CISE Research Infrastructure Grant CDA-9303152
Interactive Accessibility

Department of Computer Science
Virginia Tech

Year - 5 Progress Report
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The Research Program:

Our major goal for this year was to upgrade the departmental networking infrastructure to support rapidly growing needs in HCI, videoconferencing, digital libraries, and educational technologies. Major proposals were submitted in the areas of digital libraries and problem solving environments to support the integration of human-computer interaction techniques in these domains. Work is continuing in educational technologies, both at the university level (here described in conjunction with the digital libraries work) and at K-12 level in cooperation with the Montgomery County School System. Research work in virtual environments is expanding rapidly now that the new CAVE™ at Virginia Tech is operational. Considerable empirical work is underway in areas of remote evaluation, usability, digital libraries, data visualization, and industrial inspection.

Networking

One of the goals of the original Research Infrastructure plan was to provide funds to upgrade the departmental networking infrastructure during the last two years of the project. After much negotiation with the University's Communications and Network Services group, it was concluded that since the CS and ISE departments were the largest networking consumers on campus, it made sense to make these University-wide testbeds, beginning with the conversion of the campus networking backbone to ATM/OC3. Agreement was reached to convert every Ethernet port to 10Mbit 10-base T switched Ethernet, and that work was completed several months ago. Upon demand, any of the building hubs can be converted to 100Mbit hubs, and ATM access is now readily available.

Since this has provided the data rates and reliability we sought originally, we have shifted our emphasis to obtaining ATM-capable standards-based videoconferencing equipment for our new conference room, which would provide us with links to our Northern Virginia campus and to research partners across the country. Unfortunately, videoconferencing technology continues to change rapidly, and we are waiting as long as possible to make our purchases to ensure quality technology that is compatible with our potential conferencing partners. VTEL, PictureTel, and Zydacron are vendors under active consideration.

K-12 Educational Technologies

This year marked the last for the LiNC project and the second year of the PCs for Families project. Both of these projects have benefited from the Research Infrastructure which has provided video conferencing, video recording and editing, and server support which would have been otherwise difficult to obtain.

The LiNC project **(http://simon.cs.vt.edu/nie-public/)** has created and is evaluating a K-12 infrastructure for constructing and conducting experiments in a virtual laboratory. It has developed software and other tools to support real-time collaboration between remote locations, and examine the online interactions between students of differing grade levels and in differing locations. The project team has invested much effort to study the participatory design process by means of which teachers work with software specialists and designers to create educational software for their students. On the software side, important advances have been made to our understanding and tools for creating synchronous Java-based collaborative WWW-based applications.

The PCs for Families program **(http://pixel.cs.vt.edu/edu/fis/)** is attempting to determine whether, under the best of circumstances, access to networked computing by both students and their families has measurable effect upon long-term student achievement. Initiated September 1, 1996, the program leverages the resources of our community network, the Blacksburg Electronic Village. A 5th-grade classroom has been designed at Riner Elementary School, a national Blue Ribbon School, with a networked computer for every two students. Virginia Tech is lending a computer for an extended period of time to the family of each student in the program. That will enable the students to work at home with their families in the same way that they do at school. A constructivist curriculum was designed to encourage reading, writing, exploration, collaboration, and critical analysis. Parents are trained in networked computing along with their children, and extensive data is being collected to determine the effects of the program on families, children, and teachers.

Virtual Environments

In this final year, Hix has acquired equipment that will largely facilitate three major projects. The first is an on-going project between Virginia Tech and the Naval Research Laboratory in Washington DC. We are studying techniques for user-based navigation through a virtual world map. The map currently is presented on a Responsive Workbench and on a desktop. We are comparing strategies for navigation, including the role of head-tracking. This grant purchased an Ascension Flock of Birds that we are using in this sizable project. The second is a collaborative

virtual environment application that is studying how users get a sense of presence and awareness of each other in VEs located at different physical sites. A pair of wireless phones were purchased with NSF funds to enhance this work and make it possible for participants to work unencumbered by wires in our CAVE™. The third is an interdisciplinary project among Hix (in Computer Science) and collaborators from the Virginia-Maryland Regional School of Veterinary Medicine and Virginia Tech's Instructional Design Department. This project is developing enhanced learning applications for teaching veterinary medicine students to generate problem lists leading to possible diagnoses, based on patient laboratory data. This grant provided a high-end Macintosh G3 for this project.

During this past year, the virtual environment (VE) research across the University has greatly expanded, for example, developing a VE for determining defects in particular kinds of molecular structures, developing a virtual planetarium through which a spaceship is ridden, studying the effects of design in virtual environments, etc. Further, we are incorporating an eye-tracking system into the CAVE™; we believe ours to be the only CAVE™ in the world with this capability. VE evaluation work with the Naval Research Laboratory in Washington DC is ongoing, exploring user navigation in the Marines' Sea Dragon VE project. A virtual environment laboratory has been established in ISE which provides a capability for using haptic responses and spatialized sound in VE. Our system manger is now transitioning to managing VE hardware and software in the CAVE™.

Digital Libraries

During the course of the RI grant there has been wonderful synergy between infrastructure support and activities in the teaching and research arena. In particular, the EI grant, funded 1993-96, has been extended with supplements to end July 31, 1998. Throughout its course there have been extensive benefits to the teaching and research efforts of the entire Department of Computer Science, ending up with:

- over 40 courses online with over 10K WWW files **http://ei.cs.vt.edu/courses.html**
- 11 million accesses worldwide
- a successful workshop summer 1997, with nationwide attendance
- a WWW site with information on all EI projects nationwide **http://ei.cs.vt.edu/~csei/**
- a WWW site of courseware on digital libraries **http://ei.cs.vt.edu/~dlib/**

Over the RI period the Network Research Group, led by Abrams and Fox, developed thanks to a 3 year NSF grant on caching and prefetching, as well as WWW characterization. This has led to collaboration with the W3C and its HTTP- Workload Characterization Group since Fall 1997. During the 3rd year of that effort, and thanks to a new $5K REU supplement, a small digital library of log files, tools, and publications in this area will be developed.

Over the period 1997-98 the following were accomplished with RI aid:

- The Information Access Laboratory housed several research groups related to digital libraries and network research.

- The Information Access Laboratory supported class projects in CS6604, Digital Libraries, Fall 1997 and the Spring 1998 course, CS4624, Multimedia, Hypertext and Information Access.
- The collaboration room, 104c, served as classroom for Honors 3004, Fall 1997, on Digital Libraries.
- Support was provided, through equipment and use thereof, for the Networked Digital Library of Theses and Dissertations, which grew to over 1100 items in the collection, and to 39 members, scattered around the world: **http://www.ndltd.org**
- A new grant was awarded from NSF DUE on Curriculum Resources in Interactive Multimedia, for 2 years: **http://ei.cs.vt.edu/~crim/**
- A subcontract from The College of New Jersey was awarded, since they received an NSF DUE award on the Computer Science Teaching Center, for 2 years: **http://ei.cs.vt.edu/~cstc**/
- A proposal was submitted to University of South Florida which served as coordinator for a KDI proposal to NSF, about improving the quality of electronic theses and dissertations.
- A proposal was submitted to NSF for their Digital Libraries Initiative, Phase 2
- IBM was approached under their SUR program for a donation of equipment to help with digital library efforts. At least $120K will be given in 1997, which adds to the $650K given in 1995 and 1996. More than $300K other equipment will be given to Virginia Tech that will complement the $120K with networking equipment and other cognate facilities around campus.
- A proposal was submitted to the Virginia Center for Innovative Technology (CIT) by a consortium of 4 universities in Virginia, to establish an Internet Technology Innovation Center (ITIC). This proposal was reviewed in a final round for selection, and prospects are excellent for a $2M award.

In summary, the EI project, supported by RI, has completely changed the way students learn computer science at Virginia Tech, and has supported millions of accesses around the world. This has led to two new DUE grants and ongoing involvement in national efforts relating to CS and digital libraries.

Other digital library activities also have had international impact, especially as the Networked Digital Library of Theses and Dissertations, led by Virginia Tech, expands. In Fall 1998 the CS Department will host a seminar series on digital libraries. If the DLI2 proposal submitted is funded, it will establish digital libraries as a key area of research of the department, and involve scores of faculty, students and staff around campus as well as diverse partners around the world.

UMRL - Usability Methods Research Laboratory:

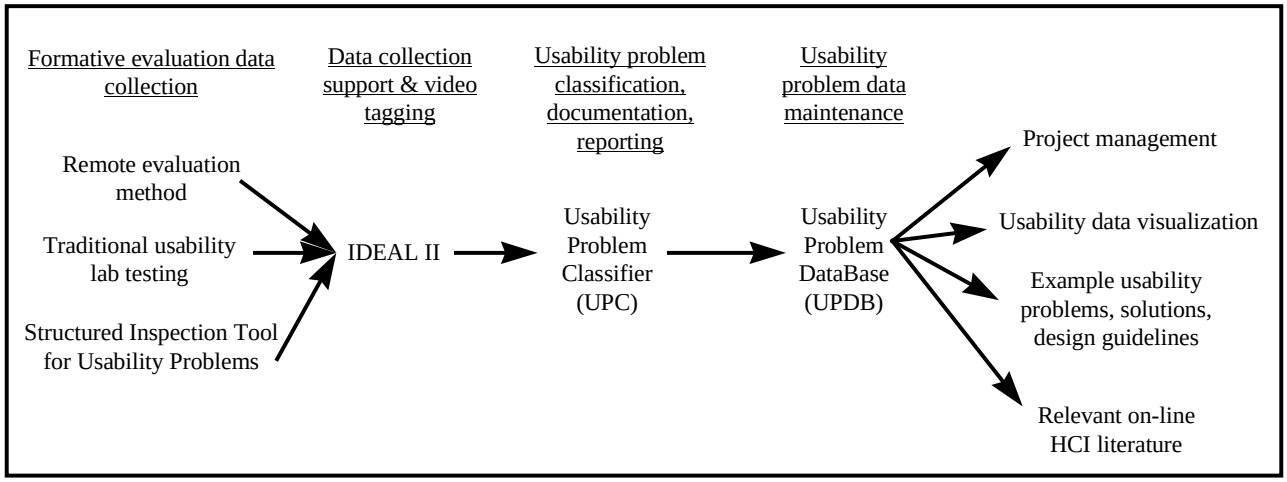

Figure 1 - Overview of current conceptual work in usability methods.

Remote usability evaluation method: We have developed the User-Reported Critical Incident Method for remote usability evaluation to include the network and remote work setting as intrinsic parts of usage patterns. Because most software applications have a life cycle extending well beyond the first release, remote evaluation also allows formative evaluation to continue downstream, after implementation and deployment. Our method is based on self-reporting of critical incidents by remote users via a Web-based reporting tool. Our recent studies show that users with no background in software engineering or human-computer interaction, and with the barest minimum of training in critical incident identification, can effectively identify, report, and rate the severity level of their own critical incidents.

Usability lab testing: In conjunction with the NSF Research Infrastructure grant, Virginia Tech has built state-of-the-art usability evaluation laboratories for developing new usability evaluation methods and for training students in existing methods.

Structured Inspection Tool for Usability Problems (SIT-UP) We are developing a new usability inspection method for very early evaluation of usability in design sketches, prototypes, and implemented systems. The structure of SIT-UP heuristics (the questions that drive an inspection) are structured identically to the classification types within the Usability Problem Classifier, since both are based on the User Action Framework (described below). Thus, when a usability problem is identified in SIT-UP, classification within the Usability Problem Classifier is automatically mapped into the corresponding part of the UPC structure.

IDEAL II: We are planning to construct a follow-up to our original tool for quantitative and qualitative data collection and video tagging. Thus, IDEAL II will be used to gather records of critical incidents, indicators of usability problems in interaction design, that occur during usability evaluation of user task performance. Most of the features of the original IDEAL will be retained in addition to the use of digital video technology in place of videotape and voice recognition technology for automating transcription.

Usability Problem Classifier (UPC): The UPC is a Web-based tool for classifying each usability problem within a hierarchical taxonomy of usability problem types.

Usability Problem DataBase (UPDB): Each node of the Usability Problem Classifier has links to a Web-based Usability Problem DataBase tool which supports: storage and retrieval of usability problem data by project and across projects generalized sample usability problems and sample solutions to illustrate similar design situations and help in finding fixes project management life cycle documentation for history of treatment of usability problems (cost-benefit analysis, approval signoffs, action taken, cost of fix, resulting effect on usability in further testing) usability data visualization to identify clusters of usability problems within particular parts of the usability problem space (e.g., multiple problems that appear different on the surface but which are of the same underlying type could be an indicator of a factor needing improvement in the development process) links to relevant (to each usability problem type) on-line HCI literature in a digital library and on the Web

User Action Framework (UAF): As we worked with the Usability Problem Classifier, Usability Problem DataBase, Systematic Inspection Tool for Usability Problems, and a method for organizing design guidelines, we noted that each tool required an organizing structure similar to the one we had built into the UPC based on usability problem types. But in each case the content needed to be adjusted to reflect the perspective of the specific tool. We factored out a common core conceptual framework of usability concepts and issues, expressed in more general and abstract terms than those required by any specific tool. As a theory-based foundation, we developed an adaptation and extension of Norman's seven-stage theory of action which provides high level organization and entry points to the common structure of usability concepts. The net result we call the User Action Framework.

The UAF is then specialized into a given tool (e.g., SITUP or UPC) via a mapping that maps each node of the abstract UAF contents to a tool-specific expression. The UAF owns the content and structure, and the methods and tools embody expressions of the UAF. The mappings are a kind of element-by-element linguistic translation. We see this as a future opportunity for semi-automatic translation work.

Video Prototype of Integration: These methods and tools currently exist in various stages of development, some only conceptual. We have developed a videotape prototype tying most of them together in our vision of integrated support for interaction development (as opposed to tools for user interface software development).

Use of the research infrastructure and equipment purchased under the NSF/RI contract resulted in several thesis research projects in Industrial and Systems Engineering directed by Dr. Williges during this past year. All of the equipment was instrumented in a research laboratory to allow controlled testing and experimentation on human subjects. A new research project was started to evaluate the usability of a voice interface for E-mail was initiated and will use some of the methods developed in the UMRL to include both auditory and visual user interfaces as well as laboratory and remote usability testing. We used the virtual reality equipment to conduct a thesis

to determine negative side-effects while using virtual environments (McGee, 1997). We investigated the effects of age and field-of-view on spatial learning in an immersive virtual environment (McCreary, 1998). Additonally, Satanek (1998) conducted a laboratory experiment designed to evaluate three types of navigational techniques for retrieving and browsing complex file structures characteristic of modern sophisticated web pages. The three techniques were one-dimensional, two-dimensional, and perspective three-dimensional representations. We were interested both in the best overall navigation procedure as well as individual differences among people using these techniques.

IAL - Information Access Laboratory:

Work initiated in previous years to create a worldwide digital library of theses and dissertations is expanding, as are efforts to create and integrate multimedia digital libraries into the university-level curriculum. Due to the number of participating students and the amount of equipment, the IAL ran short on space. The University agreed to provide off-campus space at the Pointe West Commons, and the IAL is now located there. We have now negotiated an agreement with the University's Learning Resources Center to create in the vacated space a Center for the Development of the 21st Century Classroom, in which the RI investigators and the Computer Science Department will have an opportunity to experiment with the most advanced multimedia learning environments available.

Equipment:

So far this year, major expenditures have been made this year for Pentium II workstations and servers and server upgrades. Dr. Hartson has collaborated with two startup companies which are producing professional versions of IDEAL, our experiment management facility. Now called Portable Usability Laboratories, we have purchased one of each product from Triangle Research and from UserWorks so that we may use them ourselves and also take them into the field to collect data remotely. Other significant expenditures include magnetic media for the mass storage server obtained in the past year from IBM, presentation equipment, and portable multimedia computers.

Plans for Next Year:

Two emerging research areas seem to warrant follow-on human-computer interface research based on these laboratory investigations. These areas include (1) design of usable digital libraries, (2) applications of virtual reality displays in industrial manufacturing, and (3) usability methods and tools.

Currently, we are extending our initial investigation of enhanced electronic browsing by developing a demonstration of a way to browse electronic libraries using true three-dimensional representation on desktop computer workstations. We are using the Electronic Thesis and

Dissertation Project at Virginia Tech as our database. Rather than use the standard web query system to find a particular document by author or title, we organized the listing in a three-dimensional world configured around colleges and departments within the university linked via an electronic roadway to enhance browsing. With a three-dimensional controller the user can navigate throughout this electronic world of theses and dissertations. Subsequently, the complete document can be accessed electronically and read on-line. Other ways to improve electronic libraries need to be considered in order to improve visualization and representation. They include (a) alternative metaphors for library representation, (b) completely immersive three-dimensional environments, (c) personalized electronic libraries, (d) on-line consultation, and (e) multimedia browsing. We believe we have an excellent chance to obtain a 5-year NSF DLI/2 grant in the coming year. This work will focus on users, use, and usability, and will be the culmination of our efforts to unify the HCI and Digital Library thrusts at Virginia Tech as originally proposed in our original Research Infrastructure proposal.

We also made an initial attempt to extend our use of virtual reality display technology by using a see-through, augmented-reality display to improve industrial inspection. The results of this demonstration study showed that inspectors who used an augmented-reality display could complete their inspection of part thickness 2 to 3 times faster than manual or computer-presented inspection with no loss in inspection accuracy. Augmented reality displays can be used to improve various aspects of industrial manufacturing. Areas the hold the most promise and require additional research include (a) quality inspection, (b) industrial assembly, (c) plant layout, (d) mechanical repair, (e) maintenance, and (f) industrial training.

Finally, a team of investigators has formed to attack the human and technical problems associated with collaborative problem solving for large scientific problems. The work stems from the observations that (1) it is difficult to integrate codes from multiple, diverse disciplines developed by a divers group of people on a multitude of platforms at widespread locations, (2) it is difficult to share software between potential collaborators in a multidisciplinary effort, and (3) current tools for synchronous collaboration are inadequate. The goal is to help scientists and engineers make the best use of their codes and computing resources while improving collaboration in multidisciplinary work.

Budget:

Research expenditures are exactly as planned. The budget balance as of June 30, 1998 was $114,000, with 7 months remaining in the project. Major expenditures in the remaining 7 months of the project include:

Videoconferencing equipment for the Teleconferencing Laboratory
High quality color cameras and microphones
Digital video camcorders and playback deck

APPENDIX

Infrastructure-Related Publications:

Abdulla, G., Fox, E.A., Abrams, M. (November 1997). Shared user behavior on the world wide web. Proc. WebNet 97. Toronto, Canada.

Begole, J., Struble, C.A., Shaffer, C.A., and Smith, R.B. (October 1997). Transparant sharing of Java applets: a replicated approach, Proceedings of UIST'97. Banff, Alberta, Canada, 55-64.

Carroll, J.M. (Ed.) (1998). Minimalism beyond the Nurnberg funnel. Cambridge, MA: MIT Press.

Carroll, J.M. 1997. Toward Minimalist training: Supporting the sense-making activities of computer users. In QuiFlones, M.A. and Ehrenstein, A. (Eds.), Training for a rapidly changing workplace: Applications of psychological research. Washington, DC: American Psychological Association, 303-328.

Carroll, J.M. (1997). Scenario-based design. In M. Helander and T.K. Landauer (Eds.) Handbook of Human-Computer Interaction, Second Edition. Amsterdam: North Holland, 383-406.

Carroll, J.M., Rosson, M.B., Chin, G., and Koenemann, J. (1997). Requirements development: stages of opportunity for collaborative needs discovery. Proceedings of DIS'97: Second ACM Symposium on Designing Interactive Systems (Amsterdam, 18-20 August). New York: ACM Press/Addison-Wesley, 55-64.

Carroll, J. M., Rosson, M. B., Chin, G. and Koenemann, J. (1997). Requirements development: stages of opportunity for collaborative needs discovery. Proceedings of DIS'97. New York: ACM 55-64.

Castillo, J.C., Hartson, H. R., and Hix, D. (April 1998). Remote usability evaluation: can users report their own critical incidents? Proc. SIGCHI'98. Los Angeles, CA.

Chin, G. and Rosson, M. B. (in press). Progressive design: staged evolution of scenarios in the design of a collaborative science learning environment. Proceedings of Human Factors in Computing Systems, CHI'98 Conference. New York: ACM, 611-618.

Darken, R. and Hix, D. (March 1998). Usability evaluation methods in a new medium. Proc. Virtual Reality Annual International Symposium (VRAIS) 98. Atlanta, GA.

Ehrich, R.W., McCreary, F., Reaux, R., Lisanti, M., Rowland, K., and Ramsey, A. (June 1998). Design of technology-based learning environments that support both teachers and students. Proc. 1988 National Educational Computing Conference. San Diego, CA.

Fox, E.A. and Marchionini, G. (April 1998). Toward a worldwide digital library. CACM 41(4), 28-32.

Fox, E.A. (November 1997). Networked digital library of theses and dissertations: an international collaboration promoting scholarship. ICSTI Forum 26, 8-9.

Fox, E.A., Hall, R., Kipp, N. (1997). NDLTD: Preparing the next generation of scholars for the information age. The New Review of Information Networking 3, 59-76.

Fox, E.A., Hall, R., Kipp, N., Eaton, J., McMillan, G., and Mather, P. (November 1997). NDLTD: Encouraging international collaboration in the academy. DESIDOC Bulletin of Information Technology 17(6), 45-56. 3, 59-76.

Fox, E.A., Eaton, J., McMillan, G., Kipp, N., Mather, P., McGoigle, T., Schweiker, W., and DeVane, B. (September 1997). Networked digital library of theses and dissertations: an international effort unlocking university resources. D-Lib Magazine, The Magazine of Digital Library Research, ISSN 1082-9873.

Fox, E.A. (March 1998). Update on the networked digital library of theses and dissertations (NDLTD). Proc. 35th Annual Clinic of Library Applications of Data Processing, GSLIS'98, ISSN 0069-4789.

Han, S.H., Williges, B.H., and Williges, R.C. (1997). A paradigm for sequential experimentation. Ergonomics, 40(7), 737-760.

Isenhour, P.L., Begole, J., Heagy, W.S., and Shaffer, C.A. (October 1997). A Java-based collaborative visualization environment, Late Breaking Hot Topics Proceedings, IEEE Visualization'97. Phoenix, AZ, 13-16.

Hartson, H. R. (1997). Trends in human-computer interaction research and development. In More Than Screen Deep: Toward Every-Citizen Interfaces to the Nation's Information Infrastructure, National Research Council, National Academy Press, pp. 221-240.

Hartson, H. R. (in press). Human-computer interaction — interdisciplinary roots and trends. Journal of Systems and Software.

Kies, J.K., Williges, R.C., and Williges, B.H. (1997). Desktop video conferencing: a systems approach. In M.G. Helander, T.K. Landauer, and P.V. Prabhu (Eds.), Handbook of human-computer interaction (2nd. Edition). (pp. 979-1002) Amsterdam: Elsevier Science.

Kies, J.K., Williges, R.C., and Rosson, M.B. (1997). Evaluating desktop video conferencing for distance learning. Computers and Education, 28(2), 79-91.

Koenemann, J., Carroll, J.M., Shaffer, C.A., Rossen, M.B., and Abrams, M.A. (in press). Designing collaborative applications for classroom use: The LiNC Project. In The Design of Children's Technology, Allison Druin, ed. New York: Morgan Kaufmann.

McCreary, F., Reaux, R., Ehrich, R.W., Hood, S., and Rowland, K. (October 1998). PCs for families: a case study in the participatory design of a technology-rich elementary school classroom. Proceedings of the 42nd Human Factors and Ergonomics Society Annual Meeting. Chicago, IL.

McCreary, F., and Williges, R. (1998). Effects of age and field-of-view on spatial learning in an immersive virtual environment. Proceedings of the 42nd Human Factors and Ergonomics Society Annual Meeting. Chicago, IL.

McGee, M.K. (1998). Using psychophysics to measure negative side effects in immersive virtual environments. Proceedings of the 42nd Human Factors and Ergonomics Society Annual Meeting. Chicago, IL.

McGee, M.K. (1998). Freedom of speech. In Marc Abrams (Ed.), World Wide Web Beyond the Basics. New Jersey: Prentice Hall, 343-356

McGee, M.K., Amento, B., Brooks, P., Harley, H. D. (1997). Fitts and virtual reality: evaluating display and input devices with Fitts' law. Proceedings of the 41st Human Factors and Ergonomics Society Annual Meeting. Santa Monica, CA.

McGee, M., Neale, D.C., Amento, B.S., and Brooks, P.C. (1998). Telepresence in ACTV media spaces. Proceedings of the 42nd Human Factors and Ergonomics Society Annual Meeting. Chicago, IL.

Neale, D.C. (1997). Factors influencing spatial awareness and orientation in desktop virtual environments. Proceedings of the 41st Human Factors and Ergonomics Society Annual Meeting. Santa Monica, CA, 1278-1282.

Neale, D.C. And Carroll, J.M. (1997). The role of metaphors in user interface design. In M. Helander and T.K. Landauer (Eds.) Handbook of Human-Computer Interaction, Second Edition. Amsterdam: North Holland, 441-462.

Reaux, R. and Carroll, J.M. (1997). Information access to distributed systems. In G. Salvendy (Ed.), Handbook of Human Factors and Ergonomics, Second Edition. New York: John Wiley and Sons, 1783-1807.

Shaffer, C.A. (1998). A practical introduction to data structures and algorithm analysis -- Java edition. New York: Prentice Hall.

Snow, M.P. and Williges, R.C. (in press). Empirical models of perceived presence in virtual environments based on free-modulus magnitude estimation. Human Factors.

Snow, M.P. and Williges, R.C. (September 1997). Empirical modeling of perceived presence in virtual environments using sequential experimentation techniques. In Proceedings of the Human Factors and Ergonomics Society 41st Annual Meeting, (pp. 1224-1228), Albuquerque: Human Factors and Ergonomics Society.

Williges, R.C. (March 1998). Advancing scholarly research through the electronic world. Blacksburg, VA: Virginia Polytechnic Institute and State University, Hypermedia Technical Report HCIL-98-03.

Talks:

Balci, O., Ulusarac, C., and Fox, E.A. (to be given December 1998). A library of reusable model components foor visual simulation of the NCSTRL system. Winter Simulation Conference, Washington, DC.

Andre, T.S., Kleiner, B.M., and Williges, R.C. (April 1998). A conceptual model for understanding computer-augmented distributed team communication and decision making. RTA-NATO Conference on "Collaborative crew performance in complex operational systems," Edinburgh, Scotland.

Carroll, J.M. (1997). Overview of minimalism. Panel presentation for "Reconstructing minimalism: New developments in the application of minimalist principles for the education and information of users." ACM SIGDOC'97: ACM Conference on Computer Documentation, Salt Lake City, Utah, October 22, 1997.

Carroll, J.M. (1998). Scenario-based design. Presentation at Dagstuhl Workshop on Scenario Management, Schloss Dagstuhl Internationale Begenungs und Forschungszentrum fur Informatik, February 9-13, Saarbrucken, Germany.

Ehrich, R.W, Rowland, K., Ramsey, A., and Hoback, K. (November 1997). PCs for families - evaluating student success when placed in a collaborative learning environment in the classroom and at home. Conference on School and Community: Partners for the New Century, Radford VA.

Ehrich, R.W. (December 1997). Design of technology-based learning environments that support both teachers and students. Virginia Department of Education Educational Technology Leadership Conference, Roanoke VA.

Ehrich, R.W. and McCreary, F. (invited paper, February 1998). PCs for families - can student and family access promote student achievement? American Association for the Advancement of Science, Philadelphia, PA.

Ehrich, R.W., McCreary, F., Hood, S., Lisanti, M., and Rowland, K. (February 1998). Experience with an immersive technology-based environment for constructivist learning. 2nd Annual Conference on Teaching Inquiry with the Latest Technologies, Roanoke VA.

Ehrich, R.W., McCreary, F., Reaux, R., Rowland, K., and Ramsey, A. (April 1998). Testing a network-based approach to home and school connections, American Educational Research Association, San Diego, CA.

Fox, E.A., Abdulla, G., Heagy, W. (July 1997). Quantitative analysis and visualization regarding interactive learning with a digital library in computer science. Poster at ACM Digital Libraries'97, Philadelphia, PA.

Fox, E.A. (March 1998). A scalable digital ecology for a networked digital library of theses and dissertations. Winter Workshop of the Human-Computer Interaction Consortium (HCIC), Fraser, CO.

Fox, E.A. (November 1997) Networked digital library of theses and dissertations. FIPSE PI Meeting, Arlington, VA.

Fox, E.A. (March 1997). Digital libraries: their educational applications and uses. Opening presentation, keynote session for Web Week, Rice University.

Fox, E.A. (February 1998). Proposing a partnership for education innovation: NSF, Virginia Tech, and SCT. Invited presentation, Malvern PA.

Fox, E.A. (December 1997). Transfer Conference presentations on changes in computer science instructional offerings using instructional technology, Blacksburg, VA.

Fox, E.A. (November 1997). Distributed learner spaces with digital libraries: future of digital library technologies across high-speed distributed systems, Washington, DC.

Fox, E.A. (July 1997). Panel discussion, NCSTRL: experience with a global digital library. D-Lib Panel on Interoperability I, ACM DL'97, Philadelphia, PA.

Fox, E.A. (July 1997). Information retrieval, digital libraries, education innovation, theses and dissertations, and WWW traffic analysis/modeling: related work at Virginia Tech, ISS, Singapore.

Fox, E.A. (July 1997). Powerful interactivity in a networked world. Computer Society of Singapore, Singapore.

Fox, E.A. (June 1997). The digital era: implications for librarians, information providers and users, ISS, Singapore.

Fox, E.A. (April 1998). Improving education through the networked digital library of theses and dissertations (NDLTD) and the computer science teaching center (CSTC). Invited presentation at the Gore-Chernomyrdin Telecommunications Working Group, Moscow.

Fox, E.A. (April 1998). Digital libraries to enhance learning: case studies in computer science and graduate education. Invited presentation at Pacific Northwest national Laboratory, Pasco, WA.

Fox, E.A., talks at universities: Massachusetts, Amherst (March 1998); Denver (March 1998); Case Western Reserve (February 1998); Drexel (February 1998); James Madison (February 1998); Florida International (January 1998); Virginia Commonwealth (January 1998); Berkeley (July 1997 and January 1998); Michigan (October 1997); University of Lisbon (October 1997); Illinois (Champagne-Urbana) (September 1997); Virginia (August 1997); Florida Institute of Technology (August 1997); North Florida (August 1997); Pennsylvania (July 1997); Stanford (July 1997); Naval Postgraduate School (July 1997); Santa Barbara (July 1997); Singapore (July 1997); Carnegie Mellon (June 1997); Waterloo (June 1997); New York University (May 1997); South Florida (April 1997); Clemson (March 1997); Georgia (March 1997); Alabama at Tuscaloosa (March 1997); Alabama at Birmingham (March 1997); Tennessee (March 1997); Vanderbilt (January 1997).

Fox, E.A. (March 1998). Progress on the national digital library of theses and dissertations (NDLTD). Invited presentation for Computers in Libraries '98, Arlington, VA.

Fox, E.A. (February 1998). Digital libraries: preparing the next generation of scholars. NFAIS'98, Philadelphia, PA.

Fox, E.A. (February 1998). The worldwide electronic thesis and dissertation initiative: building the networked digital library of theses and dissertations. National Agricultural Library, MD.

Fox, E.A. (November 1997). Implications of the electronic thesis and dissertations (ETD) initiative. Invited presentation at DTIC Annual User's Conference, Arlington, VA.

Fox, E.A. (October 1997). The worldwide electronic thesis and dissertation initiative: joining the networked digital library of theses and dissertations. Invited presentation at Fall CNI Meeting, Minneapolis, MN.

Fox, E.A. (July 1997). Renaissance Consortium report on the worldwide ETD initiative. IBM Almaden Laboratory, San Jose, CA.

Fox, E.A., Eaton, J., and McMillan, G. (May 1997). National digital library of theses and dissertations. Invited session for CAUSE/CNI regional conference, University of Delaware.

Fox, E.A. (May 1997). Networked digital library of theses and dissertations. AAP PSP Executive Council, NY, NY.

Fox, E.A. (April 1997). Publishers and electronic theses. Coalition for Networked Information, Spring meeting, Crystal City, VA.

Hartson, H.R. (July 1997). Usability problem classification. Institute for Perception Research (IPO), a joint research facility between Philips Corporation and Eindhoven University of Technology, Eindhoven, The Netherlands.

Hartson, H.R. (July 1997). The user-reported critical incident method for remote usability evaluation. User-System Interaction Technology Department, Philips Natuurrkundig Lab, Eindhoven, The Netherlands.

Hartson, H.R. and Castillo, J.C (May 1998). Remote evaluation for post-deployment usability improvement. AVI '98, Advanced Visual Interfaces, International Working Conference, L'Aquila, Italy, in cooperation with: ACM-SIGCHI, ACM-SIGMM, and SIGCHI, Italy.

Hix, D. (June 1997). Invited keynote speaker at American Management System's Associate's Conference, for outstanding employees world-wide, Vienna, VA.

Hix, D. (November 1998). Invited keynote speaker at Lucent Technologies, International Human Factors Conference, Holmdel, NJ.

Hix, D. (December 1997). Invited presentation to Office of Naval Research, "Evaluation of a Responsive Workbench User Interface."

Hix, D. (October 1997). Invited presenter, "Usability Engineering in Digital Libraries," Digital Renaissance Symposium.

Hix, D. (October 1997). Invited presenter, as expert in human-computer interaction, to two-day review of ONR's major virtual environment grants (approximately $2 million each per year).

Hix, D. (January 1998). Invited presentation to Boeing, Philadelphia representatives, regarding Virginia Tech VE research.

Hix, D. (January 1998). Invited presentation to Naval SPAWAR representatives, regarding Virginia Tech VE research.

Hix, D. (August 1997). Invited presentation to President of Prosolvia Corporation (major international VE company), regarding Virginia Tech VE research.

Rosson, M. B., (March 17, 1998). Computer-Supported Collaborative Science Learning: The LiNC Project, Radford University, Computer Science Department.

Rosson, M. B., (April 16, 1998). Computer-Supported Collaborative Science Learning: The LiNC Project, University of British Columbia, Computer Science Department.

Williges, R.C. (April 1998) Lecture at Virginia Tech, Scholarship in the Electronic World Seminar Seminar, "Advancing scholarly research through the electronic world."

Williges, R.C. (August 1997). Electronic lecture for the Engineering Summer Conference, The University of Michigan, "Introduction to experimental design."

Infrastructure-Related Workshops and Conference Activities:

Fox, E.A., Member, Program Committee for CoLIS 3, 1997-99.

Fox, E.A., Associate Program Chair, ACM Multimedia '98, 6th ACM Int'l Multimedia Conf., 12-16 Sept. 1998, Bristol, UK.

Fox, E.A., Member, Program Committee of 2nd European Conf. for Digital Libraries, Crete, 1997-98.

Fox, E.A., Member, Program Committee for ACM Digital Libraries '98, Pittsburgh, PA, June 23-26, 1998, (also, Workshop Chair).

Fox, E.A., Member, Program Committee for ACM SIGIR '98, Aug., Melbourne, Australia.

Fox, E.A., Member, Program Committee for BAS98, The 3rd Symposium on Computer Networks, June 25-26, 1998, Dokuz Eylul University, Izmir, Turkey.

Fox, E.A., Member, Program Committee for The Seventh International Conference on Information and Knowledge Management (CIKM'98), Nov. 1998.

Fox, E.A., Member, Program Committee for IEEE Multimedia Systems'98, IEEEMM98.

Fox, E.A., Member, Program Committee, SICON '98, IEEE Int'l Conf. on Networks, 30 June - 3 July 1998, Singapore.

Fox, E.A., Member, Program Committee for RIDE98, Eighth International Workshop on Research Issues in Data Engineering: Continuous-Media Databases and Applications, February 23-24, 1998, Orlando, Florida, Sponsored by IEEE Computer Society Technical Committee on Data Engineering.

Fox, E.A., Chair, IBM Renaissance Meeting, Oct. 20-22, 1997, Virginia Tech, Blacksburg, VA.

Fox, E.A., US Representative, Workshop on Curricular Development on Information Management and Digital Libraries, Lisbon, Portugal, Oct. 3-4, 1997.

Fox, E.A., Program committee member, First European Conference in Research and Advanced Technology for Digital Libraries, Pisa, Italy, 9/1-3/97.

Fox, E.A., Member, workshop on a Digital National Library for Science, Mathematics, Engineering and Technology, sponsored by National Research Council, Washington, D.C., August 7-8, 1997

Fox, E.A., Program committee member, 20th Intern'l Conf. on R&D in Information Retrieval, SIGIR '97, July 27-31, 1997, Philadelphia; also chair of session on Image Retrieval; also on Best Paper Committee.

Fox, E.A., Chair of Education and Curriculum Development for Multimedia, Hypertext, and Information Access: Focus on Digital Libraries and Information Retrieval workshop, sponsored by both ACM Digital Libraries'97 and ACM SIGIR'97, July 23, 1997, Philadelphia.

Fox, E.A., Technical papers committee member, 2nd ACM Intern'l Conf. on Digital Libraries, DL'97, July 21-23, 1997, Philadelphia.

Fox, E.A., Chair of Interactive Learning with a Digital Library in Computer Science workshop, June 15-21, 1997, Virginia Tech, Blacksburg, VA funded in part by NSF (as supplement to EI grant 1993-97).

Fox, E.A., Chair of Courseware, Education and Curriculum in Multimedia workshop, held with ICMCS'97, IEEE International Conference on Multimedia Computing and Systems, June 6, 1997, Ottawa, Canada.

Fox, E.A., Program committee member, IEEE Multimedia Systems'97, the IEEE International Conference on Multimedia Computing and Systems (ICMCS), June 3-6, 1997, Ottawa, Canada.

Fox, E.A., Program committee member, 1997 International Conference on Software Engineering, ICSE 97, May 17-24, 1997, Boston, MA.

Fox, E.A., Chair of Joining the National Digital Library of Theses and Dissertations, half-day pre-conference seminar for CAUSE/CNI regional conference, Univ. of Del., May 21, 1997.

Fox, E.A., Organizing comm. member, Workshop on R&D Opportunities in Federal Information Services, May 13-15, 1997, Arlington, VA; also met 12/3-5/96.

Fox, E.A., Invited attendee, Computing and Humanities workshop, Computer Science and Telecommunications Board, National Research Council, March 28, 1997, Washington, D.C.

Fox, E.A., Invited attendee and co-chair of one of four working groups, NSF Workshop for a Research Initiative on Distributed Knowledge-Work Environments, Santa Fe, March 9-11, 1997.

Fox, E.A., Program committee member, Multimedia Computing and Networking 1997 (MMCN97) Conference (sponsored by SPIE and IS&T), San Jose, Feb. 10-12, 1997.

Hix, D., Serving as invited member of VRAIS'99 Conference Program Committee, Houston TX, March 1999.

Rosson, M.B., Member, Program Committee, 8th Israeli Conference on Computer Systems and Software Engineering, 1996-1997.

Rosson, M.B., Member, Program Committee, OOPSLA 1998.

Rosson, M.B., Member, Program Committee, DIS'97.

Honors and Awards:

Kies. J.K. (October 1997) 1997 Alphonse Chapanis Best Student Paper Award, Human Factors and Ergonomic Society.

Liu, X. (1997). Analysis and reduction of Moire patterns in scanned halftones, most referenced dissertation in the Virginia Tech Electronic Theses and Dissertations (ETS) digital library, approximately 10,000 downloads in 1997.

Snow, M.P., Kies, J.K., Neale, D.C., and Williges, R.C. (October 1997). Best Article Published in Ergonomics and Design, 1996 Volume, Human Factors and Ergonomics Society.

New Grants and Proposals Related to Infrastructure:

Balci, O., Carroll, J.M., Fox, E.A., Lee, J.A.N., Rosson, M.B., and Tranter, W.H., A virtual corporation for model-based learning in computing, NSF, $600,272 (declined).

Carroll, J.M. and Rosson, M.B., Supporting authentic learning in a community network, NSF, $689,152 (pending).

Carroll, J.M. and Rosson, M.B., Making the community a learning community. Hitachi, $99,000 (funded).

Fox, E.A., Curriculum resources in interactive multimedia (CRIM), NSF, $87,000 (funded).

Fox, E.A. and Knox, D., A digital library based computer science teaching center (CSTC), NSF, $72,820 (funded).

Fox, E.A., Advanced information retrieval for toxicology and environmental health databases, NLM, $25,000 (funded).

Fox, E.A., SiteSearch software license, OCLC, $50,000 (funded).

Fox, E.A., Carroll, J.M., Hartson, H.R., Shaffer, C., and Williges, R.C., Digital Libraries for Users (DL4U): Sustainable participatory development of personal and shared environments, NSF/DLI, $4,000,000 (pending).

Hix, D. Enhancing a CAVE™ with eye tracking systems for human-computer interaction research in 3D visualization. ONR Defense University Research Instrumentation Program, $57,800, June 1997 - May 1998 (funded).

Hix, D. Developing high impact usability evaluation methods for virtual environments. ONR, $132,000, January 1996 - November 1997 (funded).

Hix, D. Systematic development of testbeds, principles, and methodologies for ensuring usability of virtual environment user interfaces. ONR, $232,478, January 1996 - December 1998 (funded).

Hix, D. Ensuring usability of virtual environments. NSF CISE/POWRE program, $40,000, December 1998 - January 1998 (funded).

Hix, D. Bender, H., Mills, R., and Lockee, B. An interdisciplinary partnership in biomedical informatics. Virginia Tech ASPIRES program, $86,000, January 1998 - December 1998 (funded).

Hix, D., Shaffer, C., Kafura, D., Rappaport, T., and Trantor, W. Developing a wireless communication system design tool, NSF, $1,000,000 (pending).

Hix, D. And Kriz, R. Programming support for the CAVE™. Virginia Tech ASPIRES program, $16,000 (declined).

Kamke, F.A., Watson, L.T., Ribbens, C.J., Allison, D.C.S., Abrams, M., Kafura, D., Rosson, M.B., and Shaffer, C.A., Towards leadership in problem solving environments for science, engineering, and manufacturing, ASPIRES, Virginia Tech, $25,000 (funded).

Moxley, J.M., Fox, E.A., and Rosson, M.B., Electronic thesis and dissertation resource environment (ETDRE) for scientists and engineers, NSF/KDI, $572,106 (pending).

Rosson, M.B., Ribbens, C.J., and Farkas, D., Interaction and integration in problem-solving environments for materials science simulation, NSF, $246,983 (pending).

Rosson, M.B., POWRE supplement: learning and use of a simulation environment by middle and high school science teachers, NSF, $71,007, (pending).

Shaffer, C.A., Batra, R., Farkas, D., Kafura, D.G., Kamke, F.A., Kapania, R., Mason, W.H., Ramakrishnan, N., Ribbens, C.J., Rosson, B.B., and Watson, L.T. Collaborative problem solving environments for design and analysis in science and engineering, NSF, $2,045,294 (pending).

Williges, R.C. Usability evaluation of a voice e-mail message system. Virginia Center for Innovative Technology, $26,667 (pending).

Service:

Carroll, J.M. and Rosson, M.B. 10 hours of lectures on the topic of network communities to Finnish graduate students at the University of Tampere, Finland, on May 13 and 14, 1997.

Hix, D. Member, Interactions editorial board.

Hix, D. Serving as invited member of Board of Advisors, Federal Intelligence Document Understanding Laboratory, Vienna VA.

Hix, D. Invited reviewer for Special Issue of Journal of Systems and Software, on usability engineering.

Fox, E.A., Chair of Steering Committee meeting, for Networked Digital Library of Theses and Dissertations, held at Coalition for Networked Information offices, Washington, D.C, March 27, 1998.

Fox, E.A., Chair of Technical Committee meeting, for Networked Digital Library of Theses and Dissertations, held before Coalition for Networked Information Spring Meeting, Arlington, VA, April 14, 1998.

Fox, E.A., Chair of Technical Committee meeting, for Networked Digital Library of Theses and Dissertations, held before Coalition for Networked Information Spring Meeting, Minneapolis, Oct. 26, 1997.

Fox, E.A., Chair of Steering Committee meeting, for Networked Digital Library of Theses and Dissertations, held at Coalition for Networked Information offices, Washington, D.C, Sept. 19, 1997.

Fox, E.A., Chair of Technical Committee meeting, for National Digital Library of Theses and Dissertations, held before Coalition for Networked Information Spring Meeting, Crystal City, VA, April 1-2, 1997.

Fox, E.A., Chair of Steering Committee meeting, for National Digital Library of Theses and Dissertations, held at Coalition for Networked Information offices, Washington, D.C, March 14, 1997.

Fox, E.A., Member, Steering Committee, Monticello Electronic Library, a project of SURA and SOLINET (re TIAPP grant), 1996-98.

Fox, E.A., Member, NCSTRL (Networked CS Tech. Report Library) working group (part of D-Lib working group program), 1995-.

Fox, E.A., Co-chair, Working Group on Theses, Technical Reports, and Dissertations, in Monticello Electronic Library Initiative, sponsored by SURA and SOLINET, 1993-.

Hix, D. Serving as invited Co-Chair of CHI'99 Doctoral Consortium, Philadelphia PA, April 1999, 1993-.

Fox, E.A., Member, SIGIR Education Committee, 1993-

Fox, E.A., Member, SIGIR Electronic Publishing Committee, 1995-

Fox, E.A., Co-chair, SIGMM Education Committee, 1995-

Fox, E.A., Member, ACM SIGIR Executive Committee, 1995-

Fox, E.A., Networked digital library of theses and dissertations, demonstration for ACM SIGIR'97, Philadelphia.

Fox, E.A., Multimedia information and systems, tutorial for ACM SIGIR'97, Philadelphia.

Fox, E.A., Building and applying digital libraries, tutorial for ICMCS'97, Ottawa.

Fox, E.A., Digital libraries for computer science education, tutorial for ACM SIGCSE'97, San Jose.

Fox, E.A., Editorial board, IEEE Multimedia (IEEE-CS), 1997-

Fox, E.A., Editor, Morgan Kaufmann Publishers, Inc. Series on Multimedia Information and Systems, 1995-

Fox, E.A., Editorial board, Electronic Publishing - Origination, Dissemination and Design Journal (Wiley), 1994-

Fox, E.A., Editorial board, Multimedia Tools and Applications (Kluwer), 1994-

Fox, E.A., Foundation Editor, The Journal for Universal Computer Science (Springer) and manager of VPI&SU Foundation Server, 1994-

Fox, E.A., Editorial board, Multimedia Systems (ACM/Springer-Verlag), 1992-.

Fox, E.A., Editorial board, Journal of Educational Multimedia and Hypermedia (AACE), 1990-.

Fox, E.A., Editorial board, Information Processing & Management (Elsevier), 1987-.

Fox, E.A., Member, Steering Committee, ACM Preprint Database, 1997-.

Fox, E.A., Member, OCLC's Research Advisory Council, 1996-.

Fox, E.A., Member, Columbia U. Digital Library Advisory Committee, 1995-.

Rosson, M.B., Panel Member, CISE/CCR/SEL Review Panel, 1997.

Williges, R.C. Co-Editor of Special Section of Human Factors on "Virtual Reality: Models, Methodology, and Empirical Studies."

Infrastructure-Related Degrees Awarded:

Gahleb Abdulla, PhD, *Digital library and web scalability through characterization and modelling*

Jose Castillo, MS, *User-reported critical incident method for remote usability evaluation*

Laura Clark, PhD, *Design and testing of a quick-connect wheelchair power add-on unit*

Philip Isenhour, MS, *Sieve: a Java-based framework for collaborative component composition*

Binzhang Liu, MS, *Analyzing the spread of CS education innovation*

Faith McCreary, MS, *Adult-child differences in spatial learning in an immersive virtual environment as a function of field of view*

Lucy Nowell, PhD, *Graphical encoding for information visualization: using icon color shape, and size to convey nominal and quantitative data*

Michael McGee, MS, *Assessing negative side effects in a virtual reality maze environment*

Jose Pesante, PhD, *Applications of the theory of signal detectability to multitasking and industrial quality inspection in manufacturing*

Brandon Satanek, MS, *The effects of multidimensional navigational aids and individual differences on WWW hypertext navigation*

Paige Smith, MS, *Human-centered communication technologies to enhance the tutoring of minorities*

Linda Van Rens, MS, *Usability problem classification methodology*

Samthongs Thevongs, MS, *Use of integrated displays in work system design*

Roland Wooster, MS, *Optimizing response time, rather than hit rates, of WWW proxy caches*

Infrastructure-Related Degrees in Progress:

James (Bo) Begole, PhD, *Bringing collaboration awareness to collaboration transparent applications*

Brian Amento, PhD, *Developing and evaluating new interaction techniques for virtual environments*

Terrence Andre, PhD, *Specification of usability problems*

George Chin, PhD, *Integrating ethnography, scenarios, and participatory design*

Kevin Curry, MS, *Supporting collaborative work in a CAVE*™

Hope Doe, MS, *Evaluating the effects of automatic speech recognition word accuracy*

Lizann Epley, MS, *An integrated environment for student-teacher communication*

Ahsan Habib, MS, *Internet congestion*

Junni Fan, PhD, *Digital libraries (to be determined)*

Joey Gabbard, PhD, *Developing a taxonomy of usability characteristics for virtual environments*

Craig Ganoe, PhD, *Dissertation area to be determined*

Rajat Gupta, MS, *A digital library for learning about interactive multimedia*

Hope Harley, PhD, *An environment for guided exploration of object-oriented programming and design*

Win Heagy, MS, *WWW server log data visualization and evaluation for the improvement of educational web sites*

Tommy Johnson, PhD, *Improving caching in the World Wide Web*

Jae Kim, MS, *The effects of frequency of interaction and quality of interaction in a web-based learning system*

Neill Kipp, PhD, *A language for implementing digital library scenarios and a supporting personal digital library application*

Suzanne Lee, PhD, *An investigation of the FHWA hearing requirements for commercial vehicle operators*

Paul Mather, PhD, *Digital libraries for theses and dissertations*

Faith McCreary, PhD, *Evaluating the educational efficacy of technology-supported learning at 5th grade*

Chung-Tzu Mou, MS, *Evaluation of 3-D controllers of virtual environments*

Sornil, Ohm, PhD, *Digital libraries (to be determined)*

Constantinos Phanouriou, PhD, *Providing browsing support for digital libraries of theses and dissertations*

Zaodat Raman, MS, *Handwriting enhancement for document archival*

Ray Reaux, PhD, *Reference object analysis and design; an object-oriented software engineering process*

Cheryl Seals, PhD, *Documenting and supporting the reuse of object-oriented application frameworks*

Hussein Suleman, PhD, *WWW traffic and performance analysis*

Stephen Van Aken, PhD, *Team effectiveness: an investigation of semi-autonomous teams in manufacturing*

William Wake, PhD, *A model and interface for documents with multiple views*

Chang Zhang PhD, *Multimedia in digital libraries*

Jianxin Zhao, MS, *Future digital library systems -- architecture and implementation*