MARTIN A. SIEGEL
Associate Professor
Graduate School of Library and Information Science
Assistant Director
Computer-based Education Research Laboratory
Department of Educational Psychology
University of Illinois at Urbana-Champaign

Architectural and Instructional Worlds: Insights for Interface Design

This paper will examine the design of computer/human interfaces from the perspective of two older design professions: architecture and instructional design. Insights can be drawn from these design worlds, lessons learned from their successes and failures. By sharing selected architectural images and instructional strategies, the author will attempt to draw a parallel to interface design.

ARCHITECTURAL WORLDS

The word architecture is derived from the Latin and Greek for "master builder." The ancient Roman Vitruvius, whose Ten Books on Architecture is the only surviving ancient architectural treatise, gave the term its clearest meaning: Architecture is the union of "firmness, commodity, and delight." It is, in other words, a structural, practical, and visual art. "Without solidity, it is dangerous; without usefulness, it is merely large-scale sculpture; and without beauty..., it is not more than utilitarian construction" (Trachtenberg & Hyman, 1986, p. 41). Rob Krier (1988) explained the goals like this: "Architecture has to provide us with physical shelter from our environment, create a framework for our activities and, above all, express symbolic and ethical values" (p. 11).
Function, Construction, and Form

At the heart of all architectural debate is the appropriate balance of function, construction, and form. Of these, function is the starting point for all architectural design. How do people interact with the built environment? What are their needs? Construction is closely related to function. What are structural solutions for a given spatial organization? What materials can be used given the building’s climate, landscape, and the availability of natural materials? While these basic questions of function and construction must be addressed by the design, inhabiting the built environment ideally gives enjoyment and aesthetic pleasure as well.

To the ancient Greeks, form was aesthetics. At the Temple of Concord, built in 430 B.C., the Greeks combined mathematics, the “golden rectangle,” with construction to create idealized beauty. These were not user-centered structures. The steps, for example, are in proportion with the ideal proportion of the whole, but were out of shape for human scale. These structures were not built for people; they were built for gods.

Unlike the ancient Greeks, more modern architects did not over-emphasize form at the expense of function. Nevertheless, these buildings were designed to convey to their users certain attitudes and feelings. King’s Chapel in Cambridge, England, and Saint Chapelle in Paris both convey feelings of inspiration and faith. The Bibliothèque Nationale and the Library of Congress Reading Room make patrons feel humbled as they are surrounded by vast quantities of knowledge and information. These buildings do not simply function as structures for the shelter and housing of books; they convey to the patrons how they should think about their environment.

Other structures appear friendly and approachable: a Williamsburg house; a bungalow in Chicago; the Cloud Street Bank in McLeansboro, Illinois; “row houses” in San Francisco; the Cottage Tire Store in Nashville, Tennessee; or Principia College Church in southern Illinois. But what makes these structures friendly and approachable is likely to be a function of our age, our sex, our cultural background, and our notions of what is familiar. The Church of the Sagrada Familia in Barcelona, Spain, is a bit strange and certainly unfamiliar to one unused to viewing a church that looks like a dripping sand castle with tumors!

Other structures conjure up positive images of the past; they are reminders of the classics and the nobility. The New York Public Library is like a Roman temple; the Stinson Public Library in Anna, Illinois, is like an Egyptian or Babylonian tomb; the Old Capitol in Baton Rouge, Louisiana is like a castle; a Hudson, New York house is like a small
middle ages castle; and the Trans America building in San Francisco is like an ancient pyramid. Even the conference building at the University of Illinois, the Illini Union, was a 1939 copy of the Wren building on the William and Mary College campus, originally built in 1695.

Some structures, such as the Biltmore House of the Vanderbilts in North Carolina, were designed to express the prestige and wealth of the owner. Other buildings appear to poke fun at the structures after which they are modeled: the Tower of Pizza in New Jersey; the Wigwam Village in Kentucky; the Pagoda Gas Station in Wisconsin; and the Dinosaur Museum in California.

Some structures appear to evoke an overindulgence in form, as does the interior of St. Peter’s Basilica. To modern eyes, this structure may seem excessively and unesthetically decorated. But in the sixteenth century, perhaps these overly baroque structures were viewed as an appropriate glorification of God. On the other hand, Mies van der Rohe’s glass houses on Lake Shore Drive in Chicago emphasize function over form. These buildings define space, and these structures define their function. Both the Vatican dome in Rome and the glass houses of Chicago upset the delicate balance of function and form.

The French architect Le Corbusier, invoked the “architecture as machine” metaphor. Even his Citrohan House looked like a car. The Bauhaus movement, started by Walter Gropius, promoted the machine-like metaphor not only in buildings (for example, Gropius’s apartment building looks like a factory), but in art, drama, and in everyday ways of life. Men and women lived in machine-dominated worlds, and the Bauhaus school promoted the thought that their homes and workplaces should remind them of this.

Le Corbusier expanded this idea as a cultural statement. On paper he designed the “city for three million,” a labyrinth of walkways, tunnels, and highrises. His concrete park even accommodated a landing strip for the ultimate machine, the airplane.

However, a smaller version, designed by a different architect, became a low-income housing complex in St. Louis in the early fifties. It was called Pruitt-Igoe, and it was characterized by large apartment complexes surrounded by open spaces. This new urban development did away with traditional streets, gardens, and semi-private spaces. It won an award from the American Institute of Architects. But in 1972, it was blown up by the city authorities. The problem was that the design was totally inappropriate for the needs of the Southern migrants who had no experience living in such densely-packed living compartments. Le Corbusier’s “streets in the air” became the site of vandalism, drug abuse, and crime. Pruitt-Igoe did not meet the needs of its users.

Must there be a tradeoff between form and function? Certain
designs appear to be in balance: Frank Lloyd Wright’s Fallingwater in Bear Run, Pennsylvania, magically blends into the surrounding environment. Monticello, Thomas Jefferson’s home, and the University of Virginia meld form and environment. The Santa Cruz dormitories on the University of California campus allow students to recreate their own individualized spaces; and the Hyatt Regency Hotel in San Francisco creates an outdoor environment indoors.

Instead of looking at a building’s form or function, perhaps one should look at its façade. This is what most people experience first: an introduction to a building. Some façades, such as that of the Citicorp Building in New York, give no indication of what is inside. However, the Notre Dame Cathedral façade clearly expresses what happens inside.

Or one can think of façade as entryway. Beyond the entrance to St. Peter’s in Rome, and the doors of the Notre Dame Cathedral, it would be surprising to discover an aerobics and exercise center! In a Japanese garden in Kyoto, user perspective is important; the design draws and leads the viewer.

What can be concluded from this brief tour of architectural images? When a building is out-of-balance, the user is dissatisfied. A building may be aesthetically pleasing, yet awkward to use. Or it may be of solid construction and utilitarian, but also dull and uninspiring for its residents. For a building to be successful, there must be a delicate balance among function, construction, and form.

Similar statements can be said for the design of computer/human interfaces. The interface must allow the user to complete the desired tasks effortlessly and transparently (function). The interface must be efficient in execution (construction). And, finally, the interface must be pleasing to the user (form). It is difficult to measure the negative effects of misuse of color, typography, and graphics; but all play a part in the level of user satisfaction with the interface.

**Examples of Interface Design**

This paper will examine the entryways to two different computer systems. The first is the logon procedure for the UNIX system at the University of Illinois (see Figure 1). The date and time are written in an unfamiliar format (year/month/day and twenty-four-hour clock). The user types “name” as “231004321” and must indicate who will pay the computer time bill.

The second entryway is the logon procedure for the NovaNET system at the University of Illinois (see Figure 2). The date and time are displayed in familiar formats, and the system greets the user with a “welcome” message. The user types his or her “NovaNET name” as
given by the instructor: tom o'brien. On the screen, the user is prompted to press the HELP key (an actual key on the NovaNET keyboard) if assistance is required.

To be fair, the first screen was designed for computer scientists and students of computer science; the second screen was designed for students and instructors enrolled in a computer-based curriculum. Nevertheless, the NovaNET entryway is accessible to all users. The interface's image communicates an important message to its users: This system is for you; it will be easy to use. The UNIX interface image communicates a different message: You'd better know what you're doing if you're going to use this high-powered system.

Architects sometimes use metaphor to communicate meaning. For example, Le Corbusier's Citrohan House glorifies that favorite machine, the automobile. "The house was to be a mass producible 'machine for living' to alleviate the severe postwar housing shortage. . . . The model
projected an aura of salutary efficiency and vitality. What is more, it was named the Citrohan House not only by analogy, for if one steps back and looks at the 1922 model, it has the generalized shape of a 1920 Citroen sedan” (Trachtenberg Hyman, 1986, p. 529).

Computer/human interface designers use metaphor as well. For example, the Macintosh interface makes extensive use of the desktop metaphor: Familiar objects such as the trash can, clock, Rolodex, and bookshelf are used as icons and “interface façades”; files are opened and appear as sheets of paper overlaying other sheets of paper (see Figures 3-5). Is there any doubt that when one drags a file to the trash can one is destroying the file? The interface takes advantage of a person’s common knowledge to increase ease of use.

Compare these interfaces with the Disk Operating System (DOS) used on IBM machines (see Figure 6). Command statements such as “A>diskcopy a: b:” remind the user that the machine must be engaged on the machine’s terms. Le Corbusier would have made a good C.S. major!

Other computer/interface designs successfully balance the architectural equivalent of function, construction, and form. Two popular examples are Microsoft Word (Microsoft Corporation, 1989) and SuperPaint (Snider et al., 1986) (see Figures 7 and 8). Word makes use of the

![Image of Macintosh interface](Figure 3)
Dr. Martin A. Siegel  
Graduate School of Library and Information Science  
410 David Kinley Hall  
University of Illinois  
Urbana, IL 61801  

217-333-3247

Figure 4

| Year | Month  | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 |
|------|--------|---|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|    |
| 1988 | January | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10| 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 |    |
|      | February| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10| 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 |    |    |    |    |
|      | March   | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10| 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 |    |

Figure 5
Current date is Tue 1-01-1980
Enter new date (mm-dd-yy):
Current time is 0:00:07.79
Enter new time:

The IBM Personal Computer DOS Version 3.10 (c) Copyright IBM 1985
(c) Copyright Microsoft Corp 1985

A>format b:
Insert new diskette for drive B:
and strike ENTER when ready

Formatting...Format complete

362496 bytes total disk space
362496 bytes available on disk
Format another (Y/N)?n
A>diskcopy a: b:

Figure 6

Typing in Microsoft Word is like using a typewriter. The screen image metaphor is like typing on a piece of paper!

Figure 7

typewriter metaphor to enter text as it would be printed on paper. It was the first widely distributed word processor to give a true "what you see is what you get" feeling. SuperPaint allows use of paint brushes or spray cans to "paint on walls." Pictures and graphics are produced in powerful ways, creating a new art form.
INSTRUCTIONAL WORLDS

Instructional design is at the intersection of three separate analyses: the analysis of behavior, the analysis of communications, and the analysis of knowledge. The analysis of behavior seeks empirically based principles that provide the basis for teaching any task: how to motivate and get attention, how to present examples, how to secure student responses, how to reinforce appropriate answers and to correct mistakes. This part of the analysis can be summarized as the mastery-learning model.

The analysis of communications seeks principles for the logical design of teaching sequences that effectively transmit knowledge, prevent the learning of misrules, prevent overgeneralization to inappropriate examples, and deter undergeneralization. This analysis focuses on the ways in which sets of stimuli are the same and how they are different (that is, on what discriminations must be taught).

The analysis of knowledge systems is concerned with identifying commonalities across different concepts or procedures. This provides a basis for teaching broad general cases, "big ideas" or insights, that provide a framework for understanding. Moreover, similar knowledge structures share similar communication strategies; that is, if two sets of concepts are similarly structured, then they can be taught in similar ways. It is these last two analyses, communications and knowledge, that most influence the design of computer/human interfaces.
The new user of a computer program is faced with the task of learning a set of concepts and procedures associated with that system. Learning is accomplished primarily by what is communicated to the user by the interface. In designing an interface to best facilitate that learning, designers must understand how generalizations are learned. Every interaction with the user is a potential opportunity to learn a generalization. Sometimes, however, an incorrect generalization or misrule is learned.

Teaching Generalizations Through Interface

What is the single greatest advantage for learning a generalization? Efficiency. Indeed, without generalizations we would not know how to function. Fortunately, humans are "wired" for generalization learning. When a baby hears the word daddy and sees a particular man, the baby begins to make a connection between the label and the person. Sometimes the man is wearing a suit, sometimes he is wearing pajamas, but that man is always daddy. Over time, the generalization is formed.

Babies have a "natural" way of learning. Direct instruction is minimal. No one has to teach babies that when they turn over a pail of water, the water pours out. In this case, gravity is a good teacher. Moreover, babies have plenty of time to learn the principles of carrying water in pails.

The adult learner has no such luxury. The boss hands the employee a copy of the company's chosen word processor and says, "Learn it." The boss expects the employee to master the computer tool within days rather than years. Learning is more cognitive than physical. No matter how many times the user forgets to press a particular function key to mark text, the environment does not provide the kind of feedback that it does for babies carrying pails of water upside down; gravity does not affect word processors. The computer/human interface designer, therefore, cannot depend on "natural" and casual learning. The designer must create an interface that is immediately understandable and easy to use so that the employee can master the product quickly.

The challenge for the instructional designer is to analyze a concept's features so that generalizations can be taught. Similarly for the interface designer, the challenge is to analyze the product and design the product's interfaces so that the user can take advantage of any underlying generalizations. If every command is presented as a unique case, the learning rate is slower than if clusters of commands are taught as a single generalization. To say this another way, the user either thinks about many boxes of concepts or procedures, or the user thinks about
one unified box. Obviously, learning a single unified concept is more efficient than learning many seemingly unrelated concepts.

But what box? The trick is to identify the most powerful boxes—those that give the user insight into using the tool. To take a simple example, can all menus in the system be opened in the same way? Does the interface make this clear? Big concept teaching empowers the user.

Examples of Interface Design

If users only need to insert text from the beginning straight through to the end, word processors are easy to use. But writers must edit their work; they must return to the text frequently to make additions, deletions, and corrections, and to rearrange a draft’s content. When using paper and pencil, this operation is relatively easy. The writer merely picks up a pencil, moves over the page, erases or crosses something out, and inserts new material.

Of course, if the writer makes extensive changes, the draft becomes difficult to read, and if the writer wants to move blocks of the text, the pieces are cut and pasted. One of the word processor’s chief advantages is that, when the writer makes these changes, a “clean copy” can be printed incorporating the modifications. Nevertheless, with paper and pencil these operations are at least conceptually easy to grasp and thus transparent. They are not so conceptually easy on a word processor. Before a user can actually make the desired changes in a text, the user must tell the computer where the changes will occur. To do that, the user moves a cursor, or indicator, over the screen until it appears in the desired place within the text. Then the user can add, delete, or move things from that point. But the user must first learn to use a series of directives that control the movement of the cursor, and that is where the transparency problem occurs. If writers must learn and use a large number of commands simply to move the cursor on the screen, they can easily be distracted from writing and thinking. This does not occur if they are using paper and pencil. Yet, if the word processor is to provide writers with power and flexibility in writing, many such directives must be available.

A few years ago, the author and a colleague designed a new educational word processing system called Electronic Ink (Siegel & Felty, 1986). The system solves the cursor command dilemma by employing generalizations that govern keypress conventions. One such generalization governs “amount of move.” For example, in Figure 9, the arrow keys move the cursor horizontally, while the Ctrl and Alt keys add power to keypresses. Thus, the left arrow moves the cursor one space to the left; Ctrl-left arrow moves the cursor one word to the left; and
Alt-left arrow moves the cursor all the way left, to the first character on the line.

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Left arrow = moves cursor one space to the left
Ctrl-Left arrow = moves cursor one word to the left
Alt-Left arrow = moves cursor one line to the left

Right arrow = moves cursor one space to the right
Ctrl-Right arrow = moves cursor one word to the right
Alt-Right arrow = moves cursor one line to the right
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Figure 9

The generalization is:

- Key = small move
- Ctrl-key = medium-sized move
- Alt-key = big move

Then, when students learn to use the backspace directive (Bksp) to erase text to the left of the cursor, they employ the same generalization:

- Pressing Bksp erases one character to the left of the cursor.
- Pressing Ctrl and Bksp erases one word to the left of the cursor.
- Pressing Alt and Bksp erases everything on that line to the left of the cursor.

The same relationship exists between the right arrow and the delete directive (Del), which erases text from the cursor to the right. Moreover, the directives Home and End utilize the same generalization. Pressing the Home key takes the student to the first character on the screen; the End key takes the student to the last character on the screen. Using the Ctrl key with Home and End gives bigger moves—to the first and last characters in the file.

Everything about an interactive system is communicated to the user through the interface: the keypresses, the procedures, the overall structure, and even the inconsistencies. While this presents many problems to the computer/human interface designer, it presents opportunities as well. Knowledge about instructional design principles can be used to facilitate good interface design.
CONCLUSION

The world of architectural design reminds us that interfaces are more than art objects. They are designed to interact with people. They must be constructed in such a way so as to balance function and form. The interface of any system must do what it is intended to do, but it must do so with flexibility appropriate to the user's needs. The best interface design helps the user think about tasks in powerful ways.

The instructional design world serves as a reminder that people learn from their environment and that the most subtle cue may trigger learning (misrules as well as rules). A well-designed interface can make learning easier by taking advantage of people's ability to generalize. Similar procedures should be implemented in similar ways. A powerful interface makes visible a product's features. The user is freed to concentrate on the task at hand rather than on the idiosyncrasies of the machine.

REFERENCES