

**CISE Research Infrastructure Grant CDA-9303152
Interactive Accessibility**

**Department of Computer Science
Virginia Tech**

Year - 1 Progress Report

Year - Start Date: 1 August, 1993

Principal Investigators:

Roger W. Ehrich
Edward A. Fox
Deborah Hix
H. Rex Hartson
Robert C. Williges

The Research Program:

The Departmental research focus can be discerned from the titles of published papers and student theses given in the Appendix to this report. One of the thrusts of the HCI work continues to be interface and requirements specification. Another is formative evaluation and evaluation methodology. The addition of digital video capability will facilitate the development of new formative and summative evaluation techniques for useability evaluation. A new area that will be facilitated by our new laboratory is meta-evaluation...the laboratory will be so designed as to facilitate evaluation of evaluation procedures themselves.

Both the research in digital libraries and specific work in HCI is being heavily influenced by the Envision project, the results of which are affecting virtually every aspect of Computer Science Education in the department. As a result of the massive introduction of digital course materials and the authoring (mostly through Mosaic) that is taking place, numerous spinoff problems are being investigated, such as problems in formulating search queries and interpreting the results.

Other research areas in the Department are also benefiting from the new departmental focus and the expanded availability of our laboratories. This year formative evaluations were carried out on the GeoSim project, which concerns a system for instruction of geography through interactive exploration.

All the principals of the Research Infrastructure have been actively working with the Blacksburg Electronic Village in its efforts to create digital libraries and online materials and in its work to dramatically alter K-12 education in the County schools through networking technologies. Specific research projects involving CS faculty and elementary school teachers have been

initiated. These include studies of the design process for the introduction of networking into the schools and studies to determine just what it is about computers that promotes learning in young children.

The following are some of the other activities and achievements of the Research Infrastructure program:

- Created an initial publicity flyer for the HCI program and Research Initiative program at Virginia Tech.
- Designed MOSAIC pages for the HCI/RI program at Virginia Tech.
- Held our promised workshop at CHI '94 on formative evaluation methods.
- Organized and initiated active use of the Usability Methods Research Laboratory.
- Installed IDEAL in our laboratory and observing preliminary use. This is an interactive tool environment that supports a broad scope of user-centered interface development activities that will be the nucleus of our instrumentation for years to come.
- Continued research on a task mapping model for user interface analysis and redesign.
- Continued development of the User Action Notation, a behavioral technique for interface design representation.
- Continued development of GeoSim, our geographic educational system.
- Initiated work on SWAN, a data structure visualization tool.
- Began a Virtual Reality initiative to specify VR equipment for research on the human factors of virtual reality.
- Received an equipment gift from Bell Northern Research of two Visit systems for video interactive computer conferencing using ISDN switching.
- Established a Kodak Intern Fellowship program to investigate access to consumer products for users with special needs. Specifically, access to the Kodak Photo CD Player for visually impaired users and access to cameras by users with hand impairments was assessed as a means of developing a new model of usability design incorporating needs of special populations of users.
- Investigated the efficacy of dual coding theory and visual momentum in choosing media for computer-based multimedia training was conducted under the support of the SUCCEED coalition project sponsored by NSF.
- Created a case study prototype using video interactive communication coupled with remote computer control via the Internet to support surrogate electronic travel for users with mobility impairments.

Space and Renovations:

Initial construction that will lead to the renovation of the CS Department and construction of the laboratories for the Research Infrastructure has begun. New utility lines have been laid, and building renovation for housing departments moved out of McBryde Hall (the building housing CS) are in progress. It appears that McBryde construction will begin in about 12 months. Alternative laboratory designs are still being evaluated.

Usability Methods Research Laboratory (Williges):

The principal function of the UMRL is to provide a core facility for departmental empirical research in human-computer systems and information access. Per agreement, the laboratories in the Industrial Systems Engineering (ISE) Department have been networked and modified to accommodate the initial needs of the Research Infrastructure. Equipment, including the IDEAL platform, has been moved into place. Existing space has been modified to accommodate meta-usability assessment prototypes.

Detailed alternative floor plans for the new Usability Methods Research Lab (UMRL) were developed, and general floor plans were developed for the other two laboratories to facilitate considerations of space requirements and locations of the three new RI labs. Laboratory design is being treated as a human factors design problem, and every effort is being made to ensure the usability of the resulting designs.

Plans to purchase high quality digital video equipment in support of research in interface beta testing have been deferred due to the high cost and limits of current technology (see budget section). We are expecting substantial changes in that situation in the next half year.

Interaction Technology Laboratory (Hartson and Hix):

The principal purpose of the Interaction Technology Laboratory is to provide state-of-the-art equipment for research in human-computer interaction. Until renovations are complete, space in an existing laboratory in Femoyer Hall, in the UMRL in the ISE Department, and in the main CS student laboratory is being used to house new equipment. This latter space is designated as the eventual ITL, and equipment is slowly being introduced into that space. Although this equipment is now distributed, the Research Initiative program has been extraordinary in its ability to provide both hardware and software support for the research effort described above.

Information Access Laboratory (Fox):

The Information Access Laboratory has been in existence for some time; the general theme concerns the integration of areas such as information retrieval, database systems,

hypertext/hypermedia, multimedia, and networked information. The laboratory houses a variety of workstations and PCs for integrating multimedia systems and keeping track of the state of the art in hardware and software. After renovation, considerably more space will become available. The laboratory is acquiring multimedia equipment; mass storage purchases have been delayed because we are still waiting for suitable technology (see budget section). Besides imminent improvement in cost per bit, reasonably priced CDROM and DAT jukeboxes have become available. However, commercial developments for integrating these very different devices into a seamless storage system are lagging behind.

Ongoing research activities include the MARIAN library system project, electronic report and dissertation publishing, digital libraries, the ENVISION education project, retrieval work on the TREC project, and networked access of multimedia systems for the SUCCEED project (an engineering outreach program).

Interaction Consulting Service (Ehrich):

Although the service has not been advertised, faculty members are already consulting on HCI design issues. The service will be primarily staffed by senior graduate students, and we are waiting primarily for the consolidation of the Information Technology Laboratory before proceeding with a full implementation.

Curriculum and Education:

Depending upon resources available for teaching, the RI grant has spurred the development of several new HCI courses in the curriculum.

CS5714, previously the only HCI course, will now be updated and revised to focus specifically on usability methods within the development process for interactive software systems.

An undergraduate level course is being planned as a broad introduction to the field of HCI for undergraduates across the entire university.

An undergraduate course on usability methods will be developed for CS majors with the direct goal of preparing our graduates for the work world which now demands attention to the user interface in addition to the software.

An advanced topics course, CS6704, entitled Scenario-Based Design, will be offered this fall (1994) semester.

Further HCI courses at the graduate level are being planned for specific topic areas including applications areas of HCI (e.g., HCI theory, Computer supported Cooperative Work, etc.).

The entire CS curriculum is undergoing both revision and change. It will reflect the change in focus of the Department and the methodological changes introduced by networking and digital libraries through the Envision project.

New Personnel:

- John M. Carroll, a leading HCI researcher, became CS Department Head on January 15, 1994. He comes to us from IBM, Yorktown Heights.
- Mary Beth Rosson, a well-known HCI researcher, joined the CS department beginning January 15, 1994. She comes to us from IBM, Yorktown Heights.
- John Kelso joined our support staff beginning January 31, 1994 to manage the three new RI laboratories. He has concentrated on setting-up and networking our coordinated laboratories in Engineering and in Computer Science. He assists in hardware and software installation and evaluation, purchasing, and handles facility use scheduling for the new RI labs. He comes to us from the College of Engineering, University of Maryland.
- Joe Cochran and Dennis Neale were appointed Research Assistants, funded by this RI grant, beginning August 15, 1993.

Equipment:

A large number of PC's and workstations have been purchased, including an SGI for investigations of the use of 3D in visualization of complex data structures. The SGI also serves as the first purchase for providing virtual reality capability. These have been supplemented by a number of additional workstations through a grant from the State Council of Higher Education of Virginia. Also purchased have been numerous displays, cameras, printers, large disks, and software.

Ethernet lines were added to the UMRL to facilitate communication pathways to the three new RI labs and to provide Internet access. Video interactive communication links via the Internet were prototyped.

Plans for Next Year:

During the next program year, work will proceed on most of the ongoing research topics; many of the research directions have been set this year. Laboratory design plans will be finalized, digital video and mass storage systems will be ordered, and most of the video equipment for the new Usability Methods Research Laboratory will be ordered.

Budget:

There are three main program items for which we wish to request a funds carryover into the second grant year, although most of the carryover funds will be expended in the flexibility period. The total carryover request is **156,880** as detailed below:

1. Programmer salary: We were able to recruit a top person with HCI background from the University of Maryland. However, he was not available until February this year, and as a result we wish to slide his employment period ahead in time by about 4 months. NSF's share of his salary was to have been expended half way through year 5; this would mean only that the funds would be expended near the end of year 5. However, this requires your permission to carry over roughly 4 months of his salary each year.
2. This year's acquisitions were to include a mass storage system for the information access work which is closely related to the education initiative. We now have three technical options of CDROM, Magneto Optical, and DAT jukeboxes, and are on the verge of significant technical advances in storage density. Since the results from the educational initiative will give us guidance on our choice of technology, and since the technologies are about to change, we felt we should defer a decision until this year. We therefore request permission to defer the expenditure of \$68,052 until the middle of the second year.
3. Digital video technology has not met our expectations; C-Cubed seems to be the leading chip manufacturer for real-time technology, but the implementers are charging premium prices for real-time technology. Since there are not yet systems that meet our needs at the prices we have budgeted, we wish to defer the purchase of our digital video equipment until the second grant year. We wish to request that \$30,000 be carried over for this purpose. Should suitable equipment not be forthcoming in the second year, we will discuss the options with NSF then.

There are no programmatic changes. In the case of items 2 and 3, we feel that for technical reasons our purchases should be deferred. We expect to purchase our mass storage within the flexibility period of our first year's funding, but the digital video purchases will depend on some complicated issues such as the property rights issues associated with MPEG compression and the release of new boards based on the MVP chip from Texas Instruments.

The following tables details our request. The **Committed** column lists expenditures initiated before August 1, 1994 that have not appeared on the August 1 accounting run. The **Carryover** column lists the above requests with fringe and overhead.

Expenditure	Committed	Carryover	Total Carryover
PI/PD summer	4,033		4,033
John Kelso, Res. Ass.		17,633	17,633
Clerical	400		400
Fringe	237	705	943
Maintenance	10,852		10,852
Equipment	6,852	98,052	104,904
Indirect Costs	8,305	9,811	18,116
TOTALS	30,679	126,201	156,880

APPENDIX

Infrastructure-Related Publications:

- Belkin, N., Kantor, P., Fox, E., and Shaw J., *Combining the Evidence of Multiple Query Representations for Information Retrieval*, Inform. Proc. and Management 30, to appear in 1994.
- Can, F., Snavely, C.D., Fox, E.A., and France R.K., *Incremental Clustering for Very Large Document Databases: Initial MARIAN Experience*, Proc. Eighth Int. Symp. on Computer and Information Sciences (ISCIS 8), eds. L. Gun, R. Onvural, and E. Gelenbe, Istanbul, 1-3 November, 1993.
- Carstensen, L.W., Jr., C. A. Shaffer, R. W. Morrill, E. A. Fox, *GeoSim: A GIS-Based Simulation Laboratory for Introductory Geography*, Journal of Geography, 92(5), pp. 217-222, 1993.
- Carroll, J.M., Alpert, S.R., Karat, J., Van Deusen, M., and Rosson, M.B., *Raison d'Etre; Capturing Design History and Rationale in Multimedia Narratives*, Proc. CHI '94, pp. 192-197.
- Carroll, J.M. and Rosson, M.B., *Reuse of Uses in Smalltalk Programming*, submitted to ACM Trans. on Human-Computer Interaction.
- Carroll, J.M., Mack, R.L., Robertson, S.P., and Rosson, M.B., *Binding Objects to Scenarios of Use*, International Journal of Human-Computer Studies, in press.
- Carroll, J.M. and Rosson, M.B., *Putting Metaphors to Work*, Proc. of Graphics Interface '94, Banff, May 1994.
- Carroll, J.M., *Techniques for Minimalist Documentation and User Interface Design*, in Quality of Technical Documentation, M.F. Steehouder, C. Jansen, P. van der Poort, and R. Verheijen, Eds, Rodopi, Amsterdam, 1994.
- Carroll, J.M., *Redrawing the Borders for Artifacts in Use*, Jour. of Human-Computer Interaction, in press.
- Carroll, J.M., *Designing Scenarios for Human Action*, accepted by Jour. Performance Improvement Quarterly.
- Carroll, J.M., Alpert, S., and Singley, K., *Multiple Multimodal Mentors: Delivering Computer-Based Instruction via Specialized Anthropomorphic Advisors*, accepted by Behaviour and Information Technology.
- Carroll, J.M., Mack, R., Robertson, S., and Rosson, M.B., *Binding Objects to Scenarios of Use*, accepted by Int. J. of Human-Computer Studies.
- Carroll, J.M., *Artifacts and Scenarios: An Engineering Approach*, in Disciplines and Traditions for the Study of Human-Computer Interaction, A. Monk and N. Gilbert, eds., Academic, 1994.
- Chase, J.D, Schulman, R.S., Hartson, H.R., and Hix, D., *Development and Evaluation of a Taxonomical Model of Behavioral Representation Techniques*, Proc. CHI '94, pp. 159-165.
- Fox, E.A., Hix, D, Nowell, L., Heath, L., Brueni, D., and Wake, W., *User Tasks and Objects: Envision, a Digital Library*, J. Am. Soc. Info. Science 44(8), pp. 480-491, September, 1993.
- Fox, E., *Digital Libraries*, IEEE Computer, "hot topics" section, November 1993, 26(11), pp. 79-81.
- Fox, E., and Lunin, L., *Introduction and Overview to Perspectives on Digital Libraries* (Guest editor's introduction to special issue), J. Am. Soc. for Info. Science 44(8), pp. 441-443, September, 1993.

- Fox, E., and Abdulla, G., *Digital Video Delivery for a Digital Library in Computer Science*, Proc. High-Speed Networking and Multimedia Computing Workshop, IS&T/SPIE Symposium on Electronic Imaging Science and Technology, Feb. 6-10, 1994, San Jose, CA.
- Fox, E., Shaw J., *Combination of Multiple Searches*, Proc. Second Text Retrieval Conference (TREC-2) (Aug. 30 - Sept. 1, 1993, NIST, Gaithersburg, MD), NIST Special Publication 500-215, 1994, ed. D. K. Harman, pp. 243-252.
- Fox, E., *Seamless Multimedia Integration for Digital Libraries*, Dagstuhl Seminar on Fundamentals and Perspectives of Multimedia Systems, International Conference and Research Center for Computer Science, Dagstuhl Castle, Germany, pp. 118-123, July 4-8, 1994.
- Gladney, H., Fox, E., Ahmed, Z., Ashany, R., Belkin, N., and Zemankova, M., *Digital Library: Gross Structure and Requirements: Report from a March 1994 Workshop*, Digital Libraries '94, June 19-21, 1994, College Station, TX, ed. J. Schnase, J. Leggett, R. Furuta, T. Metcalfe, pp. 101-107.
- Green, C.A. and Williges, R.C., *Using a Group Editor with Alternative Communication Media in a Co-authoring Environment*, Proc. Human Factors and Ergonomics Society 37th Annual Meeting, 1993, pp. 254-257.
- Hartson, H.R. and Mayo, K.A., *A Framework for Precise Reusable Task Abstractions*, Eurographics Workshop on Design, Specification, Verification of Interactive Systems, Carrara, Italy, June 1994.
- Hix, D. and Hartson, H.R., *IDEAL: An Environment for User-Centered Development of User Interfaces*, Proc. EWHCI '94.
- Hix, Deborah, Siochi, A., Hartson, H.R., and Rupert, D., *The Customer's Responsibility for Ensuring usability: Requirements on the User Interface Development Process*, J. Systems Software, to appear, 1994.
- Koenemann-Belliveau, J, Carroll, J.M., Rosson, M.B., and Singley, M.K., *Comparative usability Evaluation: Critical Incidents and Critical Threads*, Proc. CHI '94, pp. 245-251.
- Kurstedt, P. and Neale, W.C., *Using Multimedia to Teach TQM to Engineering Freshmen and Sophomore Students*, Proc. Ann. Conf. and Exposition on Engineering Education, 1994.
- Mayo, K.A. and Hartson, H.R., *Synthesis-Oriented Situational Analysis in User Interface Design*, Proc. EWHCI '93, pp. 134-150, August 1993.
- Neale, W.C. and Kurstedt, P., *The Development of an Interactive Multimedia Courseware Program highlighting Visual Momentum*, Proc. Annual Conf. on Human Factors in Computing Systems (SIGCHI), 1994.
- Nowell, L. and Hix, D., *Query Composition: Why Does it Have to be so Hard?* Proc. EWHCI '93, August, 1993.
- Nowell, L. and Hix, D., *Visualizing Search Results: User Interface Development for the Project Envision Database of Computer Science Literature*, Proc. 5th Int. Conf. on HCI, August, 1993.
- Qian, Y., Fox, E., and Farley, W., *An Object-Oriented Database for the Display Measurement and Analysis System*, Proc. CIKM 93, 2nd International Conference on Information and Knowledge Management, Nov. 1-5, 1993, Washington, D.C., ACM Press, pp. 384-392.
- Robertson, S.P., Carroll, J.M., Rosson, M.B., and Singley, M.K., *Comparative Usability Evaluation: Critical Incidents and Critical Threads*, Proc. CHI '94, pp. 245-251.

- Robertson, S.P., Carroll, J.M., Mack, R.L., Rosson, M.B., Alpert S.A., and Koenemann-Belliveau, J., *ODE: A self-guided, Scenario-Based Learning Environment for Object-Oriented Design Principles*, Proc. OOPSLA '94.
- Rosson, M.B. and Carroll, J.M., *The Reuse of Uses in Smalltalk Programming*, submitted to TOCHI.
- Scholtz, J.M., Chidamber, S., Glass, R., Goemer, A., Rosson, M.B., Stark, M., and Vessey, I., *Object Oriented Programming: the Promise and the Reality*, The Software Practitioner 4(1), pp. 4-7, 1994.
- Williges, R.C., Williges, B.H., and Koushik, G., *Assistive Technology to Facilitate Surrogate Electronic Travelling for Physically Disabled Workers*, paper at APA Symposium on Overcoming Barriers to Work: Interactions of Social and Technical Systems, American Psychological Assn., Toronto, August 1993.

Talks:

- Jack Carroll: Invited talk at the Japanese FRIEND21 '94 International Symposium on Next Generation Human Interface, Tokyo. Published in Proceedings.
- Jack Carroll: Invited talk at the Canadian AI/GI/VI '94 Conference, Banff. Published in Proceedings.
- Jack Carroll: Colloquium at the University of Toronto on building and evaluating multimedia systems.
- Jack Carroll: Invited talk at the Rice university Symposium on Training for 21st Century Technology: Applications of Psychological Research.
- Ed Fox: Seminar at Norfolk State University.
- Ed Fox: Panel presentation for session on Education of the New Information Specialist, ACM CSC'94, ACM Computer Science Conference, Phoenix, AZ, March 8, 1994, *Components of the Informatics Discipline*.
- Ed Fox: Presentation for ACM SIG Chairs Meeting, Phoenix, AZ, March 6, 1994, *Electronic Publishing Experiments: Report on Digital Libraries and their Relationship to SIG Activities*.
- Ed Fox: Invited plenary presentation for EG-MM '94, First Eurographics Symposium and Workshop on Multimedia: Multimedia/Hypermedia in Open Distributed Environments, June 6-9, 1994, Graz, Austria, *Toward a Widely Used Hypermedia Digital Library in Computer Science*.
- Ed Fox: Invited plenary presentation for Tenth IEEE Conf. on Artificial Intelligence for Applications (CAIA), San Antonio, March 1-4, 1994, *Digital Libraries: Why People Use Tools, Not AI*.
- Ed Fox: Keynote address. In G. Knorz, J. Krause, C. Womser-Hacker, eds., Information Retrieval '93, Proc. der 1. Tagung Information Retrieval '93, 13-15 September, 1993, University of Regensburg, Germany, Univ. of Konstanz Press, 116-124, *From Information Retrieval to Networked Multimedia Information Access*.
- Ed Fox: Invited presentation for Workshop on Intelligent Access to On-line Digital Libraries, in connection with IEEE CAIA '94, San Antonio, TX, March 1, 1994, *Background to Current Work on Digital Libraries*.
- Ed Fox: Invited presentation for Workshop: Innovative Uses of High-Tech in Graduate School Operations, CSGS'94, Conf. of Southern Graduate Schools, 23rd Annual Meeting, Clearwater Beach, FL, Feb. 18-21, 1994, *Electronic Theses and Dissertations*.

- Ed Fox: Seminar at Case Western Reserve University, Cleveland, OH, Dec. 21, 1994, *Digital Library Related Research*.
- Ed Fox: Invited presentation for panel on Academic Research Trends in Information Storage and Retrieval, sponsored by SIG/SRT and SIG/MGT, ASIS'93, October 25-29, 1993, Columbus, OH, *Research In Digital Libraries and Networked Multimedia Information Access*.
- Ed Fox: Invited presentation for IBM European Networking Center, Heidelberg, Germany, Sept. 16, 1993, *Networked Multimedia Information Retrieval*.

Ed Fox: Coordinator and presenter in team representing the Blacksburg Electronic Village in briefing at National Science Foundation, Aug. 27, 1993, Washington, DC, *Blacksburg Electronic Village and the NREN*.

- Ed Fox: Invited presentation and chair for panel on Digital Libraries of the Future, ACM Multimedia 93, Aug. 4-6, 1993, Anaheim, CA, *Envision-ing a Computer Science Digital Library*.
- Ed Fox: Invited presentation for 1994 Workshop on Digital Libraries: Current Issues, *A digital library connecting Envision, KMS, and Mosaic with Interfaces, Communications, and Data Interchange*, sponsored by Rutgers and Purdue Universities, AT&T and Bellcore, at Rutgers Univ., Newark, NJ, May 19-20, 1994. Abstract in SIGOIS Bulletin 15(1):6, August, 1994.
- Fox, E. and Balci, O., Invited talk, *MDDS Design Evaluation Environment*, Massive Digital Data Systems Workshop, Feb. 1-2, 1994, Reston, VA, sponsored by Director of Central Intelligence, Community Management Staff, Advanced Technology Office, 1 page abstract, reviewed.

Infrastructure-Related Workshops and Conference Activities:

- Virginia Tech had 20 attendees at the Computer-Human Interaction Conference, **CHI '94** in Boston in April, 1994.
- Jack Carroll: Member of workshop, *New Directions in HCI Education and Research*, **NSF/DARPA**.
- Jack Carroll: Member, Program Committee, **AVI '94** International Workshop on Advanced Visual Interfaces.
- Jack Carroll: Co-Organizer of Workshop at **CHI '94** (with A. Sutcliffe) on Design Rationale.
- Ed Fox: Chairman, **Workshop for Working Group on Theses, Technical Reports, and Dissertations**, in Monticello Electronic Library Initiative, sponsored by SURA and SOLINET, Aug. 12-13, 1994, Virginia Tech, Blacksburg, VA.
- Ed Fox: Associate Program Chair, **Digital Libraries '94**, June 19-21, 1994, College Station, TX, 1994.
- Ed Fox: Conference chair, **Workshop on Information Retrieval and Genomics**, sponsored by ACM SIGIR and SIGBIO, Lister Hill National Center for Biomedical Communications, National Library of Medicine, Bethesda, MD, May 2-4, 1994.
- Ed Fox: Member, **NSF Information Engineering Task Force**, initial meeting Nov. 4-6, 1993, Alexandria, VA, preparing NSF Task Force Report on Developing a Framework for Academic Programs in Informatics: Educating the Next Generation of Information Specialists.

- Rex Hartson, Deborah Hix, and Jacob Nielsen organized workshop, *A Taxonomic Model for Developing High Impact Formative Usability Evaluation Methods*, **CHI '94**, Boston.
- Rex Hartson: Member of Program Committee and group discussion leader at the **Eurographics Workshop on Design Specification, Verification of Interactive Systems**, Carrara, Italy, June, 1994.
- Mary Beth Rosson: Member of Program Committee, **OOPSLA '94**.
- Mary Beth Rosson: Doctoral Symposium Chair, **OOPSLA '94**.
- Mary Beth Rosson: Papers Chair, **CHI '94**.
- Mary Beth Rosson: Member of workshop, *Using Scenarios to Elicit User Requirements*, **CHI '94**.

New Grants and Proposals related to Infrastructure:

- Carroll, John M. and Ehrich, R.W., **Workshop on K-12 Networking** (preproposal), NSF, \$23,100 (pending).
- Dodl, N.R., Ehrich, R.W., Hix, D., and Kavanaugh, A.L., **Planning for Schools in Electronic Villages**, NSF, \$99,824 (pending).
- Ehrich, R.W., Williges, R.C., and Williges, B.H., **Research for Advanced Human-Computer Interface Environments and Interface Development Tools**, Carlow International, \$398,906 (declined).
- Ehrich, R.W. and Fox, E.A., **Interactive Accessibility and Learning for K-12 in the Blacksburg Electronic Village**, NSF, \$780,817 (declined).
- Fox, E.A. and Ozsoyoglu, G., **A Usable, Scalable, Sustainable, Active Digital Library**, NSF, \$4,800,000 (pending).
- Fox, E. A., **Hypertext and Automatic Document Indexing**, PRC, \$25,308 (funded).
- Fox, E. A., Abrams, M., and Newcomb, S., NSF, **SUCCEED: Network Multimedia File System with HyTime**, \$60,000 (funded).
- Fox, E. A., Lee, JAN, Shaffer, C., Hartson, H., and Barnette, D., NSF, **Education Infrastructure: Interactive Learning with a Digital Library in Computer Science**, \$449,088 (funded).
- Fox, E. A., **Text Retrieval Methodologies**, NIST/DARPA, PRC Inc., \$17,489 (funded).
- Fox, E., Balci, O., Abrams, M., and Akscyn R. (President, Knowledge Systems Inc.), ORD/SETA, **Scaling Up the Integration of Multiple Multimedia Servers for High Performance through Visual Simulation**, \$275,717 (declined).
- Fox, E. and Rosson, M.B., SURA (for Dept. of Education), **Unlocking Research in Dissertations, Theses and Technical Reports Through Advanced Information Technology**, \$101,871 (pending).
- Hartson, H.R., Hix, D. Fox, E.A., Ehrich, R. and Williges, R., NSF, **Graduate Traineeships in HCI at Virginia Tech**, \$566,500 (declined).
- Hix, D. and Hartson, H.R., **Evaluating Evaluation - the Search for High-Impact Usability Evaluation Methods**, NSF, \$499,000 (pending).

- Hix, D., Schmidt-Nielsen, A., and Jacobs, R., Beyond Wimp Interfaces: **Creating and Evaluating Next Generation Interaction Techniques**, DARPA, \$1,588,865 (declined).
- Shaffer, C., **The GeoSim Interface Library for Introductory Programming Courses**, NSF, \$19,768 (pending).
- Schaffer, C., **A Network-Based Scientific Database Browsing System**, NASA, \$269,668 (pending).

Infrastructure-Related Degrees Awarded:

James M. A. Begole, MS, *The Effectiveness of Online Interactive Tutorial v. Online Help and Printed Manual in Project GeoSim's User Assistance System.*

Sangita Betrabet, MS, *A Query Language for Information Graphs.*

Joseph D. Chase, PhD, *A Study to Develop and Evaluate a Taxonomic Model of Behavioral Representation Techniques.*

Amjad Daoud, PhD, *Efficient Data Structures for Information Storage and Retrieval.*

Kenneth Hinson, MS, *A Foundation for Translating User Interaction Designs into OSF/Motif-based Software.*

Geetha Koushik, MS, *Specifications of an Expert System for Configuring Teleconferencing Systems.*

Kevin Mayo, PhD, *Definition and Evaluation of a Synthesis-Oriented User-Centered Task Analysis Technique: The Task Mapping Model.*

Infrastructure-Related Degrees in Progress:

Ghaleb Abdulla, PhD, *A Methodology for Modeling and Design of Hypermedia Digital Libraries for Education.*

Michael Bibeau, MS, *Evaluation of Learning Modes of Young Children Using Computers.*

Jeffrey Brandenburg, PhD, *Timetrees: A Branching-Time Structure for Modeling Activity and State in the Human-Computer Interface.*

Joseph S. Cochran IV, MS, *Critical Factors in Three-Dimensionally Displayed Hierarchical Databases.*

Kaushal Dalal, MS, *Database Manager and Session Coordinator for Envision.*

Sophie Davoine, MS, *Evaluation and Adaptation of a Non Single Lens Reflex Camera for Users with Manual Impairments.*

Susan Keenan, PhD, *Using Defect Analysis to incorporate User Interface Activities into Software Engineering.*

Stuart Laughton, PhD, *Participatory Design of Network-Based Collaborative Applications for Education.*

Juli Lin, MS, *A Method of Applying Rating Scales to Evaluate the Accessibility and Usability of Consumer Products for Users with Special Needs.*

David Martin, *Fast Algorithms for MRPs and k-Bounded Maximal Repeating Patterns.*

Albert Moore, MS, *A Computer-Based Training Program for Accessing Material Safety Data Sheet Comparison.*

Dennis Neale, MS, *Field of View and Visual Momentum in 3-dimensional Perspective Displays.*

Wayne Neale, PhD, *An Experimental Test of Dual Coding Theory Using Various Media and Visual Momentum in a Multimedia Environment.*

Lucy Nowell, PhD, *User Interfaces for Visualizing Search Results.*

Carlton Petitt, MS, *Simulating User Experience in Computer-Based Multimedia Instruction.*

Joseph Shaw, MS, *Combining Information for Effective Retrieval.*

Yanchun Su, MS, *Hypermedia Support for a Digital Library in Computer Science.*

Madhan Subhas, MS, *(Semi-)Automatic Creation of Hypertext Links in Digital Libraries.*

William Wake, PhD, *Multiple Views of Information.*

Visitors:

Larry Smarr, NCAR

Stephen Robertson, City University, London.

Paul Kantor, Rutgers University.

Springer-Verlag electronic publishing directors and vice presidents from NYC and Heidelberg, Germany.

Julie Sabaratnam and Wu Choy Peng, National Computer Board, Singapore.

Michael Bieber, Director, New Jersey Inst. of Tech. Hypermedia Research Lab.

Sandra DeLoatch and John Urquhart, Norfolk State Univ.