# ¡Hola Sarita!

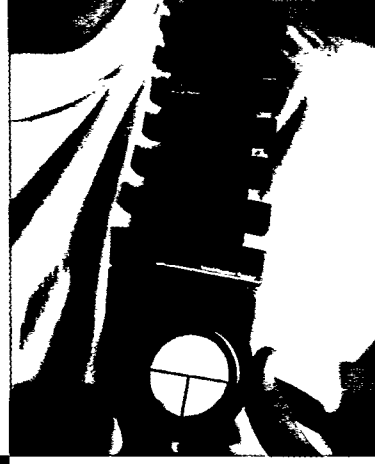
## Computers and Communication Design:

# Anything To do for you today

Two factors have shaped the perspective of the Department of Design at Carnegie Mellon University in its approach to human-computer communication. One is the tradition of graphic and industrial design thinking on which our professions are based. While HCI represents a departure from previous forms of design practice, it is also a natural extension of many of the fundamental ideas and methods of communication design and industrial design. In particular, it is a natural extension of the department's information-based design curriculum and our fundamental concern for effective communication. The second factor is a history of practical experience with the computer industry that began in the mid-1980s through faculty consulting and matured in regular departmental course offerings in human-computer interface design from 1989 to the present. This was a formative experience whose most important consequence, aside from satisfying the specific briefs of industrial sponsors and providing an introduction to HCI for students who have since gone on to professional employment in the computer and software development industry, was to model the problem of HCI for further investigation in the context of communication design. Specifically, we learned how to treat the problem of human-computer communication as a rhetorical problem, where computer hardware and software are the mediating influence between the human beings who use computers and the computer scientists, software engineers, production managers, and other business representatives who are responsible for systems development.

# Exploring the Rhetoric of HCI

Daniel Boyarski
Richard Buchanan



**About the Authors**

DANIEL BOYARSKI *is Professor of Design and Director of Graduate Studies in the Department of Design at Carnegie Mellon University. He is interested in how words, pictures, sound, and motion may be combined for effective communication. He teaches courses in typography, kinetic information design, and human-computer interaction design. email: dan+@andrew.cmu.edu*

RICHARD BUCHANAN *is Professor of Design and Head of the Department of Design at Carnegie Mellon University. He specializes in communication planning and the rhetoric of design, technology, and visual communication. He is editor of* Design Issues: A journal of history, theory, and criticism, *published by MIT Press. He is also co-editor of the forthcoming book* Discovering Design: Explorations in Design Studies, *to be published by the University of Chicago Press. email: buchanan+@andrew.cmu.edu*

As a rhetorical problem, designing human-computer communication is remarkably similar to the traditional problems faced by graphic and industrial designers. In the worst case, the designer is given the prototype of a product and asked to adapt it to potential users. This leads to styling: mold a pleasing cover to conceal the electrical and mechanical parts, select a color scheme, design an icon, apply a trendy typeface, develop packaging and instruction manuals, and so forth. If the designer notices a flaw in the technological reasoning, recognizes a user need that is not well met, or doubts the functionality of the product in a specific environment of use, it is usually too late for any change in the concept of the product. In the best case, the graphic or industrial designer is involved from the beginning of the product development process. They are part of a development team in which each member has a knowledge-zone that overlaps with other members of the team. There are different perspectives on a common problem, and all perspectives contribute to the development of the product from concept prototyping and evaluation to production and documentation.

What does the graphic or industrial designer bring to the team? Certainly, he or she brings a set of technical design skills: a knowledge-zone of two-, three-, and four-dimensional visualization and form-giving techniques. These are the features of design that make it easy to reduce the role of a designer to that of a product stylist or to imagine that design education can be accomplished in the environment of a technical trade school. But the designer also brings a knowledge of effective communication: how to conceive and plan a product that is well-adapted to a specific type of user in a specific situation of use for a specific purpose. All members of a development team participate in the activities of conception and planning, but the designer approaches conception and planning by employing a variety of ideas and methods that are unknown or uncommon in other disciplines. The goal of the designer's discipline is to build the argument of a concrete product. This argument is sometimes expressed in words and descriptive documentation, but more often it is expressed in two-, three-, and four-dimensional forms that excite the user with new possibilities for work or play and facilitate the situated activity of taking personal ownership of the product. Designers have the ability to provide the stylistic embellishment of a product, but they also have the ability to join in an exploration of the nature of the product, particularly as it is adapted to human beings in concrete situations of use.

For the designer, conception and planning mediate between the universal knowledge possessed by experts and the particularity of the product in its psychological, social, and cultural settings. Indeed, mediation is one of the roles that the designer plays as a member of a cross-functional product development team, where other members of the team are scientists and engineers or experts in manufacturing or various business activities (e.g. marketing). Each member of the team brings specialized knowledge, but they must integrate their understanding and work together to actualize what is only vague and potential in their minds. The designer helps to catalyze the team process and encourage every member, whatever their expertise, to become a designer.

#### From interface to interaction design

In 1989 the Department of Design offered the first course in human-computer interface design at Carnegie Mellon University. Enrollment was limited to graphic design seniors, and the course was one of several senior project options. Eight students worked alone or in two-person teams on an NCR-sponsored project that focused on designing the user interface for self-service terminals. Situated in public spaces, these terminals came with specific constraints. For example, unlike PCs that allow for lengthy work periods by one user, time spent at a self-service terminal should be as brief as possible, thereby facilitating as large a number of users as possible—clearly the goal for automated teller machines (ATMs). With interaction time reduced to a minimum, the conceptual model of the interaction sequence, as well as the visual interface, needed to be be simple, consistent, and clear: no different than the goals for any interface design. Content topics were left open to the students, which allowed them to push beyond the too-familiar ATM. Topics included an encyclopedia searching tool for

I wish to withdraw...

**Genie One**

*Why do ATM interfaces have to all look alike? This student team suggests customizing interfaces for specific communities of users, such as this fanciful one for a university campus. Completing a transaction takes the form of completing a sentence, a more natural and time-saving way when compared to the current query-answer model. (Client: NCR Corporation).*

Patricia Shanahan, *Graphic Design;* Rob Jordan, *Creative Writing*

high schools students, a real estate browser, and an on-line florist.

We ran the semester-long project as we do any design project: explicit goals and milestones, careful consideration of the audience, and periodic evaluations of progress. The client was part of the process, setting the stage for the project, providing a mid-project evaluation, and reviewing the final presentation. Objectivity, client needs, corporate culture, and technical constraints were supplied by the client—necessary ingredients to any successful project course. These were not regarded by us as limitations, but as an essential part of solving real interface design problems. In fact, the client and students enjoyed the interaction; it offered both parties a break from the norm.

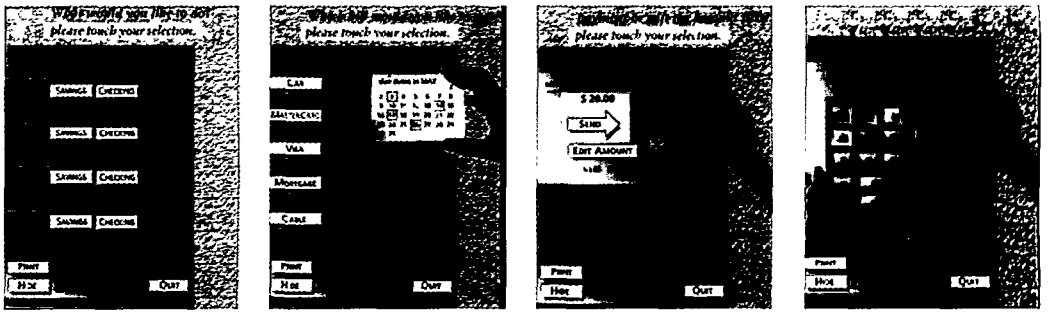
Once each project had a problem statement, a user profile, and clear goals, the next step was to develop a map—a flow-chart—of a "typical transaction." This was best done by diagramming on large sheets of paper pinned to a wall. Eventually, this transaction map gave way to storyboards, a visual screen-by-screen representation of the transaction. It was only in the final four weeks of the project that students attempted to build screens and the final sequence in a beta version of MacroMind Director. It was intense work, to be sure. What finally emerged were kinetic storyboards: simple and effective animated sequences that clearly illustrated the look, feel, and sound of each interface. Working prototypes with code behind them were not required, since this project focused on concepts.

In the following year, the course was offered not only to design students but to students from across campus. The response was enthusiastic, and this eventually became our model for courses that promoted collaborative interdisciplinary work, in either human-computer interface (CHI) or human-machine interac-

**The Helping Hand**

*Introducing a human element in an ATM interface was a challenge posed to this team. After user studies rejected the idea of a talking (teller) head, the concept of a helping hand evolved from research into historical paintings and instruction booklets. The transaction is simplified by hands bringing tools to the screen that help the user check a calendar, pay bills, or calculate a new total. (Client: NCR Corporation).*

Jackie Voellinger, *Graphic Design*; Krishna Pendyala, *Computer Science*




tion (HMI) projects. Graduate and undergraduate students came from departments such as English (professional and technical writing), Computer Science, Information Management, and Architecture. Teams of two, three or four students worked together, bringing their different perspectives and approaches to solving the problem at hand. Learning to work productively as a team sometimes proved to be difficult. But valuable lessons were learned in the process, and these have since been carried into professional practice by some of our graduates working as interface/interaction designers.

We have worked on a variety of projects with a number of clients over the past five years. We continue to explore the potential of the self-service terminal with NCR, touching upon issues such as customized interfaces for specific user populations, "transparent" interfaces for those hesitant about using the technology, and the use of kinetic typography for a sequential presentation of information. Apple, on the other hand, presents broad themes for the teams to explore, each team redefining the boundaries as their concepts emerge in both two- and three-dimensional models. Adaptive interfaces and scalable computers have been recent themes. A year ago, Hewlett Packard challenged our students to think broadly about hand-held digital information devices—why a person might use one, to do what, and how. These young designers were asked to explore potential uses for such devices. What emerged were concept sketches, three-dimensional models, and written reports documenting their research and process. Fundamentally, this was a planning project, one that sought ideas, not final solutions.

The Engineering Design Research Center (EDRC) and the Department of Design have been collaborating on a unique project over the past two years. The Center's mandate is to develop design methods and practices for low cost, high quality products, in the shortest amount of time. Our contribution has been in integrating design thinking into every stage of the product's development cycle. The project is to develop a family of wearable computers. An interdisciplinary team of students and faculty successfully completed VuMan, a device that is worn on the body and moves with the user. It provides real-time information about the work environment, such as an assembly plant; the information is processed through a belt-worn device, transmitted to the head gear and projected on the transparent visor. Users should not be forced to change their natural way of working and VuMan facilitates this. The entire

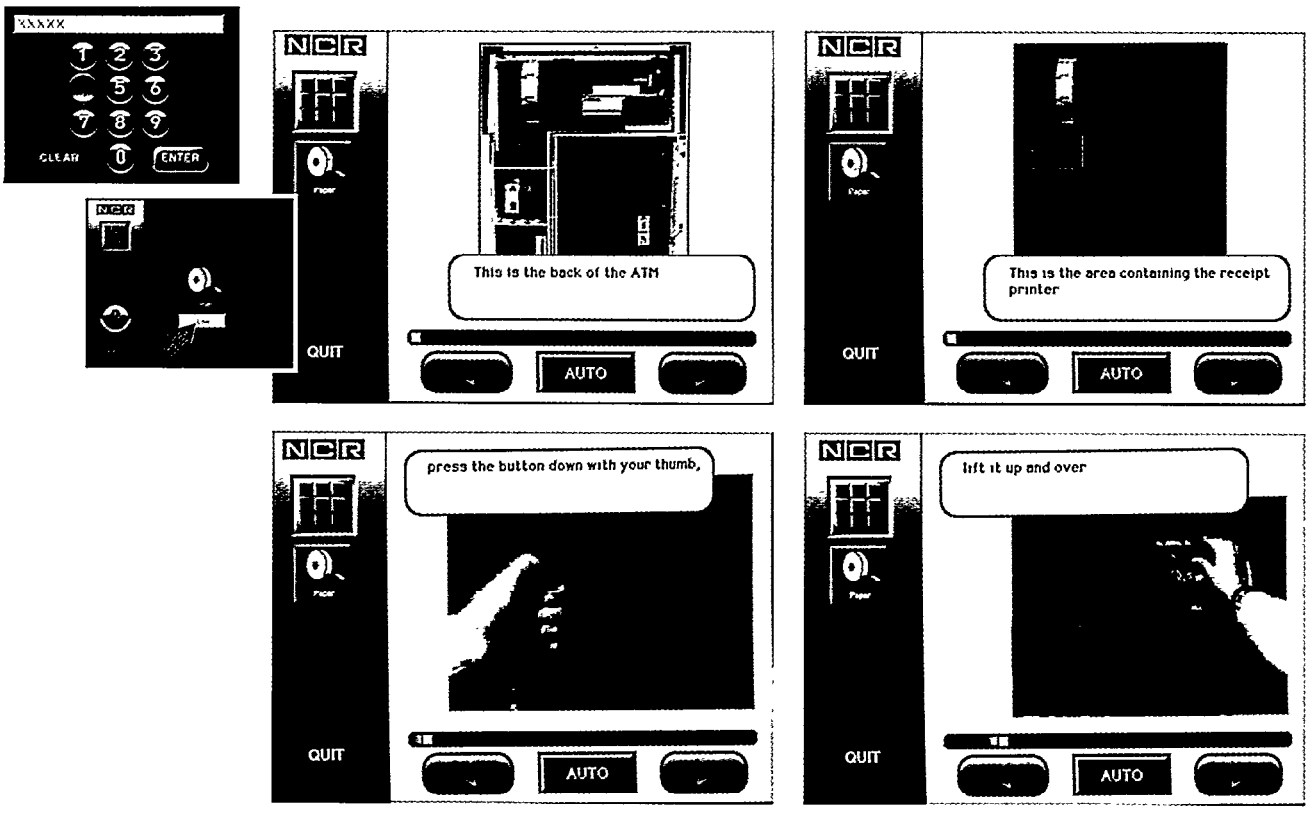
design process, which could have taken several years, was completed, from concept to final prototype, in less than six months. VuMan 2, recently completed, provides twice the functionality, weighs fifty percent less, is sixty percent smaller, requires far fewer electronic components, and consumes seventy percent less power. The success of this venture is attributed to open communication between team members and a shared vision. Finally, it will be the design process that is the invaluable tool for industry, as it develops any variety of products in the future.

Late last year, a new project challenged our established design process of planning, prototyping, and evaluating. We were asked to "come up with some ideas" for an interactive television application. Very little else was defined by the client. What we later discovered was that the project was defining itself the more we worked on it. This project turned out to be an extended brainstorming session, which resulted in a quickly-assembled prototype, in MacroMedia Director, that was shown to a number of focus groups. The feedback from these groups generated another round of brainstorming and a sec-

**ATM Diagnostics**

*When an ATM malfunctions, this device alerts the bank's staff with a red blinking icon. Any staff person may open the ATM's service door, punch in an identification number, and be guided through the diagnostic and servicing procedures by a short video. The problem is promptly solved and the machine is up and running with a minimum of down-time. (Client: NCR Corporation).*

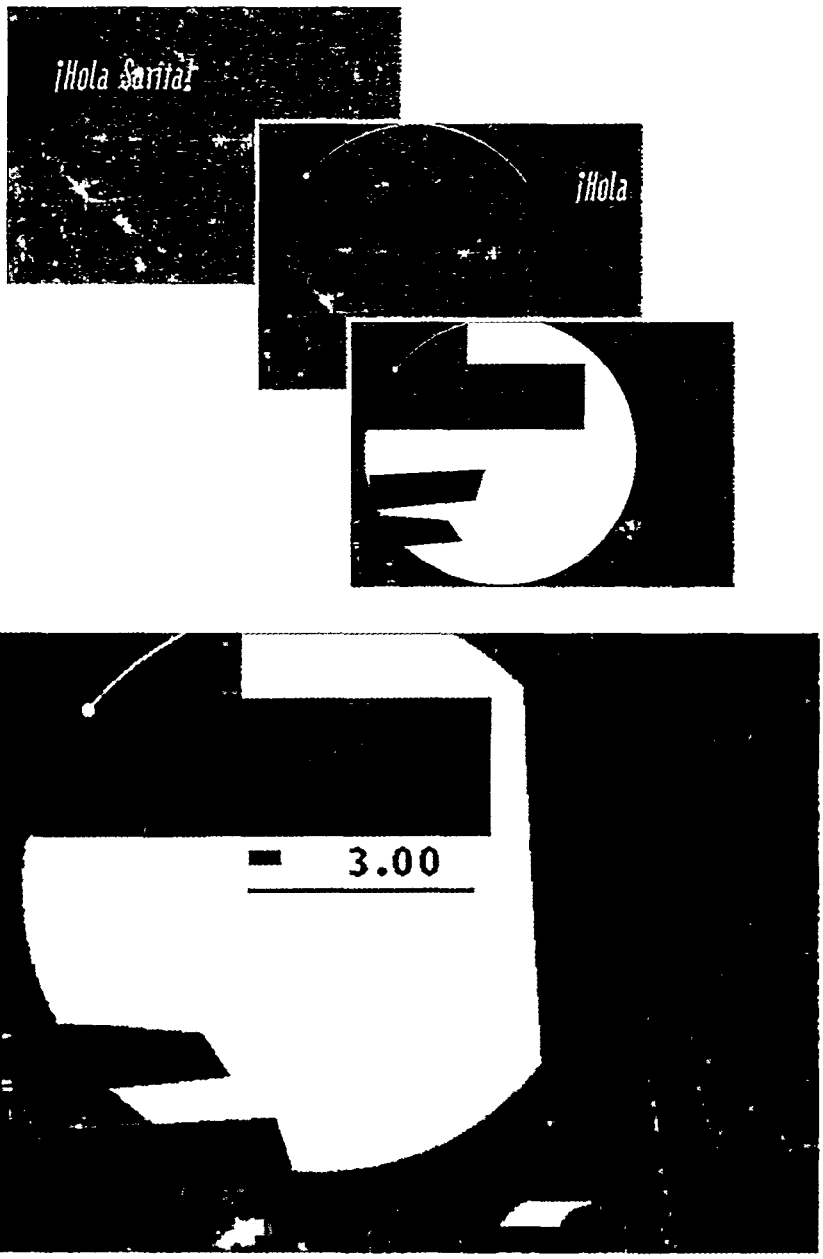
Hugo Cheng, *Graphic Design;* Felicia Ferlin, *Professional Writing;* Andrew Milmoe, *Industrial Design;* Mark Pottier, *Computer Science and Psychology*



**Sarita's Interface**

*Sarita's customized user interface communicates in Spanish—her native tongue—and with a lively and youthful look. She selected these options when she opened her bank account. Her card's magnetic strip carries this information, as well as the fact that she has only one account. (Client: NCR Corporation).*

Glynis Frost, *Graphic Design*; Jennifer Heid, *Information & Decision Systems*




ond prototype. This brief project gave us new insight into the early phases of the design process. Rather than carefully model the user population and map the transactions through the interface prior to visualizing it, this project turned that process around. After brief and intense periods of discussing audience and their perceived needs, sketches began to emerge. Those sketches contributed to the first prototype which was used to determine, in both general and specific terms, what intrigued and interested the individuals in the focus groups. Even with a fairly crude prototype, valuable answers were collected.

We were astonished at how open-ended this project was. Similar to the Hewlett Packard project, this was essentially a planning exercise. With hindsight, what was called for from each participant was an openness to new ways of solving the problem. We all had to be flexible when responding to the client's need for quick ideas and a rough prototype. What proved to be most difficult was shedding the need to produce a "perfect" artifact. In short, we were asked to work in a manner that was new to us.

Reflecting on the five years since that first interface design course, what were some of the lessons we learned regarding interface/interaction design? There were many, but three deserve special attention: the importance of knowing the user, the value of early visualization, and the need for documenting the design process.

Knowing the user. Much has been written on this topic, but it bears repeating that users are the reason we do what we do. There is solid work on evaluation procedures and techniques, most of this occurring, however, in the latter stages of development. Early in the design process, in an attempt to understand the user population we are addressing, we have found great value in conducting ethnographic

**Harry's Interface**

*Harry, a retired contractor living out in the country, occasionally uses an ATM to access his two accounts. His customized interface takes into consideration his failing eyesight, his love of the outdoors, and his rather conservative taste.*

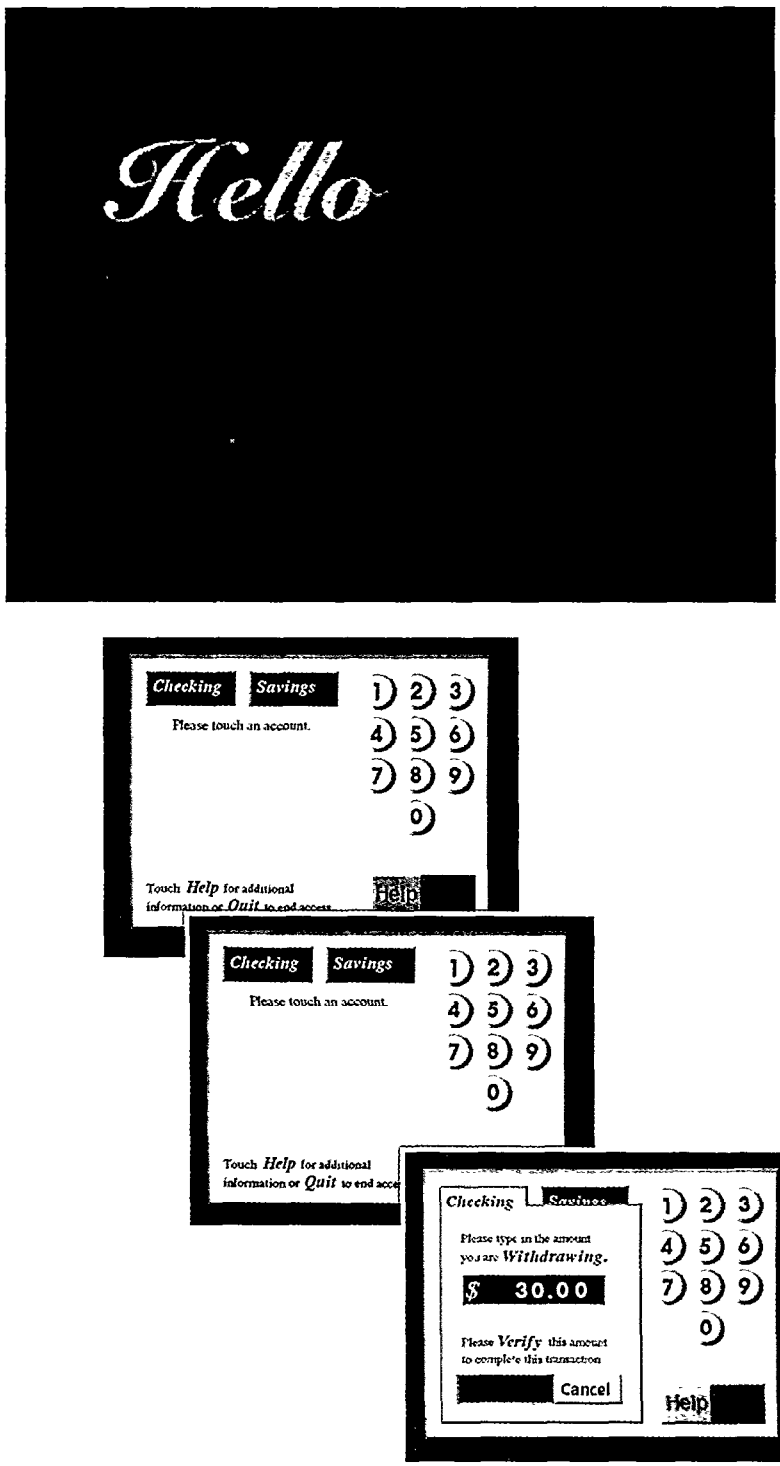
Glynis Frost, *Graphic Design*; Jennifer Heid, *Information & Decision Systems*

studies—objective observations of people in the context of where they do their work. This contributes valuable information to user profiles, task analyses, and work flow diagrams. Isolating a user from where the work is done, to conduct user studies, may yield data on keystroke hits or searching tasks. What is missing is the situated information, complete with anecdotal details, that gives us a true picture of work being done.

**Early visualization.** The visual representations of ideas need to be sketched out as early as possible, so they can be discussed and evaluated. Interestingly, when projects remain in the diagrammatic stage for too long—"We need to nail this flowchart down before we start sketching," being the favorite excuse—the resulting visual interface often resorts to the conventional, even relying on existing GUI platforms. The more innovative, and generally more appropriate, solutions come from teams that visualize early in the process. With the visual component being a major part of the interface, it makes sense to do this. Industrial designers have similarly found that "getting physical" early in the process moves the conceptual phase faster and further. It actually allows for breadth and depth of exploration.

It has been reassuring for us to observe similar methods for development and presentation within design companies and software/hardware companies. Creating kinetic storyboards allows for concept verification with team members, managers, and users alike. Compared to the often heavy investment of programming resources, this is fast, visual, and affordable.

**Documentation.** We have long required students to keep a record of major projects on which they work. A notebook of sketches, notations, briefs, and correspondence, serves as



a verbal and visual diary of the entire process. This becomes the basis for producing final written and oral reports. Putting together a final report or presentation relies on sifting through the documentation and organizing the most informative and persuasive story. This is where informal language, verbal and visual, becomes formal language, verbal and visual. For teams, this affords a review of the process, one that hopefully informs future collaborations. We have noted that the final report is often of greater interest to the client than the resulting interface. It is this methodology that they can take home and put to use.

#### Rhetorical dimensions of HCI

In the early period of HCI development, it would have been difficult to distinguish the rhetorical aspects of interface design from the logic of programming. Systems engineers assumed that computer users were like themselves, sharing the same knowledge, work habits, and values. In effect, if one wanted to use a computer, one had to become like a computer programmer. This situation changed rapidly when the market for computers began to expand to larger segments of the general public and when the purposes served by the computer shifted from scientific and engineering calculation to a wide range of other tasks, including entertainment. There was a recognition that other fields of expertise had to contribute to the conception, planning, and execution of a system interface. These fields included cognitive psychology, visual and verbal communication, anthropology, user observation, and evaluation. In short, the focus began to shift from an emphasis on technology as the driving influence behind design to an emphasis on the user and the user's experience in interacting with the system. The focus became the human component of the human-computer equation.

With this shift in focus, speculation on HCI in the Department of Design has turned to rhetoric for insight into the dimensions of effective human-computer communication. This does not mean that we turned our back on colleagues in computer science, software engineering, and the social and behavioral sciences. We routinely collaborate with individuals from each of these fields, seeking better understanding of the scientific basis of effective communication strategies. But the gulf between science and the particularities of communication is immense. Science is concerned with laws, rules, and other forms of universal regularity. In contrast, human-computer communication is a concrete problem, always situated in a particular environment of human experience. The concreteness of communication reminds us of a truth that is sometimes forgotten when scientists and engineers attempt to project their knowledge in practical application: there is no science of the particular. The chimera of a deductive and predictive science of HCI is no closer today than it has ever been. What has changed is the understanding of the natural limits of the mind to process information and the habits, desires, preferences, and values of the different types of human beings who use computers. The problem remains how to convert this general understanding into particular products that engage human beings and facilitate their activities in specific circumstances.

This is a deliberative problem unlike deliberative problems of the past. In the past, deliberation led to decisions about means to be employed in given circumstances to achieve given and desired ends. Means were deliberated, but the circumstances and ends were not subject to deliberation. Today, deliberation is inverted. The computer provides new means—the means are given by technological development—but the circumstances and ends of computer use are, themselves, the subject of deliberation in the process of product development. This is a fundamental characteristic of our time, and it profoundly influences the development of human-computer communication.

#### Models of rhetorical interaction

There are several rhetorical models of HCI cur-

**VuMan**

*A wearable computer with several components that allow a worker to retrieve and view information relevant to the task at hand. The components include a head-mounted device that transmits visual information to the user, a belt-worn processor, a neck ring with a microphone, and a hand-held camera. The headpiece projects data onto the transparent visor, allowing the person to simultaneously read the data and work with both hands.*

Engineering Design Research Center,
Carnegie Mellon University

**Portable Information Devices**

*Communicating a vision of future products and their users is what this project was about. The process included studying communities of workers, reviewing current products and trends, creating scenarios, and rapidly prototyping ideas for feedback. The project resulted in concept models that offer a look at some future shapes and uses of portable information devices. (Client: Hewlett-Packard).*

Senior Industrial Design Project, *Fall '93*

rently under investigation by the Department of Design. The most important is a practical model of persuasively effective communication. A computer interface mediates between a human being and the system of hardware and software in an analogous manner to the way that persuasive writing mediates between a reader and an author.

Imagine a writer who must make a case to an indifferent audience. The case may be presented in a variety of ways without compromising the integrity of the central idea. But some ways of presenting the case are more effective than others. A balance of three elements serves to distinguish the effective presentation from the ineffective. First, the reasoning is clear and easy to follow; each step in the presentation is intuitive, logical, and relevant to the goal at hand. Second, the implied voice of the speaker (the fictive character of the system fabricated by the development team) instills confidence; there is a sense of goodwill or caring—nothing tricky, condescending, or annoyingly unexpected. Third, the presentation arouses feelings in the audience that are appropriate to the goal; the audience is engaged with appropriate passion and feels pleasure, tension and release, and satisfaction in the completion of each step, all in a rhythm that is neither too grand nor too trivial to the task. In other words, HCI is like a persuasive speech. The user is led into the computer system and provided with every support deemed valuable for its use. A balance of reasoning, implied voice, and feeling (haptic as well as emotional) is critical to effective human-computer communication. But the criteria of balance are found in the nature of the task to be performed. Different kinds of tasks require different kinds of balance.

The old term "interface" presupposed a relatively passive user who accepted what was given by way of instructions through icons, "hot" buttons, and "rules of engagement." Theoretical models spoke of messages, coding, and decoding—all suggesting that the user was a passive recipient, subject to (benign) manipulation. The designer stood apart from the user and made all of the system decisions with the best interests of the user in mind. Unfortunately, the user was often only a mythic presence in the design activity and, in consequence, a reduced player in the actual operations of the interface. In contrast, the new terms "interaction" and "communication" point toward an active user whose concerns, values, and abilities are incorporated in design planning, with the explicit goal of empowerment. In consequence, the human user becomes an influential presence in operations. Indeed, the user is empowered to become a designer of his or her own involvement with computing devices and software—so long as this empowerment does not violate the basic social contract that is implicit in the hardware and the software package.

The model of HCI as persuasive communication is powerful and practical. It focuses on specific design tasks and the overall goal of the software package under development. It supports collaborative design, user-testing, and evaluation, all to the end of determining what is most appropriate and feasible in a specific communication environment. Among the pathways that this model opens for investigation, three stand out as critically important: communication between the development team and human users; communication between human

## Learning HCI

**Interdisciplinary education is critical to the next generation of designers concerned with human-computer communication. To continue the exploration of HCI in the context of communication design, the Department of Design has established two new graduate programs. The first is a Master of Arts in Communication Planning and Design, a joint degree of the Department of Design and the Department of English. This program explores the connection between verbal and visual communication in contemporary culture, with special focus on information visualization and the problems of navigation and way-finding in new technologies. The second is a Master of Design in Visual Communication and Product Design, combining the resources of our faculty in communication design and industrial design as well as faculty from other departments and research centers at Carnegie Mellon. The focus of this program is specifically the design of human-computer interface and human-machine interaction. The goal of establishing these programs in parallel is to foster innovation through the interplay between planning and product design. We believe that this interplay will be critical to product development in the future, and that educational programs will have to explore similar unconventional programs if they wish to do more than simply follow current HCI design practice.**

users and systems; and communication among human users through the medium of computing devices and software.

Other rhetorical models of HCI under exploration in the Department of Design are variations of the first. One is a model of meditation. This is a more speculative model, but it, too, may have serious practical implications, since it projects ahead to the changing nature of systems in contemporary culture. In this model, the problem of HCI is analogous to the rhetorical problem of meditation found in many cultures. Meditation is the interface between an individual human being and a cosmological system which cannot be perceived in its totality.

The presenting face of the system is made up of the elements or data of experience—images, signs, and other events whose meanings are not evident except through meditation. Meditation is not passive. It is an active engagement which brings a heightened sense of individual power as well as a sense of identification with the system—a sense that the central idea of the system is understood. Meditation is a kind of dialogue focused on the phenomenology of the system. The design problems concern selection of the presenting elements, decisions about the reality which the software will embody, and decisions about the kinds of pathways—the kinds of arguments and narratives, logic and myth—which the user may pursue in his or her meditation.

Clearly, there will be some systems in which the development team must tell the user how to proceed. But there will be other systems, or moments within systems, when the task of the development team is to show the user what is possible—that is, to provide the means through which the user may discover his or her powers and abilities within the system.

The development of human-computer communication is in its early phase of exploration. Design is often focused on short-term tactical solutions, without reflection on long-term strategic possibilities. One of the primary functions of a university program in HCI is to prepare a new generation of designers who can address tactical problems while remaining curious and open to new strategic directions. ■