Cynergies: Technologies that Hybridize Physical and Cyberspaces

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Abstract

This paper presents ways in which cybrids depend for their technology upon three existing models of architectural hybrid: display space, environmental computing, and augmented/mixed reality. Cybrids bring these techniques together into a synergistic whole that depends as much on the observer for its consistency as it does on its comprising technologies. This synergy is a product of corroborative behavior between different modes, which provide cybrid users with a coherent social/spatial experience. The paper notes cybrids’ similarity to theater, not only for their technological dependency, but also for the tacit yet vital role of the observer in their effect.
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1 Background

Cybrids are architectural, spatial compositions comprised of physical and cyberspaces (Anders 1998). This paper discusses three technologies that conduce to the creation of cybrids: display space, environmental computing, and mixed or augmented reality. These technologies, which hybridize physical buildings and electronic techniques, each bear values that support or vie with the phenomenological premises of cybrids and must be accounted for in their design. For example two of the technologies—display space and environmental computing—depend heavily on the integration of physical information technologies with the building fabric. Augmented or mixed reality technologies instead depend on the observer’s ability to conflate simulated entities with the physical environment. Mixed reality, unlike the other two hybrids, is based on a psychological, phenomenological model of the observer. We argue that the other two are comparatively materialist in nature, requiring physical intervention for their effect on the environment and subsequently the observer.

Despite their overt differences, however, the technologies are not mutually exclusive. In the literature of Cooperative Building, for instance, the devices of display space are found among the varied components of environmental computing systems. Augmented reality, too, makes use of display systems and computer networks. Our thesis here is that the product of such technologies may be composed to a greater holistic effect: that of a merged reality that blends simulation with material fact (Johnson 2002). In the following pages we will see the role that these technologies may play in the development of cybrids.

2 Display Space

Among the popular motifs of contemporary architecture are images of buildings whose walls and surfaces are animated by large-format screens. Such designs are emblematic of technology’s invasion of the environment—a fact readily observed on Times Square and in Las Vegas—and have been used to illustrate the integration of information technology with the material environment. However, the displacement of walls with screens becomes problematic when considering its effect on spatial experience and architecture itself. The notion that architecture becomes a substrate for arbitrary display underlies film theorist Lev Manovich’s pessimism about the discipline’s future. He notes that projected images overwhelm the presence of the physical, thereby devolving it into a mute background for effects.

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

Along similar if more optimistic lines, theorist Peter Lunenfeld believes that the future of architecture lies in combining the hardscape of building with the imagescape of new technology. Imagescape, for Lunenfeld, comprises “electronic facades, linings, and elements on, in and throughout [the] hardscape” of buildings and cities (Lunenfeld 1997). In principle this proposal resembles those of architects in the 1960s. It recalls the work of Archigram, Cedric Price, 9999, Haus-Rucker, PULSA, Coop-Himmelblau, and other visionaries who set forth technologically advanced, image-saturated environments.

The concept of Lunenfeld’s imagescape is implicit in Le Corbusier’s Brussels Pavillion, Piano and Rogers’ Centre Pompidou, and EAT’s (Experiments in Arts and Technology) Pepsi Pavillion. Architects Robert Venturi and Denise Scott-Brown’s designs also employed film/video displays. Examples include their concept of the decorated shed and their 1968 National Football Hall of Fame buildingboard project. Their analysis, in 1972, of Las Vegas’ media-ridden environments pointed to a future (now present) proliferation of imaging technologies in architecture (Venturi, Scott-Brown, Izenour 1972). Today several designers pursue the display space approach in which architecture becomes a screen for the projection of images. The projected image here plays the role of surface ornament, its contents disjoint spatially and thematically from the receiving surface. The image space is incidental to the space of the architecture that, like its display technology, remains physical.

We see Display Space’s latent materialism reflected in Jeffrey Shaw’s inflatable cinema, Herzog and Meuron’s Kramlisch Residence, Kas Oosterhuis’ Space Station Module and Transports projects, Frank Gehry’s Rock and Roll museum, Diller and Scofidio’s United Artists Complex Theater, and Rem Koolhaas’ proposal for the ZKM among other projects. These hybrids imbed display systems into their material environment. Often only the effects, not the subjects, of the displays are considered in the project design. The result is thereby a collage of unrelated display and built fabric—like television sets in a living room.
3 Cybrids and Display Space

The virtues of display space include easy viewing of information by multiple participants, and freedom from the constraints of headsets and sensors. Cost benefits over head-mounted displays would be harder to assess—especially in the long run—since large displays are often expensive. This obtains whether the display is a fixed, flat-panel screen, or a laser projection system. Conceivably, relatively inexpensive electronic paper displays may evolve that could enhance Display Space’s prospects, but the technology for such displays is still in development. We have already noted some of Display Space’s drawbacks. The space of its images is rarely related to its surroundings in any way other than residing on the thin phosphor of the screen. By definition superficial, its spatial illusion is destroyed by the viewer’s movement and changes in parallax. By moving from the ideal viewpoint, the viewer re-affirms the materiality of the display. A cybrid strategy integrating illusory and actual spaces would appear to founder on this limitation. But there are ways around this.

The trompe-l’oeil evocation of deep space is an architectural technique that pre-dates the Renaissance. One could overcome Display Space’s limitations by increasing the distance between the display and the viewer. In this way a moving viewer’s parallax changes little with respect to the display’s distance. This would cause the remote image space—on a suitably large screen—to merge with the space around it. Subtle tracking of the viewer with consequent adjustments to the display perspective could enhance the effect.2 Similar principles apply to stationary viewing. Plastic depth, best perceived as the distance between viewer and object, approaches that of the space between the viewer’s eyes. The mental reconciliation of disparate images plus the adjustment of eye muscles brings the subject into focus as a three-dimensional presence. Nearer external displays, then, would require each eye to receive unique images adjusted for perceived distance.

It is possible to do this without resorting to head-mounted displays or user tracking. Display systems are in development for providing three-dimensional effects, although few if any are available commercially. One promising technology uses diffraction grating filters applied to screen surfaces. Diffraction gratings are common in toys and novelty cards, providing illusions of movement or depth by deflecting different images to each of the viewer’s eyes. The display technique requires that the underlying image be parsed into vertical strips, alternating the image from one to the next. The binocular effect can approach holographic quality (Zucker 1997). This approach requires no tracking of observers to maintain its illusion, although the viewing angle of the 3D image is restricted. The anticipated use of diffraction displays lies presently in gaming and specialty applications. Large screen displays are unlikely to emerge from their development.

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2 Figure 1. Proposal for a building employing Display Space technology. Image by Peter Marshall

3 Figure 2. Images from Kas Oosterhuis’ Saltwater Pavilion. Note the projections on interior surfaces. Images from Hybrid Spaces, by Peter Zellner.
Another option takes advantage of the materiality of the display. Distributing the displays within an existing space and conforming the screens to their content offers compelling opportunities. For example, one could place displays around a conference table, such that each screen presents a different remote participant (Negroponte 1995). This effectively brings the remote participants together, although the illusion of a combined virtual/physical space is limited to those at the table. The contrivance falls apart quickly once a visitor's face leaves its screen.³

Architectural cybrids' social use favors larger, environmental displays. However, the fixity of such displays constrains their use to specific sites, limiting the cybrid experience to discrete, non-immersive events. Head-mounted augmented reality displays might span the gaps between external displays, provided the designers correlate the different display modes for continuity. This coordination would also be required if several HMD users were to share an experience. Conjoining such displays with the virtual environment requires sophisticated sensing and display technologies. These might be worn or—equally likely—embedded in the material environment with wireless support for mobile displays (Wren et al. 1999).

4 Environmental Computing

Environmental Computing, also known as ubiquitous or distributed computing, proposes physical environments saturated with information devices. Its proponents hold that by linking the microchips embedded in our appliances, pocket computers, automobiles and work environments new, otherwise impossible, opportunities arise. This linkage would be sustained by a network of computers and processors. Ancillary appliances may be fixed, like the screens and speakers of Display Space. Or they may be mobile, connected to the network through wireless technologies.

Environmental Computing and Display Space are not mutually exclusive, for displays are only one of many devices used in Environmental Computing. Their chief difference lies in the former's coherent integration of devices, and the creation of systemic behaviors through artificial agents and networks. Unlike Display Space, this integration extends beyond displays to servomotors, embedded and mobile appliances, even to external networks. Nevertheless, like Display Space, Environmental Computing is a material hybrid of environment and technology. Media content, space, and supporting system are conceived separately and often remain operationally distinct from one another.

Research on environmental computing centers on the supporting systems that enable communication between appliances. Its hybridization with the mundane is a result of embedding these appliances into the walls and surfaces of our surroundings. In this sense Environmental Computing differs little from prevalent concepts of Intelligent Building, aspects of Gelernter’s Mirror Worlds, and William Mitchell’s Recombinant Architecture.

Environmental computing research also asserts the creation of “intelligent” devices that are systematically and behaviorally compatible. Their compatibility is key to providing consistency for its users. It makes possible a simple dialog between machines—say, having one’s computer “recognize” and adjust to a new printer—or an elaborate and extended community of appliances that collectively give the impression of intelligence.

William Mitchell, Dean of MIT’s School of Architecture, has written extensively on the effects of distributed computing on architecture. In *City of Bits* he carefully delineates the pressures of technology on building use and typology. If, he reasons, an ATM bank machine functionally stands in for the huge banking halls of the past, what becomes of the material architecture of banks? Moreover, as ATMs pervade public places, they change the use of the spaces they inhabit. The function of an airport terminal or regional mall now includes banking as well as travel
or shopping. In what Mitchell calls Recombinant Architecture, buildings and cities become physical hybrids comprising networks, information appliances, and the brute materials of construction (Mitchell 1995). The reasoning emerges from the instrumental, even positivist, values underlying distributed computing. Simply put, machines provide services that affect the use and form of their environment. In this view—consistent with that of materialist practice—the user’s experience is a mere consequence of the material surroundings. This reinforces a materialist view prevalent in architecture and obtains regardless of whether the environment is augmented with information technology.

5 Cybrids and Environmental Computing
Cybrids will certainly require some degree of embedded, environmental computing to ensure the coherent merger of physical and cyberspaces. Computational support for disclosing such linkage is typically housed in the surrounding architecture. While wireless networks allow mobility for digital devices, these appliances usually rely on fixed support: network connections, modems, servers, and transmitters. Although environmental computing implies uniform distribution of sensors and actuators in the material environment, its intended effect is local to individual users. Lights turn on in occupied rooms, doors open for users, calls travel to the phone nearest to intended recipients. These effects require an embedded system that responds to user position and—at times—orientation. Similar systems could apply also to generating electronic simulations since they would have to be “aware” of the location and vantage of users to create suitable effects (Pentland 1999; Ishii 1999). Such monitoring and display would have to accommodate a number of occupants both physically present and telepresent. Environmental computing does not preclude either display space or, as we shall see, augmented reality. Embedded sensor systems can support augmented reality just as built-in monitors serve display space. They are all compatible within an appropriate hierarchy of use.

6 Augmented/Mixed Reality
The overlay of simulations onto physical objects and surroundings has been variously referred to as augmented reality (AR) and mixed reality (MR). These technologies have emerged from those used in virtual reality, and many of the softwares and devices are similar. AR and MR have great implications for cybrid architectures. In the eyes of several AR developers the construction industry is a potential market for the technology. Their reasoning is straightforward: AR, like virtual reality, deals with spatial and symbolic phenomena in ways useful to architects, builders, and facility managers. These industries’ increasing familiarity with—and reliance upon—computers makes them well suited for mixed reality technologies.

However, as with virtual reality before it, the success of such forecasts hinges on a variety of issues. Some of these lie outside the domain of technologists: compatibility and reliability of equipment, flexibility, purchase costs, training, and upkeep. Not least important is the degree to which AR systems serve the needs and values of architects. For if we use the history of virtual reality to guide us, AR’s best prospects may not be in architecture at all. Many of the VR and imaging technologies developed for architects found more lucrative markets in computer games and Hollywood’s special effects industry. Still, despite these reservations, a review of AR’s recent development suggests many architectural applications. For, unlike VR before it, augmented reality keeps one foot in the material world, and so may serve both physical and symbolic activities of design.

6.1 Guiding construction
The overlay of spatial computer models onto buildings has uses in many stages of the building’s life. A project’s database can facilitate a building’s design, construction, and maintenance. German researcher Gudrun Klinker proposes that a project’s mixed reality would attend all stages of development, from the earliest siting of a building to its subsequent occupation. In a paper written on uses of augmented reality models on construction sites, Klinker and her colleagues speculate on AR’s use in the building’s life cycle.

With AR, . . . virtual geometric objects can be integrated into the real environment during all phases of the life cycle of the building. Before the construction project is started, AR can support marketing and design activities to help the customer visualize the new object in the environment. . . . During construction, AR can help evaluate whether the building is constructed according to its design . . . After construction is completed, maintenance and repair tasks benefit from seeing hidden structures in or behind walls (Klinker, Didier, Reiners 1998).

This bears directly on the life-cycle management of the project, although it stresses the digital model’s role in constructing and serving a building. The use of virtual models as annotation and guides for construction and manufacture is prevalent in AR literature. Indeed, among the earliest uses for AR was in overlaying instruction manuals onto the viewing field of factory workers at Boeing. Subsequent work by Stephen Feiner, Blair McIntyre and others illustrates the use of AR for the maintenance of copy machines and other equipment (Feiner, McIntyre Höllerer 1999; Reiners et al. 1999).

6.2 Seeing the invisible
Among other virtues of mixed reality is the ability of its users to perceive invisible aspects of their surroundings. Grant Foster and his colleagues at the University of Reading have described the uses of a simulation overlaid onto a building (Foster, Wenn,
They have developed DAMOCLES, a system that enables vision or hearing impaired users to navigate a building by aural and visual cues. While this may also be used for guiding maintenance robots through corridors, Foster also believes that such AR systems can also let users see the invisible. Equipment that generates heat, for instance, can be visually keyed to keep operators from harm. Such thinking lies behind similar proposals for visualizing the invisible. Professor Anthony Webster while at Columbia University also explored the use of AR in architecture—particularly in the field of construction. With aforementioned colleagues Feiner and McIntyre, he was able to reveal the hidden reinforcing rods in a concrete column using a head-mounted display (Feiner et al. 1995). The ability to see through obstacles, such as concrete, murky water, or human flesh is a constant theme in AR’s development.

7  Cybrids and Mixed Reality
Cybrids are augmented/mixed reality compositions—spaces, objects, or other entities—designed to be so from the start. For this reason, the simulation-to-construction methodology of architecture is well suited to cybrid strategies since the digital simulation and building are related throughout the process. However, in the case of cybrids such an overlap of physical and cyberspaces is not necessarily as congruent as it would be in a conventional architectural plan. There is rarely redundancy between physical artifacts and simulations in Mixed Reality. Most experiments in Mixed Reality place simulations into an existing, unrepresented physical space. Architectural cybrids avail themselves of this option while maintaining the direct, process-based correspondence between the built and unbuilt artifacts.

Despite occasional exceptions, much of AR and mixed reality is still a private experience. As in virtual reality the simulation is still enjoyed by the individual with the helmet, leaving others to wonder what he’s seeing. Since architecture provides spaces for social interaction, it seems reasonable that architectural cybrids would serve a similar purpose. In the case of head-mounted AR, however, a shared, consensual hallucination for a cybrid’s occupants would require head-mounted displays for each user. While this may be possible with fast, inexpensive future technologies, it is also prudent to consider larger, fixed displays of Display Space.  

8  Cybrid Synergy
The case for cybrids takes selectively from existing architectural hybrids, with full awareness of their biases and limitations. We have seen the limitations of each hybrid overcome by another. AR’s bias toward private experience is countered by Display Space’s public nature. The challenge of Display Space’s fragmentation is met by the subtle coordination of Environmental Computing. And, finally, AR and Mixed Reality’s cognitive model of the user offsets the materialist focus of both Display Space and Environmental Computing. Within these three types of
Beyond our provisional definition of cybrid we can now outline, even elaborate, its technical behavior. A cybrid is a composition of interdependent material construction and electronic simulation. The simulation—a product of a managed database—precedes, attends, and succeeds any material manifestation of the project. It precedes manifestation as does any specification for construction. It attends a project by assisting the monitoring and management of the physical plant. It is also succeeds the manifestations by persisting—in its database—after their demolition.\(^5\)

The simulation would also be the locus of any mode of information provided to the user: telecommunications; telepresence; simulation; or annotations/diagrams within the environment. Most importantly, all modes by which the user experiences the cybrid’s cyberspace are mutually reinforced. Visual displays, spatial environments, sound, screen and head-mounted displays corroborate one another to reinforce the coherent, non-physical space of the cybrid. This space situates the images/avatars/environments conveyed from remote sites, as well as those emulations local to the project. Conversely, this space provides a consistent experience to both local and remote users. It forms the phenomenological backdrop of the project and its occupants.

9 The Domain of the Observer

Seen in this way cybrid becomes a theater for social, symbolic interaction. As in theater, fictional entities merge with the physical reality: facades recede within the faux space of the stage; real actors play fantasy roles; material props stand for their magical counterparts. The history of theater is filled with examples of how materiality and fantasy converge on the stage. We will not elaborate here except to say that theater depends on the observer’s imagination for its effect. Trapdoors, greasepaint, scrims, mirrors, smoke are the theater’s material attributes. But narrative coherence, magic of transformation, and spatial extension beyond the limits of the stage are all in the domain of the observer.

The crucial difference between cybrids and conventional theater is the apparent lack of a proscenium. The classical proscenium is a window onto the world of the play. It is a paradoxical boundary that exists simultaneously in both the material world of the audience and the fiction of the stage. It separates—yet links—the dark material space of the seats and the bright fantasy of the play. Cybrids diverge from the spatial juxtaposition of the proscenium theater, and are more closely allied with the montage of cinema. Montage seamlessly overlaps disparate scenes—worldviews—into one image. The effect of this overlap depends upon to a great degree upon the viewer’s interpretation. Cybrids expand this cinematic notion to include the material ambience of the user as well as the simulated space and objects with which it exists.
Conclusions
We have here discussed ways in which cybrids depend for their technology upon three existing models of architectural hybrid: display space, environmental computing, and augmented/mixed reality. Cybrids bring these techniques together into a synergistic whole that depends as much on the observer for its consistency as it does on its comprising technologies. This synergy is a product of corroborative behavior between different modes, which provide cybrid users with a coherent social/spatial experience. We have noted cybrids’ similarity to theater, not only for their technological dependency, but also for the tacit yet vital role of the observer in their effect.
References

Notes
1 Architecture as a material presence may be reduced, but, Manovich argues elsewhere, the discipline it employs may be used in the design of navigable, spatially complex digital environments. Here he cites the work of Malevich, Le Corbusier, Wright and Bernard Tschumi. Manovich, Lev. 2001. The language of new media. Cambridge, Mass: MIT Press. p. 264.
2 Such tracking of course would imply that the display would work best for an individual viewer, thereby undercutting a cybrid’s social function.
3 In his book, Being Digital, Nicholas Negroponte writes of the projection of facial images onto phosphorescent screens shaped in the form of a head. Although originally intended for military briefing, this technology has since found its way into exhibits at Disneyworld, notably the Haunted House and Buzz Lightyear rides.
4 In public displays of VR technology viewers can often see what the participant sees by means of large screens attending the exhibit. However, only the wearer of the helmet enjoys immersive interaction with the scene. CAVEs allow viewers and participants to share the experience more convincingly.
5 We must here distinguish between the simulation, or better, emulation, and its supportive data base. The emulation is a presentation of the database formatted for the user. This may take the form of plans, images, sounds, behaviors, etc. As we use the term in this discussion, emulations are spatial representations of data contingent on the material components of the cybrid. Ideally the converse is also true: the material components are contingent on the emulations as well.