

Laying the Foundation for the Information Super Highway: Human-Computer Interaction Research

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Introduction

On June 13th, the University of Maryland's Human-Computer Interaction Laboratory held its 11th Annual Symposium and Open House, attended by 100–200 visitors. This article reviews the day for those who were unable to attend.

The HCIL, headed by Ben Shneiderman, is one of the oldest laboratories devoted to human-computer interaction, and it continues to be one of the most productive and interesting to visit. The HCIL is a part of the University of Maryland's Center for Automation Research, directed by Azriel Rosenfeld. The HCIL includes labs in the Computer Science Department, Psychology Department, and the College of Library and Information Services. The open house gave us the opportunity to hear about their current progress, to try out their new interfaces and devices, and to meet the researchers that make up the lab.

The Open House began with a series of talks in the morning, followed by demonstrations in the afternoon. Several talks and demos described ongoing areas of study in the HCIL—such as dynamic queries, treemaps, pixel programming, electronic classrooms—while others discussed new areas of research—role manager, network management, video on demand. The talks were presented in three sections:

- 1 Information Seeking, hosted by Gary Marchionini from the College of Library and Information Services,
- 2 Future Graphic Interfaces, Catherine Plaisant of the Center for Automation Research, and

3 Interface Design Issues, Kent Norman from the Psychology Department. Many of the speakers were graduate students working on the projects, and they did an excellent job presenting their work. The talks were brief, interesting, well presented, and clearly very well rehearsed.

We will describe some of the highlights of the talks we heard. More detailed technical reports on all of these projects are available from the HCIL (contact information appears at the end of this article).

Session I — Information Seeking

Gary Marchionini, Associate Professor in the College of Library and Information Services, chaired the first session, which included papers on how users access data.

Is Easy-to-Use Enough for Information Retrieval? An Evaluation of WAIS (Wide Area Information System).

Gary Marchionini presented the results of a study examining a WAIS system to a standard Boolean-based search (BBS) system. Gary found that the WAIS system was very learnable and usable. However, he stated that users showed higher recall and precision using the BBS system. Implications of this study include the question, "what strategies and evaluation metrics are useful?"

How Do Users Organize Their Files?

Deborah Barreau presented a study on why users organize their files and directories the way they do. Deborah found that classification decisions in electronic environments are influenced by many of the same factors which influence classification in a paper environment. Categories created for documents in

electronic environments are highly personal and dynamic. She stated that opportunities exist for the design of better tools to support efficient storage and retrieval of electronic documents.

Evaluating a Small Hypertext as a Medium for Learning. Scott A. Butler presented a user study that evaluated the effects of different textual organizations and the use of an advance-organizer. An advance organizer is a method of providing a framework into which a user can store information by providing conceptual overviews of material in advance of the presentation of that material. He found that participants in the hypertext condition flipped through more pages of text, while still completing the task in about the same amount of time compared to participants in the linear and random text conditions. However, participants also reported that they felt disoriented more frequently in the hypertext than in the linear text conditions. Scott is planning a follow-up study with a larger and more complex learning domain.

Treemaps for Hierarchical Data Visualization: Mature Technology for Real Tasks.

Marko Teittinen presented his research in the area of extending the University of Maryland's Treemap hierarchy visualization technique. Treemaps are a variation of standard hierarchical trees that attempt to display as much data as possible in a small, yet usable area. All nodes are displayed as rectangles; children are displayed inside the representation of their parent. Marko's version of TreeMaps separates data and visual representation, allowing the user to manipulate many parameters that control how the tree is displayed. The area of the

rectangles are proportional to some attribute of the node. Marko demonstrated this new ability with data from a real user's hard drive. Marko claimed that a user can find files with particular attributes much easier with this form of hierarchical representation. We were told that Marko's implementation of treemaps for browsing and manipulating MS Windows 3.1 files and directories is now available (\$25 from the University of Maryland's Office of Technology Liaison, 301-405-4209).

Visual Information Seeking: Tight Coupling of Dynamic Query Filters with Starfield Displays.

Ben Shneiderman discussed three principles for visual information seeking:

- dynamic queries,
- starfield displays, and
- tight coupling to preserve display invariants.

Dynamic queries involve direct manipulation in query formulation and output, sliders to set ranges, buttons to make choices, and rapid two dimensional output. Starfield displays are complete visual overviews of the data field. Tight coupling is a term describing consistency through linkage among components of an interface, in addition to the ability to have output become input and details-on-demand. He stated that these three principles, when used properly, can be combined to create an intuitive and interesting visual information seeking system. As an example, Dr. Shneiderman played a video clip demonstrating the University of Maryland's FilmFinder application. Finally, Dr. Shneiderman stated the Visual Information Seeking Mantra: "Overview, zoom and filter, and finally details-on-demand." By following these three steps, the detail of information presented to the user can be managed to prevent visual clutter.

Session II — Future Graphic Interfaces

Catherine Plaisant, Assistant Research Scientist at the HCIL, chaired the second session, which included four papers covering various issues in graphical users interfaces.

Role Manager: Window Environments for Managing Long-Term Projects.

Catherine Plaisant presented an alternative approach to managing the overhead of window management that tends to reduce users' time for working on their jobs called the Personal Role Manager. This system is designed to structure the screen layout and the interface tools to better match the multiple roles that individuals have in an organization. Each role has a vision statement, schedule, hierarchy of tasks, set of people, and collection of documents. Catherine stated that the Personal Role Manager will automate many window management tasks, direct effort toward the stated vision, and facilitate description and transfer of roles.

Programming Graphical Macros with Pixel Pattern Matching: Universal End-User Programming for Free.

Richard Potter presented a system that seeks to implement end-user programming based on pixel pattern matching. Since much of a given application's state is made explicit to the user through visual feedback, this state is therefore also available in the pixels present on the user's screen, and by use of pattern matching techniques these pixels can be identified and acted upon. The technique is completely application-independent since all applications write their pixel output to the frame buffer. Richard interactively constructed numerous graphical macros, including macros to detect and act on error messages generated by a compiler, to find text-only versions of documents and drag them to the trash can, and to identify and shorten lines in a MacDraw application. Richard will be continuing his research by conducting a user study and designing further enhancements.

Lessons from the Widget Carvers of College Park.

Richard Chimera discussed the results from the Widget Carvers project at the University of Maryland. The group has been very happy with the Galaxy Application Environment and have created six new widgets for it; the Secure Toggle Switch, Range Slider, Alpha Slider, Tree data structure, Treeview, and Treemap. David Carr followed Richard and discussed Interaction Object Graphs as a methodology for specifying widgets and

small dialogs. This method utilizes three major concepts:

- a model of the user interface,
- an event description language, and
- a hierarchical state diagram.

David stated that Interaction Object Graphs can be used to precisely specify a widget in terms of the time sequence of the interface behavior, in addition to simply the graphical layout.

Visual Information Management for Satellite Network Configuration.

Harsha Kumar gave a preview of a possible interface for the next generation of network management systems. Harsha discussed the design methodology for creating such a system. Task-Oriented approach to design, compact overviews for the data and the task, dynamic queries, and an unified interface were concepts that Harsha stressed were important. His prototype for an existing network management system would reduce the number of screens from approximately 200 to somewhere around 20-40 individual screens.

Session III — Interface Design Issues

Kent Norman, Associate Professor of Psychology, introduced the final session of talks by stating that menu selection, ease of selection and dragging, additional input channels, GUI design techniques, and splay menus are still very important issues in interface design. The three papers in this session discuss research on these issues.

Dynamic Control/Display Ratios for Computer Pointing Devices.

Blake Sobloff introduced a new metaphor for pointing devices called DynaPoints. DynaPoints are characterized by a combination of a "universal" snap-dragging combined with a context-sensitive control/display ratio. Blake stated that DynaPoints should increase speed and accuracy of pointing movements by dynamically varying the behavior of the device in a "context aware" manner. A user study to test this hypothesis by comparing a fixed (generic mouse driver), velocity dependent (standard Macintosh), and context dependent (DynaPoint) control/display ratios is planned for the near future.

Enhancing Selection in Splay Menus with Color and Spatial Cues.

Ben Harper discussed the application of perceptually driven spatial and color cues to promote the use of fast parallel searches in splay menu selection. Possible applications include splay menus on systems with abundant screen space, point-of-sale terminals, dedicated instrument interfaces, and virtual reality interfaces. Ben is planning a user study in the near future to explore these issues.

Locus and Forms of Interaction as Determinants of Lecture Effectiveness in the Electronic Classroom.

Diane Lindwarm Alonso described an experiment to determine whether the ability to interact with technology and to run in-class, real-time simulations provides an advantage over other less interactive forms of instruction to students in the lecture environment. This study will be conducted at the University of Maryland's AT&T Teaching Theater. Dr. Alonso's hypothesis is that learner-controlled, highly interactive simulations will have the highest performance level and will provide the most stimulating environment, followed by learner controlled simple interaction, instructor controlled highly demonstrative, and instructor controlled simple interaction situations.

Demonstrations

Following the final talk, the research labs in the Computer Science Department, Psychology Department, and the College of Library and Information Services opened their doors for public demonstrations. Most of the presenters from the morning talk sessions were present to discuss their research in detail and provide live demonstrations. A few projects which were not part of the morning's talks were also demonstrated.

The Mole: A Foot Controller for Computers.

This joint project by Dr. Nancy Anderson of the HCIL and Dr. Glenn Pearson

of Civilized Software, Inc. provides an alternative means for users to specify on-screen cursor positions. The input device consists of a small platform which supports the ball of the foot, while the user's heel remains in contact with the floor. The platform slides left-right along a pair of bars, which in turn slide up-down along a pair of tracks (similar to the way a train car rolls along railroad tracks). Position is detected by rotary encoders which turn as the platform is moved. The input device acts as a relative-positioning device: the user can press a foot switch or "clutch" with his or her other foot, allowing temporary disengagement of the Mole's physical motion from the on-screen cursor location. The device has an innovative design which allows capture of not only gross leg movements but also fine-grain movements of the foot (by separately encoding the tilt of the small platform). The investigators envision application of the device to hands-free computer use in conjunction with speech recognition, to improving computer access to handicapped users, or possibly even as a device that could be used in parallel with the user's mouse and keyboard to control coarse-grain tasks (such as scrolling through a document).

Touchscreens.

Maryland's innovative work with touchscreens was not on the official HCIL open house agenda, but Richard Chimera (soon to be leaving HCIL to found his own company) was kind enough to demonstrate the touchscreen to us. Maryland's key innovations include:

- 1 invention of the "lift-off" touch strategy (which allows the user to drag a finger around on the screen and then lift off to select a target, instead of immediately selecting the target that the user first touches),
- 2 decoupling of the finger position and the cursor position (by displaying a small cross-hair above the user's finger, thereby allowing targets smaller than the user's finger to be selected), and

- 3 stabilization of the touchscreen cursor position, which allows very small touchscreen targets to be selected.

The techniques are natural, intuitive, and fun to use—many spectators literally had trouble taking their hands off of the demonstration programs.

Conclusion

The theme of this year's open house was "Laying the Foundation for the Information Super Highway: Human-Computer Interaction Research." Nevertheless, it is difficult to ascribe an overall theme to the day, since it encompassed so much diverse work from several dozen researchers across several different departments. One emergent theme is user control. We heard a great deal about control panels, visual information seeking, highly interactive query methods—and almost nothing about interfaces that "do everything for you automatically." The emphasis was on presenting the user with more options and providing more awareness of the situation—rather than on agents or "intelligent" interfaces.

In a nontechnical vein, the overall theme that emerged from this visit is that these people really like what they're doing. Everyone we met showed great enthusiasm for the group and for the work they are doing. Ben Shneiderman describes their overall mission as making the world "a little warmer, a little wiser, a little safer," and he has infused his laboratory with enthusiasm and zeal to accomplish this mission.

For information about the HCIL and to order videotapes, please contact:

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