

BY CHRISTOPHER M. WRIGHT

Thinking Machin

New interfaces expand technological

In the 1956 science fiction classic *Forbidden Planet*, alien technology was so highly advanced that all one had to do was form a wish, and a task was done. Computers truly had become an extension of the mind. Today, this is not entirely the stuff of science fiction. Brain-computer interfaces (BCIs) permit paralyzed people to select letters on a screen, form sentences, control cursor movements, click on desktop items, operate robotic arms, and steer battery-powered wheelchairs with a simple thought (electrodes read neuron firing patterns in the brain).

BCIs are an outgrowth of the human-computer interaction (HCI) field, which has, since the 1960s, been directed toward making information technology easier for all to use. HCI concepts brought us the graphical user interface and the mouse familiar to any computer user. Today, HCI is producing new interfaces that hold great promise for boosting the productivity of operations management professionals.

A leading light in the field is Ben Shneiderman, founding director of the HCI Lab at the University of Maryland, now in its 25th year. "I used to say to [company leaders] that they could have a competitive advantage by designing a great user interface," Shneiderman says. "Now, I say that they will fall behind their competitors unless they design a great user interface."

Just how far behind these businesses may fall can be gauged by touring Maryland's HCI Lab. Before embarking, however, let's take a quick side trip through some other HCI developments.

How far we've come

There was a time when computers could be instructed only by entering arcane, text-based commands with a keyboard. Since the inventions of the graphical user interface and the mouse at Xerox Park in the 1970s, people have become accustomed to the window, icon, menu, pointing device (WIMP) interface. But things have moved on from there. Post-WIMP and other novel interfaces now can be found in great variety. These include

- voice-directed and pick-to-light systems in warehouses
- virtual and augmented reality for assembly guidance, process simulation, and employee training
- three-dimensional, collaborative, computer-aided design tools
- wearable radio frequency identification tag readers
- online virtual worlds for business use, such as Second Life
- smiling human faces (social agents) that guide customers through online transactions.

Multitouch displays have received a lot of attention lately. CNN used one for its 2008 U.S. presidential election coverage. Another can be seen on the television series *CSI*. "Flicking" to the next menu or photo on an iPhone is another example. People can use their hands and fingers to resize photos, maps, pie charts, blueprints, and other images, then whisk them around wall-like screens measured in feet, not inches.

Another benefit of multitouch is that it enables users to display a lot of complicated data visually. They also can move an irrelevant chart out of the way with a simple hand gesture or rotate a design with two fingers. Conceived as early as the 1960s, multitouch is attracting some big players, including Microsoft and Accenture. The concepts are finding their way into table surfaces, interactive whiteboards, and laptop touchpads, in addition to the devices mentioned earlier.

Reality-based interaction builds on HCI concepts. One example is the illusion of a pliable surface created on an iPhone where some functions are executed by "pinching." Body awareness is another reality-based interaction concept that leverages peoples' skills when coordinating movements. Want to explore the "area" to the left of you while wearing a virtual reality headset? Simply change course on an omnidirectional treadmill.

Meanwhile, back at the lab

Why isn't using a keyboard and mouse always the right way to go? A WIMP interface is suboptimal if you're mobile



es
possibilities

with a small screen or have to wade through vast amounts of information, explains Allison Druin, director of Maryland's HCI Lab. When the lab started 25 years ago, there was far less information going into machines. Now, organizations generate huge amounts of data every day.

How can it all fit onto a single computer screen? This problem has been likened to looking through a keyhole. The small space forces choices—initially, between which information will be displayed first

an interface called Lifelines2, which enables users to identify patterns in a sequence of events that precedes or follows key occurrences. In a pilot project, doctors at a local hospital wanted to know how often the ingestion of a radiological contrast agent, such as barium, was followed by high creatinine readings, which would indicate the possible inducement of renal problems in some patients. Some 3,600 patient records were imported, and each was marked with a colored tag—red for high creatinine readings,

could be summarized with statistical distribution and other tools included in the interface.

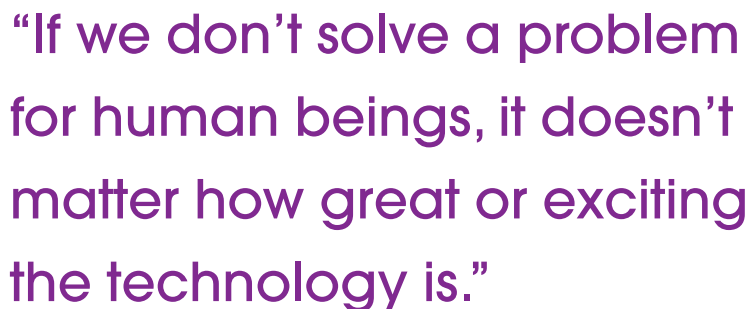
The Lifelines2 visualization interface offers significant advantages over traditional database queries, which are especially difficult for beginners. It can take 30 to 40 lines of text to formulate a 3-step sequence query, the size of the query growing exponentially with the number of events attempted. “For someone who doesn't know [structured query language] that well, what they want to ask may not be what they typed, and it's really hard for them to verify that,” Wang says.

Visualization allows for more intuitive queries. This type of interface also can help manufacturers determine whether and how soon defect rates fall in relation to the date suppliers undertake International Organization for Standardization (ISO) certification. The results might help answer questions as

to whether or not company leaders should require all suppliers to start the ISO process and if seeing the process through to completion is cost-beneficial.

Another interesting tool is a spacetime, or tree structure. Examples of tree structures include the Dewey Decimal System, an evolutionary tree, and even a pyramid selling scheme. Visualize a big chart that looks like an upside-down tree illustrating the hierarchical organization of an encyclopedia, for example. At the top is the encyclopedia itself; on the next level down are branches listing terms such as science and culture. Beneath them are more branches, dividing science into chemistry, biology, physics, and so on. Each of those listings possesses several attributes underneath, thus forming a tree structure.

Given the limitations of screen size, what is the quickest way to get to the information the user wants? What should be presented first? The answers depend on whether you are interested in the overall tree structure or the attributes of particular data points.



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and, next, how to sequence the rest. Effective HCI all depends on the context, Druin says. Every researcher starts with different parameters, and those constraints can change over time, rendering an interface a hindrance later on. Outmoded interfaces can adversely affect productivity as people change the way they work.

These concerns must be balanced with the recognition that pursuing technology for its own sake is decidedly the wrong approach. “HCI starts with the word ‘human’ because, above and beyond anything we do, we are serving human needs,” Druin says. “If we don't solve a problem for human beings, it doesn't matter how great or exciting the technology is. It fails.”

Steep learning curves and hard-to-find features are among the most common frustrations computer users can have. Ease of use is the cornerstone of HCI, and better pattern recognition through visualization is a common theme underlying many HCI-inspired techniques.

HCI Lab doctoral student David Wang and his colleagues developed

blue for normal levels, and green for low readings.

In a demonstration, Wang filtered out the blue- and green-tagged records, leaving the red-tagged records, one to a line, to be scrolled on the screen. Each line was arranged left-to-right in chronological order by the date of the events. Then, he aligned the records by the radiology event—for instance, the date a contrast was ingested. This produced the desired column (everyone's radiology date) straight down the middle of the screen. He entered a sequence query, leaving only those records with a normal reading before contrast and a high reading afterwards, screening out chronic renal failure patients.

The next step was to zoom in on those records where the abnormal reading occurred within two weeks after the contrast date. He ranked the records by the total number of high readings, moving to the top the patients most affected by the procedure. This left 127 records with the most serious cases prioritized for further study. Wang then demonstrated how the data

Spacetrees reveal the overall layout of the data (how an encyclopedia is organized) and the density of the information at each node.

The first screen of a spacetree shows only the first few levels of the tree (sometimes displayed left-to-right). A thumbnail image appears at each node. Its shape and color tell you how dense it is below, both in terms of width (the number of branches at the next level) and depth (the number of levels you will have to drill down before exhausting the entire node). The actual numbers pop up when the user mouses over the thumbnail. Clicking on a node centers that portion of the tree on the screen, and browsing continues from there. Better browsing decisions are made because people can see the size and complexity of a node before wading into it. As for business uses, think of a giant company with many layers of middle management. An organizational chart will not fit on one screen. With a spacetree, it's possible to get a thumbnail view of those departments that have the most layers and, potentially, the biggest problems with red tape.

Treemaps, another visualization technique, start with a large rectangle on a computer screen that is divided into a number of smaller rectangles, the sizes and colors of which depend on the data attributes specified by the user. In a warehousing context, the map could be divided into three columns, representing each of the company's three warehouses. The rectangles in each column might show, in response to a query, only those stockkeeping units (SKUs) that were not shipped on time last month. These could be color-coded to display another attribute—delays of one hour, four hours, and one day or longer, for example. The size could represent the number of on-time failures or the dollar amounts involved, depending on what line of inquiry would be the most fruitful for improving company performance.

Next, users employ a filter or slider to black out those items with less than a one-hour delay, showing only longer delays. It's tough to miss the big red

squares around the items and associated warehouses that cause the most grief. In this way, a treemap enables people to see the biggest problems at a glance. It's much faster and easier than formulating multiple database queries, sorting results, and trying to make sense out of actual numbers. Also, the relationships among SKU, warehouse, and financial impact are more readily apparent.

Invented by Ben Shneiderman in the early 1990s, treemaps are becoming increasingly common. Shneiderman sits on the board of advisors of The Hive Group, an enterprise software firm near Dallas that licenses Maryland's HCI Lab treemap technology. According to Hive's Web site (www.hivegroup.com), major corporations and government agencies use its treemap software to track production metrics, material flow, tool status, quality issues, inventory, and preventive maintenance. The site also lets users play with sample treemaps—sliders and all—in manufacturing and logistics settings.

A new view

Treemaps are among the visualization techniques incorporated into IFS Enterprise Explorer, a new enterprise resources planning interface. IFS has undertaken an extensive study of HCI principles to undergird its usability program, dubbed Aurora. The solution illustrates the difference in productivity a well-designed interface can make. In alpha testing with 16 European customers, a group of people unfamiliar with IFS software were pitted against each customer's fastest and most experienced super user, seated in front of the old interface. The competition involved five tasks, and the newbies won every time.


How did the newbies prevail? Anders Lif, IFS global director of product and industry marketing, says the ability to navigate quickly to a desired form is the key to raising productivity. Because not all information is equally important, initial screens (including treemaps) give a broad overview, plus tools to focus in on what's relevant. The overviews were changed a bit as a result of the alpha testing.

Lif says IFS customers expressed a desire to have more information in the overview windows than firm leaders had anticipated. "Customers really wanted to have one top view that gives them as much as possible," he says.

It proved viable to pack in more features by using colors and graphical elements to highlight the most important points inviting further drill-down. Plus, users can create their own shortcut buttons for routine tasks, and a Google-like, enterprise-wide search engine is included. The search engine can be trained to use internal knowledge about orders, equipment, and suppliers to group search-request results, thus avoiding the common frustration with keyword searches on the Web that produce an unrelated, grab bag of hits—for example, President Ford lumped in with a search for Ford vehicles.

The outer limits

Will technology ever advance to the point that making a wish is all that is needed to get your work done? That would be asking too much; but the interfaces inspired by HCI principles are making it easier for manufacturing and distribution professionals to work with computers and derive business intelligence from company data.

No single interface will prove best at every task. Each—even the humble mouse—will be the optimal choice in certain contexts. While new interfaces may be quicker to navigate, easier to use, and better for pattern recognition and team collaboration, they still are merely tools. It's up to you to figure out how to derive the most value from them. "An interface is only going to do so much," Wang says. "If you don't know what question to ask, the interface won't help you." 

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