Smoke and Mirrors

Every time I read about yet another GUI, I get this feeling of "déjà vu all over again." Isn't it time to move on?

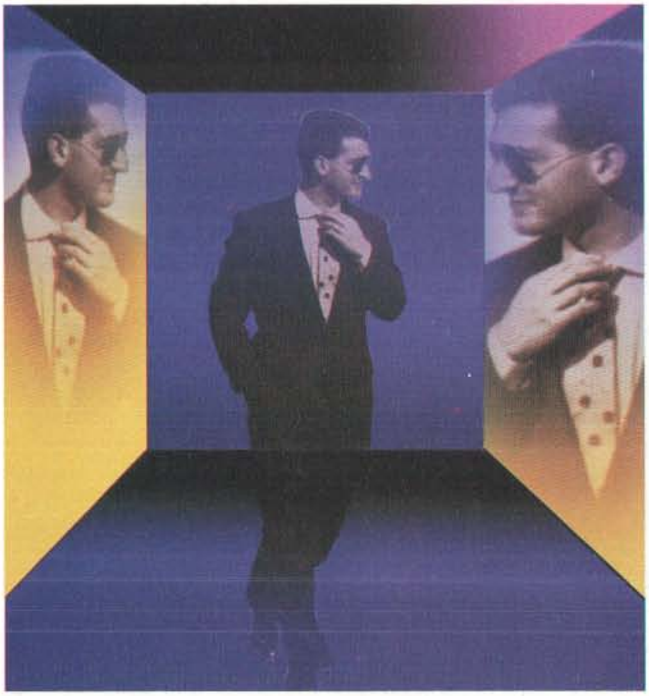
Bill Buxton

Little question remains that computers are more accessible today than they have ever been before. Introduced by the Xerox Star and popularized by machines like the Macintosh, the graphical user interface (GUI) has had a huge impact on the usability, usage, and usefulness of computers.

But now, nine years after the Star's introduction, I feel locked in a time warp. This sensation is reinforced every time I read about yet another GUI. Each one triggers a familiar flash of déjà vu.

Don't get me wrong. I'm not complaining that the PC and Unix worlds are finally becoming fit for human consumption. I have the highest respect for the teams that invented the GUI, but I just can't accept that there are no more significant breakthroughs to come.

In an industry as new as ours, it's too early to rest on our collective laurels. We can do far better than the "we can do GUIs, too" attitude that is all too common today. We can explore and champion some of the emerging alternatives to the GUI—alternatives as creative and important in today's environment as the Xerox Star was in 1982.



In the Looking Glass

Rather than use a crystal ball to look into the future evolution of user-interface development, I prefer to employ a little smoke and three mirrors. Why mirrors? Because they are reflective.

Using the first mirror, you can ask, "How well does the system reflect the human motor/sensory system?" Does it acknowledge, for example, that most people have eyes, ears, feet, and *two* hands?

Using the second, you can ask, "How well does the design reflect the human cognitive or problem-solving mechanisms?" For example, does the system reflect how people think and make decisions?

Finally, the third mirror can test how well the technology reflects the sociopolitical structure of day-to-day life and work. For example, how does the technology reflect or support group activity or affect power structures?

Together, these three mirrors emphasize how user-interface design goes well beyond questions of how to best design menus, or whether to use a joystick or a mouse. To be truly effective, a design must provide a reasonably undistorted reflection from all three mirrors. Very few systems in use today stand up to this test.

Discussions of emerging or future systems tend to include the conflict between technology and user-driven design. Too often, change has been technology-driven, resulting in a tail-wagging-the-dog situation, which creates more problems than it solves. The loser in this conflict is usually the user.

continued

Despite the pitfalls, however, technology is an important element, not as a force to drive future development, but because of the opportunities that it affords. Knowing the technology can help you create a better match between what can be done and what needs to be done. However, you need to approach the problem from both ends simultaneously.

Look and Feel

The concept of "look and feel" has had a lot of attention recently. It encompasses those aspects of the user interface reflected in the first mirror—the motor/sensory system. Today's user interfaces have far more look than feel, and the use of sound is so impoverished that it does not even rate a mention.

Even the concept of "look" is impoverished. It is unidirectional and doesn't take into account the capability of the eyes to indicate direction (or to be used as an input device, as the photo illustrates). In short, the balance is out of all proportion with what people are capable of.

Technology may be able to render wonderful ray-traced images, but without mortgaging my house, I can't purchase a system that lets me draw a line whose thickness varies continuously with pressure (something I can do with a 15-cent pencil). One of the first priorities of the next generation of user interfaces, therefore, is to correct the imbalance that the first mirror reflects.

MultiSomething

Multimedia is another topic that inevitably arises when discussing emerging technologies. The discussion usually includes two principal components: (a) Multimedia is the future! and (b) What is multimedia? The resulting debate is generally more than a little confused.

Much of the excitement about multimedia is well founded. However, by definition, multimedia focuses on the medium or the technology rather than on the application or the user. Therein lies a primary source of confusion. If you take a user-centered approach, you quickly see that it's not the medium per se that is important. Rather, it is the human sensory modalities and the channels of communication that multimedia uses that make it different. Therefore, the following terms might be more appropriate and focused:

- *multisensory*: using multiple sensory modalities;
- *multichannel*: using multiple channels, of the same or different modalities; and
- *multitasking*: recognizing that people can perform more than one task at a time (as driving a car demonstrates).

Seen in this light, the real value of multimedia is the role that it can play in smoothing out the distortions seen in the first mirror. From this perspective, you can reverse the question from "Why do I need two-handed input or audio?" to "Since I have two hands and two ears, why doesn't this system permit me to use them to full advantage?"

The SonicFinder and Beyond

One of the most interesting pieces of software that is circulating in the research underground is something called the SonicFinder. It was developed at Apple Computer's Human Interface Group by Bill Gaver. The SonicFinder is a prototype of the Macintosh Finder based on the novel proposition that most people can hear. This may seem fairly obvious, until you look at the sonic vocabulary most computer systems use.

The SonicFinder uses sound in a way that reflects how it is used in the everyday world. You can "tap" on objects to determine their type (e.g., application, disk, and file folder) and their size (small objects have high-pitched sounds; large objects are low-pitched). When you drag an object, you hear a scraping sound. When a dragged object collides with a container (e.g., a file folder, disk, or the Trashcan), you hear a distinct sound.

All this may seem to suffer from terminal cuteness, but how many times have you missed the Trashcan when deleting a file, or unintentionally dropped a file into a file folder when dragging it from one window to another? Frequently, if you're like me. Yet these are precisely the kinds of errors that disappear when you add sound.

Machines that exploit sound are finally becoming more common. It started with the Commodore Amiga, which comes with rich audio and text-to-speech capabilities. Now, audio is becoming an important ingredient in other platforms (e.g., the NeXT machine). In fact, it is the major interface in some systems (see "The Spoken Word" on page 225).

The challenge is in learning how to use audio effectively, not just for music or to provide an acoustic lollipop, but as a means of providing a sonic landscape that helps you to navigate through complex information spaces.

A One-Handed Waterloo

Just as most people can hear, most can also manipulate items with two hands. Every day, you turn pages with one hand while you write with the other. You steer your car with one hand while changing gears with the other. You hold a ruler or drafting machine with one hand and use a pencil in the other. All these tasks require everyday motor skills that computer systems largely ignore.

It seems to me that the Macintosh was designed for Napoleon: Unless you are typing, you can work all day with one hand tucked into your jacket. This is great if you are one-handed, but a waste if you're not. The image of the user reflected in the technology is lopsided.

"Hands-on" computing is largely a myth. It would be better called "hand-on" or even "finger-on." To accurately reflect human potential, a system should let you scroll through a document by manipulating a trackball with one hand and using the other to point with a mouse. You should be able to scale an object using a potentiometer in one hand, while dragging it into position with the other. Or, in a program like MacDraw, you should be able to move the drawing page under the window using a trackball in one hand and keeping the "pen" in the other.

High-end interactive computer-graphics systems have used this type of interaction for years, but it has not yet penetrated the mainstream microcomputer market. This is about to change.

The Bus Stops Here

Many of the problems of having a variety of inputs are logistical: How do you connect this device to that machine? The Apple Desktop Bus (ADB) is a good attempt to address this class of problem. It provides an electrical, mechanical, and logical standard for connecting input devices to a computer. Thus, it becomes easy to mix, match, and change devices.

But perhaps the most important (albeit hidden) capability of the ADB is its ability to sense and distinguish among different simultaneously connected input devices. At the recent SIGCHI conference, Dan Venolia and Michael Chen of Apple's Human Interface Group demonstrated this capability using a mouse and a trackball together. The result was a prototype utility on the Mac that supported many two-handed transactions. This is a clear case of technology that supports human needs and suggests better things to come.

Handling the Pressure

Just using two hands is not enough, however. Another ability that people have that current technologies don't reflect is the hands' ability to control and sense pressure. One place where this has been recognized and used is in electronic musical keyboards. Each key has what is known as "aftertouch"—the ability to sense how hard the key is being pressed.

Hopefully, aftertouch will soon be standard on mouse buttons, providing natural control for line thickness, scrolling speed, and the speed of fast-forward or rewind on videos and CD-ROMs. A few manufacturers, such as Wacom and Numonics, already make pressure-sensitive styli for digitizing tablets.

But no matter how well the look, feel, and sound of a user interface are developed, it still may not fit how you think or how you work; therefore, it will fail. Understanding these elements brings the second mirror into focus.

Data Overload

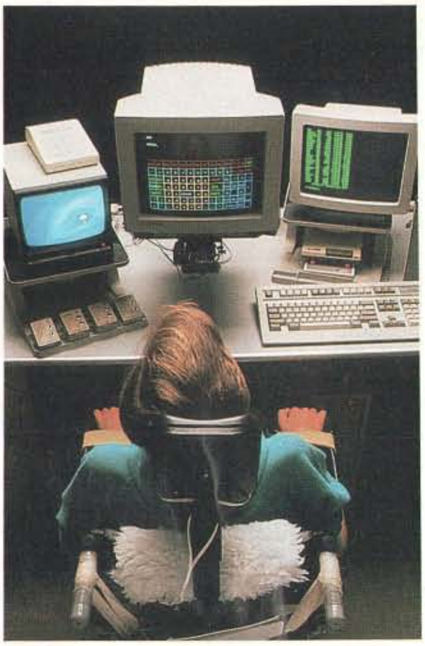
Would-be sages and futurists will tell you that we are in the middle of an information revolution—a revolution whose impact is matched only by the one that followed the invention of the printing press or the industrial revolution. Unfortunately, this is false.

By definition, information is that which informs and can serve as the basis for informed decision-making. Rather than an information revolution, the current situation is more of a data explosion. The combined advances in contemporary telecommunications and computational technologies have helped to spawn an era where true information is more and more difficult to find, and almost impossible to find in a timely manner.

Information technologies that deserve the name are less computational engines than technologies that filter and refine data into a form where it informs. Just as you want systems to reflect how you hear, see, and touch (the first mirror), you want them to accurately reflect and support how you think, learn, solve problems, and make decisions (the second mirror).

The spreadsheet is one of the greatest successes in the microcomputer world because it fits the way that people think about certain problems. Rather than generate masses of new numbers, it helps you refine data into information by enabling you to explore and understand new

continued



A nonintrusive eye tracker. A video camera mounted under the display tracks the position of the eye's pupil and translates the data into screen coordinates. Thus, the eyes can "point." (Photo courtesy of L. C. Technologies, Fairfax, VA)

A New Breed

The past 10 years have seen the development of a new profession: applied psychology. Traditionally, psychology has been a discipline that analyzed and tried to understand and explain human behavior. Now, largely due to problems encountered in human-computer interactions, a new branch of psychology is attempting to apply this understanding in the context of a design art. The shift is from the descriptive to the prescriptive.

Today, a similar phenomenon exists in the discipline of socio-anthropology. If you want the society and social structures of work (and play) to drive technology, the obvious place to look for expertise is in disciplines like sociology and anthropology. Like psychology, these are traditionally analytical, not design, disciplines. However, change is coming, and a new discipline is being born: applied socio-anthropology.

Hence, a new breed of anthropologists, such as Lucy Suchman and Gitte Jordan (who last studied birthing rites in Central America), are stalking the halls of the Xerox Palo Alto Research Center. They are studying the structure of organizations and work, with the intent of laying the foundation for a design art that takes into account the larger social context. Like psychology, socio-anthropology is becoming a prescriptive as well as analytical science.

Group Dynamics

Perhaps these social concerns are most visible in the rapidly emerging areas of computer-supported cooperative work and groupware (see the In Depth section of the December 1988 BYTE). This is a prime example of the outside-in squeeze. On one side, theory is growing out of the applied social sciences; on the other, important enabling technologies—such as LANs, new display technologies, and video conferencing—are emerging.

Architectures like Xerox's prototype System 33 will enable you to create, save, index, annotate, retrieve, and share documents independently of how they were created or stored. Human concerns, such as retinal consistency (i.e., documents' tendency to remain visually consistent) and the reality of different platforms, will drive the design.

Telecommunications, video, and computer LANs are converging, resulting in new forms of collaboration, such as the Cruiser system developed at Bell Communications Research by Robert Root and Bob Kraut, and Xerox's Mediaspace. By integrating a range of technologies, both systems permit a degree of telepresence and remote collaboration previously impossible.

Slowly but surely, the emerging technologies are going to let you come out of the corner to take a full and active role in the group. As all three mirrors start to work together, they will let you do what people do best—namely, be human.

Bringing Blue Sky Down to Earth

The danger in writing about technology and the future is that you quickly fall into the credibility gap. I have used some isolated examples to support my case for the inadequacy of the GUI to meet the needs of today and tomorrow. But are they only isolated examples, or is there some evidence of a new trend?

Evidence for a new approach to user-interface design can be found in machines such as the GridPad, Scenario's

continued

DynaWriter, Toshiba's PenPC, Sony's Palmtop, and Go Corp.'s new laptop. All these machines have portability and on-line character recognition in common (see "Sign Here, Please" on page 243).

These differences lead the way to more than just a change of interaction style. By being portable, the machines are freed of the anchor of their power cord. The technology can go with the worker, rather than the worker going to the technology. This is an important change.

Similarly, compared to the GUI, the stylus-driven interface better matches the style of work and skills that people have built up over a lifetime of work and education. While the systems' recognition skills are still fairly primitive, this style of interface leads toward a way of capturing all kinds of spatial and temporal information, such as the types of figures and annotations found on blackboards and notepads.

Several different techniques have been used for symbol recognition, including template matching, feature recognition, and neural networks. An early but elegant feature-recognition technique, called *trainable character recognition*, was developed by K. S. Ledeen in 1967. It is described in detail in Newman and Sproull's classic *Principles of Interactive Computer Graphics* (McGraw-Hill, 1973 and 1979). [Editor's note: *Pseudocode for the Ledeen character recognizer is available on BIX. See page 5 for details.*]

Being mobile still may mean working alone. But the wireless network communications of the Agilis System point toward a time when mobile workstations will be able to communicate with each other, and with larger systems such as servers.

Perhaps nowhere do these concepts come together better than in the new portable from the Active Book Company in Cambridge, England. This package has true workstation power (5 million instructions per second average, 10 MIPS peak) in a portable package powered by the Acorn RISC Machine's RISC processor. In addition to having a stylus-driven interface with character recognition, it includes a touch surface that you can use to "thumb through" the documents you are reading or editing.

The true power and insight of Active Book's machine come, however, from other emerging technologies, especially the new Digital European Cordless Telecommunications standard. In mid-1991, there will be a new pan-European cellular phone network, known as D1, that will have a digital channel with built-in error correction. Portable workstations like Active Book's will be able to network from anywhere in Europe, even when in motion, thus greatly increasing the range and scope of both telecommunications and information technologies.

People should and must be at the center of all these new technologies. As these technologies evolve, the concerns become more complex and demand ever greater attention. But I would argue that there are grounds for optimism. As technologies evolve, so do the methods and theories of design and analysis. New capabilities are emerging, and if you and I so choose, we can reap their full potential by design in human terms. ■

Bill Buxton is an adjunct professor of computer science at the University of Toronto and a consultant for Xerox PARC and Commodore Business Machines. You can reach him on BIX c/o "editors."