

# Future Space: A New Blueprint for Business Architecture

by Jeffrey Huang



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# FUTURE SPACE

## A New Blueprint for Business Architecture



PHOTOGRAPHY BY TONY RINALDO

*As the Internet changes the way people work and shop, companies will need to create spaces that seamlessly combine the physical and the virtual. That's going to require a whole new kind of architecture.*

**by Jeffrey Huang**

**I**N THE FIRST WAVE OF INTERNET HYPE, technologists painted pictures of a disembodied future in which people would shed their skins and live on-line, turning from citizens into “netizens.” But while the Internet is changing the way we perform some of our most basic everyday activities—shopping, learning, working, praying, courting, playing—it is not rendering the physical world obsolete or even less important. Indeed, the recent failures of many Web merchants testify to the fatal shortcomings of a purely virtual world. People enjoy and need social and sensual contact; they don’t want to be disembodied.

But even if the virtual world is not supplanting the physical one, the Internet is becoming an essential conduit for many

business activities. As the technology matures, the companies that succeed will be those best able to integrate the physical and the virtual, drawing on the unique strengths of each to create a whole that is greater than the sum of the two parts. I am not referring here to the popular notion of clicks and mortar, which is typically understood to mean simply the establishment of a Web channel that complements existing physical channels. It's not enough to have a few loose links between a Web site and a physical presence. The kind of convergence I'm talking about requires a new approach to designing the spaces in which business is conducted, from stores to offices to factories to classrooms. It requires a new kind of business architecture.

We are only starting to understand what such a convergent architecture will look like and how it will influence business and society. Although we have been designing buildings for thousands of years and Web spaces for about a decade, we have almost no experience merging the two. But a few formative principles are now coming into view. Over the past three years, my colleagues and I at the Harvard Graduate School of Design and the Center for Design Informatics have been conducting a research and teaching program called "Internet and Architecture." We have studied more than 150 examples of physical and virtual spaces for such activities as working, learning, playing, shopping, and entertaining, and we have derived a set of design guidelines for the creation of convergent architecture.

In this article I will draw on that body of work to explore four key challenges facing the designers of convergent structures: matching form to function, visualizing the presence of others, personalizing spaces, and choreographing connectivity. Each has important precedents in traditional architecture, but, as I'll show, designers will need to adapt

*Jeffrey Huang is an assistant professor of architecture at the Harvard Graduate School of Design in Cambridge, Massachusetts.*

those precedents to the unique characteristics of virtual space. My intent is not to give a broad lesson in architecture but to provide practical guidelines that can help managers and entrepreneurs think creatively about the structures in which their businesses operate. By designing high-quality, sustainable structures that meld the physical and the virtual, companies will be able to strengthen their relationships with customers and employees and foster loyal, enjoyable, and humane communities.

### Matching Form to Function

Many organizations have launched Internet initiatives alongside their traditional operations. Barnes & Noble created the on-line Barnesandnoble.com to complement its 485 physical stores. Harvard University's continuing education division, Harvard Extension School, offers on-line courses to students who cannot come to the campus. Staples lets customers place orders for office products through its Web site. Yet when you

look closely at such clicks-and-mortar efforts, you soon find that, even though the on-line and off-line units may share a brand and sell similar products and services, the underlying physical and virtual architectures have been conceived and constructed independently. There is little or no interaction or coordination between the activities performed virtually and those performed physically. As a result, managers sacrifice opportunities to reduce transaction costs, provide richer experiences for customers and employees, and build better relationships and deeper levels of trust across both worlds.

What this comes down to is a failure to fulfill one of the central tenets of architecture: aligning the structure, or form, of a space with its use, or function. The importance of function in architecture was first enunciated by the Roman architect Marcus Vitruvius Pollio in the first century BC. In his *Ten Books on Architecture*, perhaps the most influential work on architecture ever written,

#### Exhibit 1

*In his 1773 design for an abbot's residence, J.F. Blondel sought to link form and function, giving the outer rooms sizes and shapes that reflected their function of filtering access to the more private rooms.*

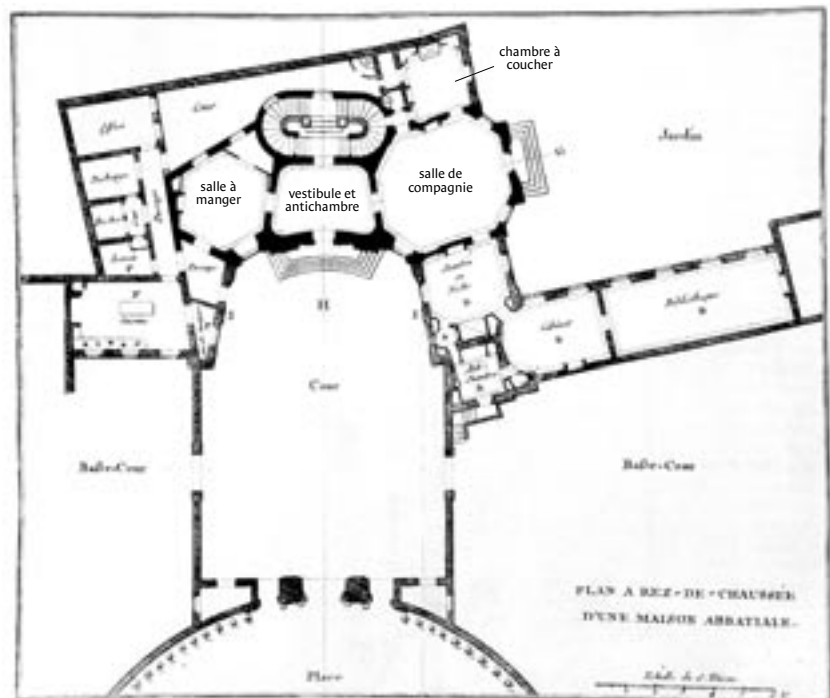


ILLUSTRATION: RIBA LIBRARY PHOTOGRAPHS COLLECTION

Vitruv argued that architecture must balance three basic requirements: function (*utilitas*), solidity (*firmitas*), and aesthetics (*venustas*). The stress on *utilitas* has been a consistent and sometimes controversial theme in architecture ever since.

In the eighteenth century, the French architect J.F. Blondel put his own gloss on Vitruv’s ideas. He stressed that architecture must strive for an appropriate relationship between form and function, which he called *convenance*. His thinking is reflected in the plan he drew in 1773 for an abbot’s residence, which is shown in Exhibit 1. Blondel carefully assessed the functions the building needed to accommodate, specified the sizes and shapes of the rooms for those functions, and laid out the rooms in a way that reflected the relationships among the functions. For example, the three main public spaces—the vestibule (*vestibule et antichambre*), dining room (*salle à manger*), and salon (*salle de compagnie*)—were given distinctive shapes

reflecting their function of filtering access to the more private rooms, such as the bedroom (*chambre à coucher*).

A similar approach can and should be taken to the design of integrated physical and virtual spaces. Rather than thinking of customers’ or employees’

*Companies need to view their physical and virtual spaces as creating a single structure.*

physical and on-line functions as separate, companies need to think of them holistically. In other words, they need to view their physical and virtual spaces as creating a single structure, much like the abbot’s residence with its many carefully connected rooms.

In creating plans for convergent architecture, I have found it useful to begin by “de-composing,” or breaking down, particular functions into their

component activities. Once the individual activities are understood in detail, they can be allocated rationally among physical and virtual spaces to create the optimal overall form. Let’s use, as an example, a fashion retailer that wants to sell clothing to customers through both a Web site and a chain of stores. It first de-composes the function of selling into seven separate activities: attracting customers, identifying needs, informing, obtaining orders, receiving payment, delivering, and managing customer relationships.<sup>1</sup> The retailer can then systematically explore the opportunities to carry out those activities, or elements of them, in on-line and off-line settings. Exhibit 2 provides a summary of the results of this kind of analysis.

The best location for performing a given activity can then be determined by looking at such factors as transaction costs, richness of emotional experience, and potential for data gathering

**Exhibit 2**

*As a first step toward creating plans for a convergent architecture, break down functions into their component activities. The business in this example is a hypothetical fashion retailer.*

Components of the selling function	Physical aspects of the function	Virtual aspects of the function
Attract customers	<ul style="list-style-type: none"> <li>• Open physical storefront at strategic location</li> <li>• Provide ads</li> <li>• List company in yellow pages</li> <li>• Run special promotions</li> </ul>	<ul style="list-style-type: none"> <li>• List Web site on portal site and in search engines</li> <li>• Enroll in affiliation programs</li> <li>• Provide ads</li> <li>• Run special promotions</li> </ul>
Identify needs	<ul style="list-style-type: none"> <li>• Ask customer</li> <li>• Scan customer’s body</li> <li>• Create social experiences</li> </ul>	<ul style="list-style-type: none"> <li>• Provide browsing tools</li> <li>• Create customer profile database</li> <li>• Do collaborative filtering</li> </ul>
Inform	<ul style="list-style-type: none"> <li>• Offer advice via salesperson</li> <li>• Provide fitting room</li> </ul>	<ul style="list-style-type: none"> <li>• Supply multimedia information</li> <li>• Post third-party opinions</li> <li>• Offer comparison agents</li> <li>• Create chat rooms</li> </ul>
Obtain order	<ul style="list-style-type: none"> <li>• Provide checkout opportunity for instant gratification</li> </ul>	<ul style="list-style-type: none"> <li>• Provide one-click checkout</li> </ul>
Receive payment		<ul style="list-style-type: none"> <li>• Allow for credit card purchase</li> </ul>
Deliver		<ul style="list-style-type: none"> <li>• Mail items</li> </ul>
Manage customer relationship	<ul style="list-style-type: none"> <li>• Make refunds if necessary</li> <li>• Enable exchanges</li> <li>• Provide warranty services</li> </ul>	<ul style="list-style-type: none"> <li>• Allow customers to send items back</li> </ul>

and learning. While certain activities can only be performed either physically or virtually—a customer can't get the feel of a fabric over the Internet, for example—many activities can be distributed between the two realms. To think through all the options for locating and connecting activities, designers can use another common architectural tool: the bubble diagram. Bubble diagrams are used in the planning stages of an architectural project to provide a graphical view of the often complex relationships among activities. They help define priorities and hierarchies among activities and determine desirable proximities and connections. Exhibit 3 shows a bubble diagram for our fashion retailer. Such diagrams also help guide decisions about outsourcing. If an activity is only weakly linked to other activities, the company might be better off letting a third party offer it or perform it.

Deep and holistic consideration of activities and their relationships can spur creative thinking. Peggy Hsu, a

graduate student at the Harvard Design School, recently used activity analyses in designing an innovative physical apparel store that tightly integrates virtual elements. At the center of the hypothetical store are body-scanning units that can create detailed digital models of customers' physiques. Once a customer has had her body scanned, she can easily and quickly "try on" clothes in the store. Take a look at the computer-generated image of the sweater display in Exhibit 4. Each of the hangers is connected to the Internet. By touching and twisting the hanger with the blue sweater at the center of the image, the shopper makes a virtual dressing room appear on the vertical screen to the left, showing the fit of the sweater on her body. Simultaneously, a translucent screen above the sweaters suggests optimal sizes, variations, and mix-and-match possibilities. Once her body scan is stored, the customer can perform these shopping activities at home over the Web.

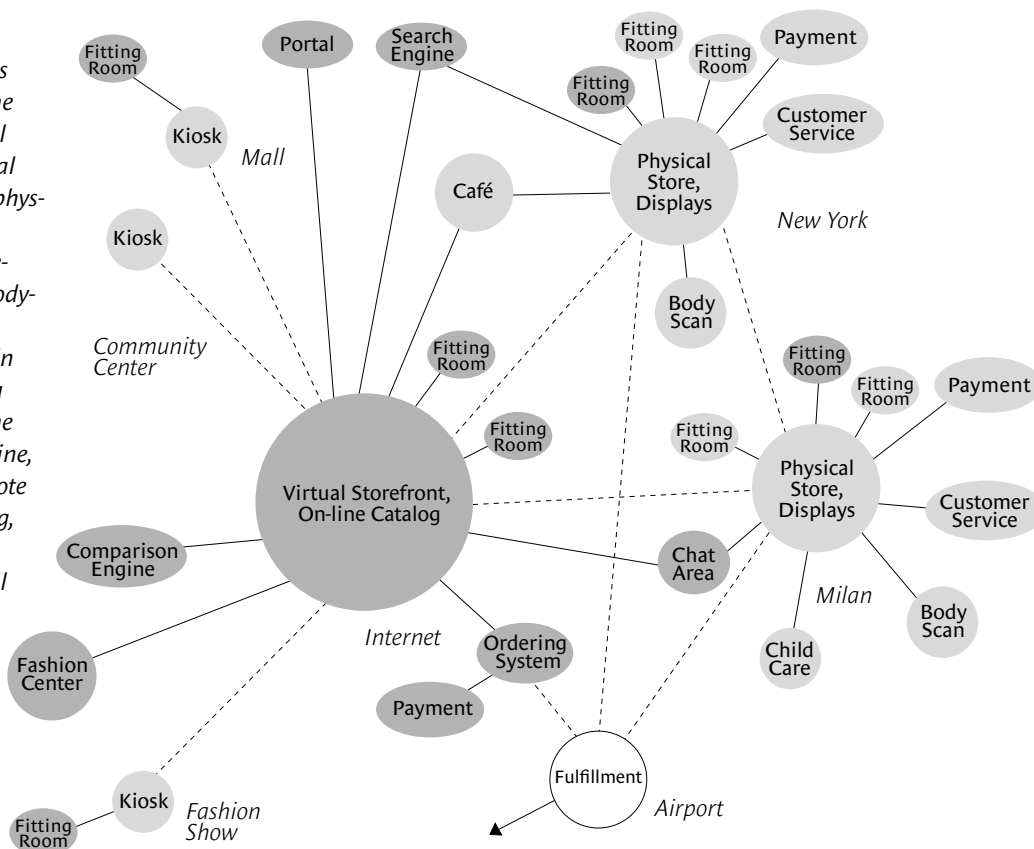
## Visualizing the Presence of Others

Plotting the connections among activities performed physically and those performed virtually is only the first step in creating convergent architecture. The next challenge is connecting the people in the two spaces, making the boundary between the physical and the virtual as transparent as possible. In any social structure, making people aware of the presence of other people is crucial to getting them to feel comfortable.

One of the great flaws of almost all Web sites is that they give no sense of a human presence. When individuals enter the sites, they are alone. They become much more conscious of the passage of time, much less likely to linger, and, because they feel no one is watching them, much more prone to discontinue an activity before completing it than if they felt the presence of others. This phenomenon is clearly apparent in on-line stores, where a very high per-

### Exhibit 3

This bubble diagram shows the relationships among the spaces in which an apparel retailer conducts its physical and virtual activities. The physical spaces, depicted in the lighter shade, include store-fronts, displays, cashiers, body-scanning units, and fitting rooms. The virtual spaces, in the darker shade, include a virtual storefront, an on-line catalog, a comparison engine, and an ordering system. Note that some activities—fitting, display, payment—are carried out in both physical and virtual spaces.



centage of customers abandon their shopping carts before checking out. In some cases, the customers simply become frustrated with technical problems. But a more fundamental problem is the lack of social interaction.

Contrast on-line shopping with physical shopping. Physical shopping is a sensual and, above all, social experience. Teenagers, for instance, can spend an entire afternoon in a boutique—socializing with their friends, meeting new people—without any specific purchase in mind. They just hang out. Smart merchandisers design physical stores to capitalize on the social aspects of shopping. On-line stores, in contrast, are designed to maximize efficiency—to enable shoppers to find items as quickly as possible and check out with a minimum of clicks. The same is true of e-learning classrooms, virtual offices, on-line museums, and almost every other kind of Internet

site. It's no wonder that people spend so little time exploring most of these virtual spaces—there's no social glue to hold them.

Web designers can learn a lot from the architects of city spaces, who have always known the importance of providing places for people to gather. Look at the city plaza in the photograph in

*Web designers can learn a lot from the architects of city spaces, who have always known the importance of providing places for people to gather.*

Exhibit 5, which is taken from the book *A Pattern Language* by the influential architectural writer Christopher Alexander and others. At first glance, this scene might appear to be just a busy thoroughfare with people passing quickly through—like our present-day concep-

tion of the Internet. But on closer inspection, we can see a multitude of social interactions—chance meetings, brief chats, leisurely conversations. Popular urban places are alive because of the presence of people. Crowds attract crowds. As Alexander writes, “Throughout history there have been places in the city where people who shared a set of values could go to get in touch with each other. These places have always been like street theaters: they invite people to watch others, to stroll and browse, and to loiter.”

Similar places where people can go to see and be seen, both physically and virtually, should be established as the hubs of convergent architecture. Web site visitors should have a sense of, or even access to, other site visitors as well as people in related physical sites; likewise, it can often be valuable to give people in a company's physical buildings a sense

**Exhibit 4**

*In this hypothetical store, a customer can virtually “try on” clothes in the dressing room at the left.*



PHOTOGRAPHY: BERNARD RUDOLFSKY ILLUSTRATION: PEGGY HSU

**Exhibit 5**

*Just a busy thoroughfare? Take a closer look and you'll see a multitude of social interactions. Similar social places should be established as the hubs of convergent architecture.*



of the current activity on its sites. And digital video and conferencing technologies can enable people in separate physical sites, such as different offices, to see and work with each other in real time, bridging geographic divides. (See the sidebar “Swisshouse: A Prototype for Convergent Architecture.”)

Art Technology Group, an innovative software design firm in Cambridge, Massachusetts, took this thinking to heart when it recently designed an intranet for BDDP, a global advertising firm with 81 offices in 42 countries. The intranet—a screen of which is shown in Exhibit 6—is called the disruption network, echoing BDDP’s philosophy of studying market conventions and then creating ads that disrupt them. According to the intranet’s lead designer, Chris Edwards, the disruption network is “a living application, a virtual information space that is wholly the product of the people who inhabit it.” It is a place where people in both physical and virtual locations see and interact with their coworkers.

The application uses a custom-developed publishing system to let users pub-

lish their ideas, hold brainstorming sessions, and locate multimedia material from past or present ad campaigns—and the activity is visible to all users. A key feature is the presence meter, depicted in the top right corner of the sample screen. It indicates, with thumbnail photographs, which employees are logged on and their current levels of on-line activity (as measured by the number of recent mouse clicks). The presence meter operates like an instant-messenger buddy list that has a direct link to the physical activities occurring in the office. So when someone is at work, she is constantly aware of who else is on-line and who is active.

Unfortunately, the disruption network was used only briefly; soon after its development, BDDP was acquired by Omnicom, an advertising conglomerate that later merged with TBWA. However, a similar application is currently being used by the Art Technology Group itself. The new application helps the firm create transparency between its physical and virtual workspaces, offering employees a shared public place for the exchange of ideas.

## Personalizing Spaces

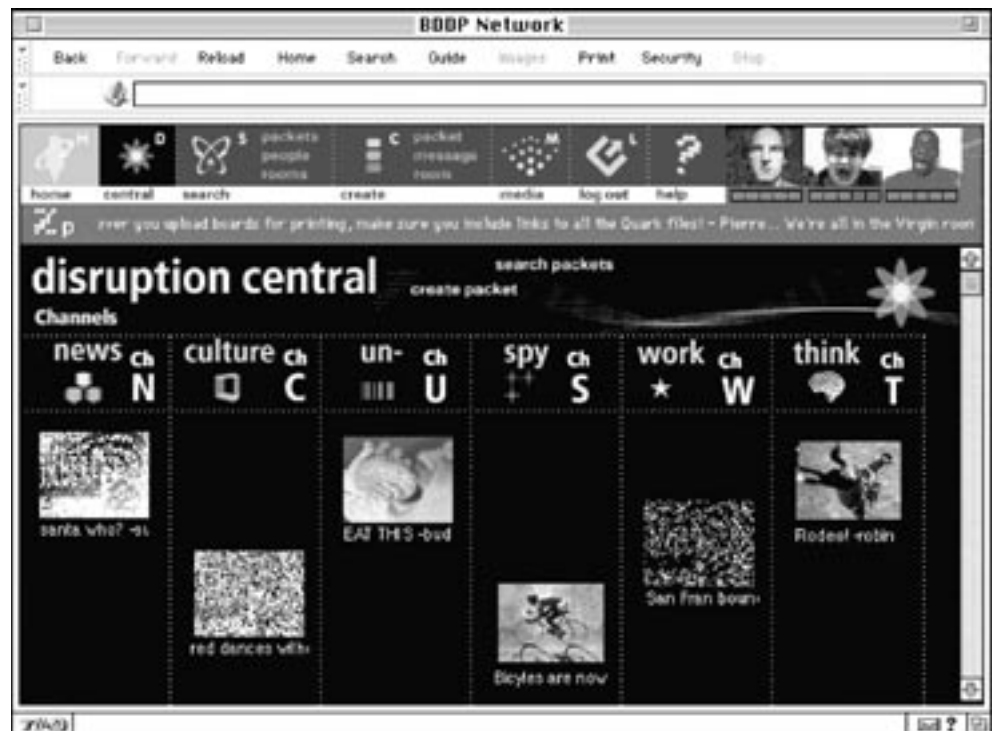
Web sites, as we all know, can be automatically personalized for individual users. As of yet, however, this kind of dynamic adaptability, made possible by the collection and rapid processing of data on users and their habits, has not been replicated in physical architecture. But it will be, and soon. Indeed, one of the hallmarks of convergent architecture will be its use of Internet technology to personalize physical spaces.

Architects have always struggled with striking the right balance between flexibility and rigidity. On first blush, it might seem to make sense for buildings to be adaptable to as wide a range of users and uses as possible. But such flexibility has traditionally had a high price. The more activities a building can accommodate, the less well suited it is to any one activity. And achieving flexibility can entail aesthetic and structural compromises; a building tends to lose its integrity and coherency as it becomes more and more adaptable.

The innovative twentieth-century French architect Jean Prouvé attempted

### Exhibit 6

*This network is “a living application” that lets people in physical and virtual locations see and interact with coworkers.*





to bridge the trade-offs by introducing movable elements into his architecture. In his *Maison du Peuple*, built near Paris in 1939 in collaboration with the firm Beaudouin, Lods, and Bodiansky, Prouvé used mechanical devices that enabled the public building's floors, walls, and ceilings to be quickly reshaped for different uses. The structure could, for example, be an open market hall in the morning, a cinema in the afternoon, and a theater in the evening.

Frank Duffy of the British design firm DEGW has gone even further in distinguishing fixed and flexible elements. He sees buildings as having four very different layers of flexibility—structure, services, scenery, and set—reflecting the longevity of the materials used. Structure encompasses the foundation, the exterior walls, and other fixed elements—the parts of a building that last longest, usually 35 to 50 years. Services include the HVAC system, the elevators, and cabling; they have to be replaced every 15 years or so. Scenery includes the layout of the interior partitions and the acoustic ceiling, which typically change every five to seven years. Set includes furniture and personal belongings, which tend to be moved often—daily, weekly, or monthly. Separating a building's elements into distinct layers makes it easier to think through ways to achieve flexibility without sacrificing integrity.

Drawing distinctions between space and structure is crucial in designing convergent architecture as well. But the structural foundation of convergent architecture—the element that provides integrity across both physical and virtual spaces—does not consist of bricks or concrete or columns; it consists of data. By using a central, shared database to instantly tailor architecture to the needs and preferences of individual users, it becomes possible to achieve an unprecedented degree of flexibility without losing coherence. Indeed, the database itself heightens the integrity of the overall architecture by ensuring users a seamless transition between the physical and virtual worlds. The Internet, in other words, helps architects

## SWISSHOUSE: A PROTOTYPE FOR CONVERGENT ARCHITECTURE



*A glass wall showing rear-projected digital images, right, defines the entrance area of the Swisshouse, a building conceived as a large-scale interface between the physical and virtual worlds.*

ON OCTOBER 10, 2000, the Swiss Confederation opened the doors of the Swisshouse, a radically new kind of consulate located both in Boston and on the Internet. I designed the Swisshouse in collaboration with architect Muriel Waldvogel. The project began as a donation by Lombard Odier & Cie, a Swiss private bank, to the Swiss Confederation to mark the bank's 200th anniversary. It serves as a prototype for convergent architecture, and its design reflects the key points made in this article.

We began the project by decomposing the function of the Swisshouse into its component activities and deciding which activities should be performed virtually and which physically. We wanted to use converging physical and virtual technologies to provide a platform that would let Swiss people connect to events and activities in Boston in the areas of research and education.

We also wanted to give Web users awareness of people in the physical consulate and vice versa. We developed links between the virtual and physical aspects of the consulate using Webcams, presence indicators, and various

other interfaces. For example, visitors are registered as they physically enter the Swisshouse or log on to its Web site. A nine-foot-by-12-foot "guest-book" wall made of glass defines the entrance area; it displays names and icons representing both types of visitors and is accessible as a Web page.

Our efforts to establish a balance between flexibility and rigidity led to the development of the building information system. We structured the spaces around a single database and a wireless audiovisual control system, both of which help personalize spaces to the activities and needs of the various groups using the consulate. Finally, we choreographed connectivity in the physical space by integrating several different types of interfaces into the architecture, including room-size digital wall projections, audio systems, and large plasma displays.

Through convergent architecture, the Swiss government is fulfilling an important goal: finding a way to efficiently share knowledge between Swiss nationals working and studying in the United States and their compatriots back home.

bridge the gulf between adaptability and integrity.

The Wellness System developed by Technogym, an Italian maker of exercise equipment, provides an early example of a physical-virtual environment that is built around a central customer database. With the Wellness System, a fitness club can provide its members with both a physical gym and a complementary Web site that adapts to their preferences and physical conditions.

Here's how it works. A member enters personal information into the system and receives a password and a hardware key. When he goes to use one of the machines, he simply inserts his key; the proper weights are selected, the seat moves to the right position, and an appropriate piece of music plays. As he begins to exercise, a screen lights up, indicating the recommended routine and pace based on his physical profile and exercise program. Details of every workout are stored in the database, ensuring that all machines always adapt to the member's progress. Members can also track their progress at home by tapping into the database through the company's Web site. And the club's trainers can use the system, within the gym or remotely, to monitor members' progress and alter routines as necessary.

The Wellness System shows, in a simple way, how a common database can enable both physical and virtual spaces to adapt quickly to the needs of individual users. It is not difficult to imagine similar applications for personalizing offices, factories, hospital rooms, stores, classrooms, and so on.

### Choreographing Connectivity

One of the most complex challenges in creating convergent architecture is the design of the interfaces between the physical and virtual worlds. We are rapidly moving beyond the age of the personal computer, in which access to the Internet was limited largely to a keyboard, a mouse, and a monitor placed on a desktop. With a multitude of new interface devices, both mobile and fixed, now emerging, companies gain many addi-

tional opportunities to connect with customers and employees. Even walls, ceilings, and floors can become portals to the Internet. But with the opportunities come new complexities. As

not. What has distinguished many of the great architects of the past is their ability to read the context of a site and envision buildings perfectly suited to it. Look, for example, at the photograph in

*With a multitude of new interface devices, both mobile and fixed, now emerging, companies gain many additional opportunities to connect with customers and employees. Even walls, ceilings, and floors can become portals to the Internet.*

physical spaces turn into dense fields of connectivity, companies will have to carefully choreograph the use of many different interfaces to ensure users a coherent experience.

While the technology is new, the overall goal – tailoring content to context – is

Exhibit 7 of the Villa Malaparte, a home designed by the Italian architect Adalberto Libera in the late 1930s and built on a cliff on the Italian island of Capri. The building blends perfectly into the landscape, becoming an extension of the rock it sits upon. The roof of one sec-

#### Exhibit 7

*The Villa Malaparte in Capri is an example of the symbiosis that can be achieved between architecture and site.*



PHOTOGRAPHY: PRINCETON ARCHITECTURAL PRESS

tion is a stairway leading to a deck that offers a magnificent view of the land and water. The interior is also tailored to the context. Windows are cut into the walls in ways that offer carefully planned glimpses of the scenery. The fireplace is made of glass; through the flames, visitors can see the sea.

The Villa Malaparte is a marvelous example of the symbiosis that can be achieved between architecture and site: a well-designed structure underscores, amplifies, and draws strength from the unique qualities of a place. Good convergent architecture will achieve a similar symbiosis between the content of the information provided through the Internet and the physical context in which that content is accessed.

There are three challenges here: selecting the right places for interfaces, choosing the right input and output devices, and ensuring that the right content is delivered at the right time and in

the right form. Information needs to be carefully structured to fit different locations as well as the different resolutions of output devices. You don't want, for example, to broadcast a football game to the tiny screen of a Palm handheld; it would be an indecipherable blur. Similarly, you don't want to stream simple, dense text to a plasma monitor in a large conference room. The richness of the information needs to match the context of its display.

Hendra Bong, another graduate student at the design school, recently designed an innovative e-learning environment that suggests the multitude of possibilities for bringing virtual content into physical spaces. In Bong's plan, shown in Exhibit 8, English-speaking travelers waiting in the Los Angeles airport would be able to interact with Spanish-speaking travelers in the airport in Barcelona, Spain, each person helping a traveler in the other country

to learn a new language. At the core of the plan is an ingenious use of airport seats as Internet interfaces. Certain seats, outfitted with monitors and headphones, would be dedicated to the e-learning effort and would serve as subtle matchmaking mechanisms. Whenever a passenger sat down in one of the chairs in Los Angeles, for example, a connected chair in Barcelona would rise slightly. Alerted to the availability of an English speaker, travelers in the Barcelona airport could choose whether to sit in the chair and make the intercontinental connection. Using customized software, participants would be able to conduct either structured lessons or unstructured conversations.

### Designing the Future

The success of companies attempting to merge on-line and traditional operations will depend on a variety of factors. But without the foundation of a well-designed convergent architecture, no company will be able to fully reap the synergies of physical space and Internet technology.

I have offered some precedents that can be valuable in designing convergent architecture. The past, however, is just a jumping-off point. It will be up to the next generation of creative architects, managers, and entrepreneurs to develop the new business models and the new combinations of activities that will bring new types of structures into being. The convergent structures will in time become part of our everyday lives, adding another chapter to the rich history of architecture. The best examples of convergent architecture built in the next few years will, no doubt, bear witness in future centuries to the social, economic, and technological changes that defined life at the start of the twenty-first century.

1. Our de-composition of shopping closely follows a process hierarchy developed by Thomas Malone, a professor at the Massachusetts Institute of Technology's Sloan School of Management. Further information on Malone's work can be found at <http://ccs.mit.edu/ph/>.

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### Exhibit 8

*An innovative design for e-learning would allow visitors in airports in Los Angeles and Barcelona, Spain, to interact with one another.*

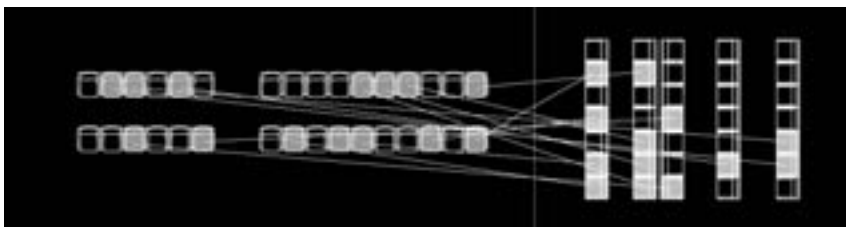


ILLUSTRATION: HENDRA BONG