Challenges in Human/Computer Interfaces: Making the Technology Serve the User

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In this position statement, challenges in three areas of information and data interface development are considered. These are: *interfaces to the technology* that are used to deliver communication primitives; *interfaces to the presentation* of a single information projection on a particular system; and *interfaces to the abstract information* containing the ultimate message that the technological messenger is trying to present. Since the nature of this statement makes the presentation cursory, I will focus on the needs of the user rather than the potential of the infrastructure.

Living in the Electronic World

The electronic world is starting to become an interesting place. From the comfort of our office or home computer, we can read the newspaper, check stock quotes, play interactive games and find factoids on more topics than we ever thought we were interested in knowing about. We can avoid the crowds at the mall by shopping electronically for everything from salami to sweaters, and when we *must* venture outside, we can book our airplane reservations and rental cars without having to deal with anyone's automated call distribution system. In all these transactions, we can read formatted text and see color images, and (with a little patience) listen to music and speech, and view video fragments—all under control of our index finger.

While this world seems like a very nice place to live—and in many ways, it *is* a very nice place—it brings with it a series of compromises and constraints that reduce the manipulation of *information* to the presentation of *data*. (Here a distinction is made between *information* as an abstract, representation-free entity and *data* as a particular encoding of that information for a particular use.) In the process, hundreds of years of information presentation rules are being replaced with technology-driven data presentation constraints that are based on a lowest common denominator model of computing interface. Using two-dimensional manipulation devices, the user is thrust into a multi-dimensional world of data fragments which are—at best—tied together by one-dimensional hyperlinks: links that connect content without providing context.

The problem, of course, is not in the data stored across the information infrastructure. It is in the interfaces that order, access and consume that data. In the following sections, a brief review of the challenges in making three types of interfaces responsive to the needs of the user is presented.

Interfacing to the Technology

Interacting with a computer used to be a pretty simple task: in the not-too-distant past, you sat behind a modified electronic typewriter and sequentially produced/consumed a set of inputs and outputs based on a simple text interface. The interface supported a rigid interaction protocol that was designed to meet the processing constraints of the technology (sequential, serial I/O) rather than the capabilities of the user.

For many years, much of the focus of interface development was on the refinement of the output device: the CRT has evolved from a low-resolution text display into a graphics display that provides a 2-$^1/_2$ dimensional visual interface [Foley, et al 1990]. At present, the focus of output interface development is to explore the more general use of 3-dimensional displays, augmented with stereo sound capabilities, to support virtual reality output.

Acceptance for changes to the input-side of

the technology interface has been less spectacular [MacKinlay et al, 1990]. It has taken more than two decades for a simple two-dimensional pointing device (the mouse) to augment the keyboard as a standard part of the input interface. And although twenty years is a long time, it is apparently not long enough to determine whether a one-, two- or three-button mouse best serves the needs of our five fingers. In this context, it is not surprising that a general move to three dimensional input has yet to begin in ernest, in spite of the fact that various types of three-dimensional manipulation devices (such as three-axis joysticks, which used to be a standard part of the 3-D graphics user interface) have been available for decades.

The primary challenge in the development of the technology interface is the need to balance the capabilities of the input and output interfaces. In particular, the parallelism in real life that is starting to be modeled at the output interface will need to be mirrored by an increased parallelism at the input interface.

The integration of parallelism into the input interface will not necessarily require a new generation of computer users: there are many examples of user interfaces from "real life" in which parallelism is commonplace. Consider the actions required to make a left turn in a left-hand drive, standard-transmission automobile:

- the eyes and ears need to scan for conflicting traffic;
- the right hand needs to select the appropriate gear;
- the left hand needs to engage the turn signal (although in many places, this is an option);
- the steering wheel needs to be turned;
- the left foot is used to manipulate the clutch; and
- the right foot is used to manipulate the accelerator and/or the brake.

(In the United States, this activity is often supplemented by the need to balance a donut and a cup of coffee, while in many parts of Europe 'turn time' is seen as an appropriate moment to further engage the hands/eyes/mouth in offering constructive suggestions to nearby motorists and pedestrians.)

The point of the example is not that driving is difficult—with a bit of training, most motorists can do it safely most of the time. The point is that the technology-imposed constraint of sequential input from one or two serial sources limits the effectiveness of human/computer interaction. (Anyone who has used a PC-based automobile or flight simulator knows this all too well.) Unlike real cars or professional simulators, a modern PC is a multi-purpose tool that needs to be configured for many uses. Defining a generic but flexible input interface that matches the abilities (and disabilities!) of the user is perhaps the greatest interface challenge facing the HCI community.

Interfacing to the Presentation

Where technology provides the physical facilities available to a user, the presentation interface determines how the physical interfaces can be combined to control a particular flow of data.

Most "current" computers provide a mechanism for presenting information of various types: text, images, audio files, videos, etc. Such support for multiple independent media has served as a catalyst for the support of *multimedia*. The key distinction between multi- and multiple-media is the degree of coordination among media during presentation.

Under various circumstances, it may be appropriate for media coordination control to be defined by the multimedia author. At other times, the end user may best control the presentation. On the Web, presentation control is usually removed from both author and end user, and placed in the local browser—probably the least appropriate place to put it, from a presentation-quality control perspective.

The challenge in designing future presentation interfaces is to allow a particular presentation to be scaled to match the capabilities of a particular presentation environment [Bulterman, 1995]. In current-generation systems, little incentive is given for users to step up to high-end presentation devices, since very little tailorability and adaptability of presentations are supported. To return to the automobile example, above: car manufacturers and marketing departments have successfully moved

from a single standard model—the Ford Model-T in basic black—to a wide range of products that can be targeted to the need/desires of the user. All models get you from A to B, but top-end models do so with greater style, comfort or safety.

In the multimedia world, we are not defining systems that are responsive to the needs of high-quality users. Time-based media are supported by accident rather than design: fast processors with spare cycles can only pump out CD-quality audio when little else is happening on the system, but when multiple short videos and high-quality text needs to be displayed, time-sensitive data suffers. The issue here is that control over the quality of the presentation needs to be given to the author and the user: the system has the responsibility to implement user policies/desires, but should not enforce its own content-free assumptions about how information fragments are related.

Interfacing to Abstract Information

Raw presentation support can provide access to data, but facilities must also be available to allow users to access information in a form that is appropriate to the context of their needs. The current use of hypertext technology does not scale well to a rich environment of multimedia data. True *hypermedia*, where references to related pieces of coordinated multimedia information can be semi-automatically defined, is still in its infancy [Hardman et al 1994].

The problems at this top level of the information hierarchy span a range of interface issues: placing content-based anchors in non-text encodings; integrating information from several sources with preservation of context; providing access charging models that serve as an incentive to make information available (and protect the rights of the content owners) rather than limiting use based solely on economic power; providing adaptive delivery systems that can tailor the quality of the data presented to the resources available locally and globally; content-based access, where the definition of content relations can change as a function of user interests or historical use; and scalability of presentations, so that browsing can be efficiently separated from detailed information consumption.

The added value of computer-based information access should not only be the transport of data fragments from world-wide sources to the home or office. It should be the ability to filter, integrate and associate data so that the user is able to get focused information from the information infrastructure.

Summary

The development of the human/computer interface has many facets. The current generation of devices and presentation tricks has provided a basis for experimentation, but a next generation of interface tools needs to be developed that is less centered on available technology and more on the basic needs of information communication. From our perspective, the problems have less to do with device development than integrating time and quality as first-class attributes of how information is saved, presented and integrated. The promise of multimedia computing may be that control over interaction will move from the implementor to the user—but before that happens, the user needs to be empowered with control mechanisms that allow information and not just raw data to be manipulated.

References

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