their role in computer-based decision support systems". 8th International Conference on Systems Research, Informatics and Cybernetics. August 14-18th, 1996, Baden-Baden, Germany.

15. Krause, Jeffrey. 1997. "Agent Generated Architecture". in Representation and Design. Jordan, P., Mehnert, B., Harfmann, A. eds., proc. ACADIA 1997 Conference, Cincinnatti, Ohio. pp.63-72. Also, recent research by author and Craig Caldwell, unpubl.

16. Anders, Peter. 1997 op.cit.

17. Technologies: Electronic Data Interchange - Value Added Networks (EDI-VAN), 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, EDI-VAN, 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 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.

26. 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. and Webster, A., Feiner, S., MacIntyre, Massie, W., Krueger, T. 1997. Augmented reality in architectural construction, inspection and renovation. unpubl.

27. Technologies: EDI-VAN, Internet fire-wall security, graphic object-oriented programming software (Visio).

28. Technologies: CAD modeler, 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, W. 1992. "Academy Leader", in Cyberspace: First steps. Benedikt, M. ed. Cambridge, Mass: MIT Press. p.29.

References

Anders, Peter. (1999). *Envisioning Cyberspace*. (pp. 193-215) New York, NY: McGraw-Hill.

Anders, Peter. (1996). Envisioning cyberspace: The design of on-line communities. In P. McIntosh & F.Ozel, (Eds.), ACADIA '96, (pp. 55-67), Tucson, AZ: Impression Makers.

Ballaguer, J. F. & Gobetti, E. (1993). Virtual reality builder II: On the topic of 3D interaction. In N. M. Thalmann & D. Thalmann (Eds.) *Virtual worlds and multimedia* (pp.99-110). New York, NY: Wiley Press.

Johnson, R. & Clayton, M. (1996). The impact of information technology in design and construction: An owner's perspective. In P. Jordan, B. Mehnert & A. Harfmann (Eds.), *ACADIA '97*, (pp.229-242). Cincinnatti, OH: Berman Printing.

Krause, Jeffrey. (1997). Agent Generated Architecture. in Representation and Design. In P. Jordan, B. Mehnert & A. Harfmann (Eds.), *ACADIA '97*, (pp. 63-72). Cincinnatti, OH: Berman Printing.

McCall, R. & Johnson, E. (1996). Argumentative agents as catalysts of collaboration in design. In P. McIntosh & F.Ozel, (Eds.), *ACADIA '96*, (pp. 153-162), Tucson, AZ: Impression Makers.

Mahalingam, Ganapathy. (1997). Representing architectural design using virtual computers. In P. Jordan, B. Mehnert & A. Harfmann (Eds.), *ACADIA '97*, (pp. 51-61). Cincinnatti, OH: Berman Printing.

Pohl, Jens (1996). Agents and their role in computer-based decision support systems. 8th International Conference on Systems Research, Informatics and Cybernetics. August 14-18th, Baden-Baden, Germany.

Ross-Flanagan, Nancy. (1998). The virtues and vices of virtual colleagues. In *MIT's Technology Review*, Mar/Apr, 52-59.

Webster, A., Feiner, S., MacIntyre, Massie, W. & Krueger, T. 1997. Augmented reality in architectural construction, inspection and renovation. unpubl.