

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

**Department of Computer Science
Virginia Tech**

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The Research Program:

The strongest focus of this year's efforts across the Research Infrastructure has been on collaborative networking. There has been intense interest in collaborative environments of different types to support problem solving, community discussion, asynchronous debate, discussion and student performance evaluation for college-level courses, and especially K-12 collaboration. This latter effort was launched through a large NIE/NSF program in cooperation with county middle and high schools that began in January. The goal is to design and evaluate networked systems for interactive, collaborative science experiments. The initial work has focused on developing a collaboration infrastructure with a Java front-end, on exploring state of the art software for science simulation and visualization, and on documenting current physics instruction patterns through observation, videotapes and student/teacher interviews.

In other research, funding from two Navy sources is supporting investigation of new interaction techniques and usability of synthetic environments. The Naval Research Laboratory in Washington, DC is funding development and evaluation of a new interaction technique called pre-screen projection, in which screen displays move in relation to a user's head movements. New funding from the Office of Naval Research is supporting a systematic study of usability characteristics for synthetic environments, to culminate in a taxonomy of such characteristics.

Work continues on the Project Envision user interface; Envision is a digital library of computer science literature with a graphical interface for which users can control different visualizations of search results. Envision's interface design is being used to empirically study psychophysical issues of interface design, including such variables as color, shape, and size of screen objects.

Other digital library projects include new joint work with IBM, the NCSTRL (Networked Computer Science Technical Report Library) group, and SURA (Southeastern Universities Research Association) support for Electronic Theses and Dissertations (ETDs). Virginia Tech now accepts the final documents for M.S. and Ph.D. students electronically instead of on paper, and will require that after 1996. Representation of ETDs using Adobe's Portable Document Format (PDF) and later, SGML, will allow search, retrieval and reuse of graduate research on an unprecedented scale. SURA support will help this project to extend throughout the Southeast and beyond.

Other research efforts that have been initiated this year include remote evaluation (usability evaluation for users of computer interfaces at remote locations), K-12 educational tools to support data exploration and visualization, support tools for statistics education for the social sciences at university level, and usability and design of WWW-based digital libraries.

Finally, to coordinate HCI activities across the University, a Center for Human-Computer Interaction was created with an initial membership of 27 researchers. The Center for Human-Computer Interaction facilitates interdisciplinary faculty interaction, and helps focus and coordinate research and service projects throughout the university and the wider community in the broad research area of human-computer interaction.

Other projects

- Continued development of GeoSim, our geographic educational system.
- Continued work on SWAN, a data structure visualization tool.
- Conducted continuing research on the topics of high-impact usability methods for developing user interfaces and a tool (IDEAL) for supporting formative usability evaluation.
- In conjunction with the HCI group at the Naval Research Lab in Washington, DC, research in inventing and evaluating new interaction techniques, especially for synthetic and virtual environments.
- Interaction with the Industrial and Systems Engineering's Software Technologies Lab, with user interface design, evaluation, and training.

Space and Renovations:

Laboratory and departmental renovations have been completed. The first floor of McBryde which houses the laboratories is closed until July for cleaning of the air handling systems in response to reports of health problems. In the meantime, research is continuing in our laboratories in Industrial and Systems Engineering. Planning for outfitting of the collaboration facility is continuing, and the construction will proceed after we regain physical access.

UMRL - Usability Methods Research Laboratory (Williges):

This Laboratory is being used for development of new methods, new tools, and new theory. Last summer a Computer Science PhD student with an NSF student fellowship joined our HCI team, and has developed a second generation IDEAL, a tool to support all activities of the user interaction development process, with emphasis on video tape control for recording, playback, and analysis of usability evaluation sessions. We have performed several cycles of formative evaluation of IDEAL, and we are meeting with developers of similar commercial tools to explore collaboration and possible commercialization. We are using a combination of the collaboration facility and the UMRL to explore the usefulness of IDEAL in two new types of applications. In the first, IDEAL was used to control video taping of a brainstorming session on a new HCI research topic. Video tapes were tagged, in real time, with important points and comments, as critical incidents of the discussion. We plan to perform a similar exercise within the context of distance teleconferencing.

We are also developing a taxonomy for classifying usability problems identified during usability evaluation. The UMRL was used to perform some formative evaluation of this taxonomy by multiply simultaneous evaluators. This work is leading to a proposal that is nearly ready to be submitted to NSF, on developing high-impact usability methods.

The UMRL facilities were used to develop and evaluate a new method of remotely evaluating an interface. Specifically, users were trained to identify critical incidents in their own task performance. This information is packaged with information about task context and sent, across the net, to developers for analysis, as a substitute for more expensive laboratory-based evaluation. UMRL provided the unique setting for making possible this research on meta-observation and meta-evaluation of evaluation methods.

Because of the very strong interest in research on collaboration, we have been conducting studies on design of the collaboration facility which is part of the UMRL. We have also discussed the designs with groups of collaborating researchers across the University. A group of students in our multimedia class also produced a detailed design document, available on the www at the address, <http://video.cs.vt.edu:90/ccr>. We are reserving as much of our NSF funding as possible to support a superb implementation, and have formed a partnership with the Learning Resources Center of the University to bring additional funding and design expertise to the project.

ITL - Interaction Technology Laboratory (Hartson and Hix):

Part of this Laboratory exists in a dedicated space, while other parts of it are distributed elsewhere to support various projects. For example, a Silicon Graphics workstation, with Ascension trackers, a SpaceBall, and other peripheral devices, is currently located in the HCI Laboratory of the Industrial and Systems Engineering Department. This equipment is being used to develop and evaluate new interaction techniques, including pre-screen projection (see above). This work, funded by the Naval Research Laboratory in Washington DC, would not have been

possible without the equipment funds provided by our Research Infrastructure grant. Equipment is being added as needed for various research projects. Projects using this Laboratory include Project Envision (see above), GeoSim (a geographical information system for geography education), and work to analyze large volumes of video taken as part of the new NIE/NSF collaborative networking project.

IAL - Information Access Laboratory (Fox):

This laboratory has expanded to the Computing Center, where various digital library systems are housed. First, we acquired an IBM SMP system with 4 processors, 512M RAM, and 2 Tbytes of digital linear tape (DLT) that serves as our large-scale storage facility and host for various digital library efforts. Second, we acquired a DEC Alpha that is the dedicated backup server for the Networked Computer Science Technical Report Library (NCSTRL) service. Third, we moved some NeXT systems there for distributed processing experiments on the MARIAN system, which now supports advanced retrieval methods for public access to almost 1 million MARC records that describe the campus library holdings. MARIAN is accessible over WWW and soon will be accessible using the Envision interface, facilitating further information visualization and interface studies.

The CS portion of our lab has one new RS/6000 on loan from IBM for large scale evaluation studies of their digital library software, and another that will be relocated at ACM headquarters to help with our ongoing CS digital library development and investigations. A variety of systems monitor, improve performance through caching, or provide access to our distributed digital library of CS publications and courseware that now handles over 25 courses. Almost 5000 WWW pages have been developed by local faculty, and weekly accesses often exceed 50,000 per week. This will expand as more of our service courses become automated through use of special interactive testing tools we have developed and enhanced with multimedia resources we have prepared.

With the Library and Graduate School we have expanded the Electronic Theses and Dissertation study, training hundreds of faculty and students on campus, and preparing materials to be used by other institutions in the Southeast and beyond. Our research in automatic conversion to an archival SGML representation may pave the way for large-scale digital library expansion through new works (ultimately including about 400K ETDs per year)!

Many studies of caching were undertaken; we are deploying 5 computers around campus to monitor WWW activities so we can model and simulate growth of digital libraries and the WWW. Clustering methods were used to help with hypermedia development in a study funded by PRC Inc. Our new digital video system featured in many of the 10 multimedia information projects undertaken by students in Spring 1996.

Interaction Consulting Service (Ehrich):

A Masters candidate from the Industrial and Systems Engineering Department performed an extensive formal formative evaluation of a commercial software product (InTouch, from Prairie Software Group). The student worked with developers to establish an in-depth usability development plan, and used IDEAL and the usability problem taxonomy, thereby providing extensive evaluation of these research efforts as well.

We are still seeking a good framework for implementing our consulting service; a new possibility we are considering is implementing this within the framework of our University-Wide HCI Center.

Curriculum and Education:

A new junior-level CS undergraduate course, CS3724, **Introduction to Human-Computer Interaction**, was taught in Fall 1995. The course included a number of demonstrations supported by hardware, software, and personnel in our new laboratories. CS4624 is the new number given to the recently approved course, Multimedia, Hypertext, and Information Access that was taught in Spring 1995 and 1996 as a special topics course.

At the graduate level, we are in the process of preparing two new courses: CS5724 will cover basic models and theories of human-computer interaction and will be taught for the first time in Fall 1996. CS5734 will focus on issues and technology for computer-supported cooperative work; a readings/project course in CSCW will be taught as an advanced topics seminar in Spring 1997. CS5714 has also been revised to focus more narrowly on usability engineering methods and will make heavy use of the HCI facilities in support of the graduate student design and evaluation projects. Finally, we have added an advanced topics course specifically targeted to human-computer interaction; prior HCI graduate seminars in Scenario-Based Design and in Network Communities have had good enrollment.

This is the first year of our new NSF Sponsored Graduate Traineeship Program, and we have so far made two awards to recruit students into the HCI program.

New Personnel:

Jurgen Koenemann was appointed to a postdoctoral research position, with primary responsibilities to assist with the NIE/NSF collaborative networking program.

Equipment:

Major equipment purchases during this year included the mass storage server (\$90,000 RI funds, plus \$80,000 university funds and \$250,000 cost shared by IBM) and a number of high end workstations (DEC Alpha, Sun Sparcstations, Power Macs, and Thinkpads), due to a strong need for platforms to support new collaborative networking efforts and Java development work. Acquisition of the 2 Tbyte IBM hierarchical storage system culminates a long effort to obtain a

system with sufficient performance, and we feel that our decision not to purchase earlier inadequate technology was well justified. The delay also made it possible for us to form a new collaborative relationship with IBM.

We accepted the digital video system whose purchase was initiated in 1995, and it was immediately used in the multimedia class to train students and produce professional quality video productions. This system is now the most advanced system in the University, and again, the decision to delay purchase until the technology was available has been well rewarded.

The University is continuing to move toward an ATM networking backbone, and discussions have continued through the past year to integrate the Department and University. The need for high bandwidth video connections to several departmental servers will require a high capacity architecture. Equipment testing by the University's Communication and Network Services division also has been continuing, and only recently has ATM equipment begun to perform at satisfactory levels. Through additional funding from the State Council of Higher Education, the first order for an ATM hub has been placed, and we expect the next one to be ordered with NSF funds as planned later this summer.

Plans for Next Year:

At this time, we feel that many of the research projects we have been nurturing over the past few years are in a position to make optimal use of our new facilities. We in-depth continued research along the lines of this year's work and the new network-based collaboration initiatives.

In the Information Access area, monitoring/modeling/simulation will be extended so we understand users' behavior when working with the WWW and digital libraries, and can improve (distance) education accordingly. The IBM system will become fully operational, better supporting our various digital library systems, especially for computer science and for theses and dissertations.

These activities were well foreseen, and NSF funding will continue to support the acquisition of workstations to continue building our laboratory capabilities. Also, as in the original plan, additional expenditures will be made to build the Departmental networking capability through ATM support.

The RI investigators feel that the strongest focus of the RI program itself in the next year needs to be the collaboration/electronic conference room facility, because it provides a common testbed for the most advanced networking and collaboration technologies that everyone will be using. Accordingly, we are planning to allocate a somewhat higher portion of RI funds than we had initially planned for that purpose. Part of this has become possible due to IBM's cost sharing of the mass storage system, which reduced our expected costs. This is not a programmatic change but rather an expression of our current emphasis.

Budget:

Since we knew that our laboratories would be sealed until later this summer due to the bacterial decontamination work, we decided to postpone purchase of some of the equipment that would be housed there. Based upon our anticipated expenditures at the end of this grant period, we wish to request a funds carryover into the fourth grant year of **129,264** as detailed below:

1. Programmer salary: As we explained in Year 1 progress report, our programmer was not available until February of Year 1, 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. Laboratory equipment: Due to the temporary inaccessibility of our laboratories, we wish to defer the purchase of \$20,000 in workstations for the Interaction Technology Laboratory and \$40,000 of the video/audio equipment for the Usability Methods Laboratory. Since the design of the collaboration facility is nearing completion, we will begin equipment acquisition shortly. However, since it is physically off-limits, we expect that half (\$50,000) of the equipment will be purchased early in the coming year.

Expenditure	Carryover
John Kelso, Res. Asst.	10,800
Fringe	2,484
Equipment	110,000
Indirect Costs	5,980
TOTAL	129,264

Since we have a great deal of experimentation to do in determining the physical configuration of this facility regarding lighting, acoustic adjustments, special workstation furniture design, and cabling, we do request the Program's permission to allocate up to \$10,000 for this aspect of our research. While we are being as deliberate as possible, we recognize that there may be aspects of our design that we will not get right the first time. Specifically, we request the Program's permission to transfer up to \$10,000 in Year 4 from facilities maintenance to an equipment category suitable for the purchase of these components.

There are no programmatic changes aside from the emphasis noted above on the collaboration facility.

APPENDIX

Infrastructure-Related Publications:

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- Fox, E.A. and Nowell, L.T., Envision: Information Visualization in a Digital Library, Demonstration for ACM SIGIR'95, Seattle, WA, July 10, 1995.

- Fox, E.A., Digital Libraries and CS Education, Invited Colloquium, George Mason U., Nov. 13, 1995.
- Fox, E.A., Education and Research with a Digital Library in Computer Science, Invited presentation for IBM Almaden Research Center, Nov. 3, 1995.
- Fox, E.A., Education and Research with a Digital Library in Computer Science, Invited presentation for IBM Watson Research Lab, Oct. 27, 1995.
- Fox, E.A., Electronic Librarians, Intelligent Network Agents, and Information Catalogues, Invited presentation for Reconnecting Science and Humanities in Digital Libraries, sponsored by the Univ. of Kentucky and the British Library, 19-21 October 1995, Lexington, KY.
- Fox, E.A., Computer Science Technical Reports Library, Invited presentation for Unlocking University Information, sponsored by SURASOLINET, Atlanta, Sept. 6-7, 1995.
- Fox, E.A., IR Education in CS. Invited presentation for Panel on Education for IR, ACM SIGIR'95, Seattle, WA, July 12, 1995.
- Fox, E.A., Digital Libraries through Information Retrieval for Education. Presentation for Distinguished Lecture Series, Univ. Utah Dept. of Computer Science, March 7, 1996.
- Fox, E.A., Rethinking libraries in the information age: lessons learned with 5 digital library projects, Henderson Lecture, UNC Chapel Hill, Feb. 1, 1996.
- Hartson, H.R., Ensuring Usability of Interactive Systems, National Institute of Standards and Technology, Gaithersburg, MD, September 17, 1995.
- Fox, E., IR Curriculum: Information Engineering to Digital Libraries, Invited presentation for Drexel University hosted Workshop/Symposium sponsored by the W.K. Kellogg Foundation "Information Retrieval 2000 --- Workplace Needs and Curricular Implications", Marriott Hotel, Philadelphia PA, May 24, 1996.
- Hartson, H.R., Ensuring Usability of Interactive Systems, Social Security Administration, Baltimore, MD, February 26, 1996.
- Hix, Deborah, Invited Presentation, Usability Engineering, Food Stamps Agency, October 1995.
- Hix, Deborah, Invited Presentation, Developing User Interfaces, AIPA Conference, Washington DC, March 1996.
- Kuchinsky, A., Carroll, J.M., Farmer, R., McDonald, S., Suchman, L.A., Invited plenary panel presentation on Future Visions of the National Information Infrastructure. Society and the Future of Computing Conference, Snowbird Utah, June 16-20, 1996.
- Williges, R.C., Iterative Design and Usability Evaluation in Human Factors Engineering, Seminar at Virginia Tech, Department of Industrial and Systems Engineering, May 1996.
- Williges, R.C., Introduction to Experimental Design, Electronic lecture for the Engineering Summer Conference, The University of Michigan, August 1995.
- Williges, R.C., Designing for Special Populations, Electronic lecture for the Engineering Summer Conference, The University of Michigan, August 1995.
- Kies, J.K., Williges, R.C., Rosson, M.B. Evaluating Parameters in a Simulated Computer-delivered Course, Poster presented at the Third Annual SUCCEED Conference, Roanoke VA. February, 1996.

- Rosson, M.B. and Carroll, J.M. 1996. Introduction to Object-Oriented Design Tutorial, CHI'96 Conference on Human Factors in Computing Systems, Vancouver, Canada, April 14, 2-page description appears in *CHI'96 Conference Companion*. New York: ACM Press/Addison Wesley, pages xx-xx.

Infrastructure-Related Workshops and Conference Activities:

- Jack Carroll, Member of Program Committee for DIS'95: ACM Symposium on Designing Interactive Systems, August 23-25, Ann Arbor, Michigan.
- Jack Carroll, Organizer of Society for Technical Communication's Workshop on Minimalism since the *Nurnberg Funnel*, Blacksburg VA, November 17-19, 1995.
- Jack Carroll, Member of Program Committee for CIC'95: Third International Conference on Computing in Context, August 14-18, 1995, Aarhus, Denmark.
- Jack Carroll, Member of Program Committee for ESP 6: Sixth Workshop on Empirical Studies of Programmers, January 5-7, 1996, Alexandria, Virginia.
- Jack Carroll, Member of Program Committee for IFIP Working Groups 8.1 and 13.2 Joint Conference on Domain Knowledge for Interactive System Design, May 9-12, 1996, Montreux, Switzerland.
- Jack Carroll, Member of Program Committee for IDS-3: The Third International Workshop on Interfaces to Databases, July 8-10, 1996, Edinburgh, Scotland.
- Jack Carroll, Member of Program Committee for PDC'96: Fourth Biennial Conference on Participatory Design, November 13- 15, 1996, Cambridge, Massachusetts.
- Edward Fox: Program committee member, IEEE Multimedia Systems '97, IEEE International Conference on Multimedia Computing and Systems (ICMCS), June 3-6, 1997, Ottawa, Canada.
- Edward Fox: Program committee member, 1997 International Conference on Software Engineering, ICSE 97, May 17-24, 1997, Boston, MA.
- Edward Fox: Steering committee member, NSF-sponsored 38th Allerton Institute, Oct. 27-29, 1996, Monticello, IL.
- Edward Fox: Program committee member, 19th Intern'l Conf. on R and D in Information Retrieval, SIGIR '96, Aug. 18-22, 1996, Zurich, Switzerland.
- Edward Fox: Technical Program Committee member, HPDC Focus Workshop on Multimedia and Collaborative Environments, part of Fifth IEEE Int. Symp. on High Performance Distributed Computing (HPDC-5), Aug. 6-9, 1996, Syracuse, NY.
- Edward Fox: Program committee member, Pacific Workshop on Distributed Multimedia Systems, DMS'96, June 25-28, 1996, Hong Kong.
- Edward Fox: Program Chair, Digital Libraries'96, First ACM International Conference on Digital Libraries, March 20-23, 1996, Bethesda, MD.
- Edward Fox: Program committee member for Multimedia Computing and Networking 1996 - part of the IS&T/SPIE Symposium on Electronic Imaging Science and Technology, Jan. 29-31, 1996, San Jose, CA.

- Edward Fox: Program committee member, ISMIS'96, organized with the assistance of the Polish Academy of Sciences, June 10-13, 1996, Zakopane, Poland.
- Edward Fox: Member, Steering Committee, Monticello Electronic Library, a project of SURA and SOLINET.
- Edward Fox: Member, Columbia U. Digital Library Advisory Committee.
- Edward Fox: Co-chair, ACM SIGMM Education Committee.
- Edward Fox: Member, ACM SIGIR Electronic Publishing Committee.
- Edward Fox: Member, IBM Digital Library Council.
- Edward Fox: Co-chair, Working Group on Theses, Technical Reports, and Dissertations, in Monticello Electronic Library Initiative, sponsored by SURA and SOLINET.
- Edward Fox: ACM SIGIR Education Committee member.
- Edward Fox: Steering committee member, NSF-sponsored 37th Allerton Institute, "How We Do User-Centered Design and Evaluation of Digital Libraries: A Methodological Forum," Oct. 29-31, 1995, Monticello, IL.
- Edward Fox: Senior Member of the Program Committee, member of conference executive committee, ACM Multimedia '95, Third ACM International Conference on Multimedia, Nov. 5-9, 1995, San Francisco, CA.
- Edward Fox: Program committee member, CIKM 95, Fourth International Conference on Information and Knowledge Management, Nov. 28 - Dec. 2, 1995, Baltimore, MD.
- Rex Hartson was Co-Organizer of the Symposium on Usability Engineering: Industry-Government Collaboration for System Effectiveness and Efficiency, NIST, Gaithersburg, MD, February 26, 1996.
- Mary Beth Rosson, SIGPLAN Executive Committee, 1995-present.
- Mary Beth Rosson, OOPSLA95 Doctoral Symposium Chair.
- Mary Beth Rosson, OOPSLA96 Program Committee.
- Mary Beth Rosson, UIST96 Program Committee.
- Mary Beth Rosson, CSC96 Tutorials Chair.
- Mary Beth Rosson, CHI97 Technical Program Co-Chair.

Awards:

- Meij, H. van der and Carroll, J.M., Principles and heuristics for designing minimalist instruction, Society for Technical Communication's Distinguished Technical Communication Award, 1996.
- Williges, Robert C., Paul M. Fitts Award for Outstanding Contributions to the Education and Training of Human Factors Specialists from the Human Factors and Ergonomics Society in October 1995.

New Editorial Positions:

- Osman Balci, Editor of *The World Wide Web Journal*, a new publication of Balzer.

New Grants and Proposals related to Infrastructure:

- Arrington, L., Burton, J., Carroll, J., Rosson, M.B., and Shaffer, C., **Leveraging Networks for Collaborative Education in the Blacksburg Electronic Village**, NSF, \$1,117,128 (funded).
- Balci, O., and Nance, R.E., **Measurement and Evaluation of Complex Navy System Designs: Phase II**, Naval Surface Warfare Center, \$ 136,552 (funded).
- Bernard, H., Ehrich, R.W., Waggaman, L., and Matusевич, M., **A Model for Systemic Reform in a Key Middle School**, DOE, \$7,025,199 (declined).
- Carroll, J., Abrams, M., Ehrich, R., Rosson, M.B, Hix, D., Hartson, R., Shaffer, C., and Fox, E.A., **Graduate Research Traineeship in Human Interface Design for Access to Computers and Networked Information at Virginia Tech**, NSF, \$562,500 (funded).
- Carroll, J., and Rosson, M.B., **Developing a Scenario-Based Framework for Mediated Usability Evaluation**, NSF, \$321,161 (declined).
- Cohill, A. and Kavanaugh, A., **Building Community in Rural America: A Replicable Model for Networking**, NTIA/DOC, \$266,710 (funded).
- Ehrich, R.W. and Matusевич, M., **Testing a Network-based Approach to Home-School School Coupling in Elementary Education**, DOE, \$571,090, (pending).
- Ehrich, R.W., **WWW-Based, High Performance Full Text Retrieval**, ICRA, Inc., \$4,541 (pending).
- Fox, E., Eaton, J., and McMillan, G., **Development and Beta Testing of the Monticello Electronic Library Thesis and Dissertation Program**, SURA, \$90,117 (funded).
- Fox, E., Abrams, M., Barnette, N. D., **Using Computers and Networked Information: Distance Learning with Networked Multimedia**, NSF SUCCEED, \$32,000 (funded).
- Fox, E., **Program Equipment Donation** for 4-processor SMP machine for digital library research, IBM: SUR, \$250,000 (funded).
- Fox, E., Eaton, J., and McMillan, G., **Improving Graduate Education with a National Digital Library of Theses and Dissertations**, Department of Education, \$270,000 (pending).
- Fox, E., **Multimedia, Hypertext and Information Access**, NSF, \$400,000 (pending).
- Fox, E., **Information Retrieval Systems Evaluation**, IBM, \$11,002 (funded).
- Hartson, H.R. and Hix, D., **Developing High-Impact Usability Evaluation Methods**, NSF, \$500,000 (pending).
- Heath, L. S., Green, E. L., and Rosson, M. B., **Challenging hard problems in symbolic mathematics**, NSF, \$458,030 (declined).

- Hix, Deborah, **Developing a Taxonomy of Maneuvering Tasks and Techniques in Synthetic Environments**, Naval Research Laboratory, \$74,000 (funded).
- Hix, Deborah, **Developing High Impact Usability Evaluation Methods for Virtual Environments**, Office of Naval Research, \$75,000 (funded).
- Kriz, R., Hix, Deborah, Abbott, L., Abrams, M., Shaffer, C., Watson, L., Williges, R., Ehrich, R., and Farkas, D., **Breaking the Barriers of 3D Visualization**, Department of Defense, Multidisciplinary Research Program of the University Research Initiative, \$4,500,000 (declined).
- Klemperer, D. and Ehrich, R., **World Wide Web-accessible Interactive Learning Software for Forest Economics Courses**, USDA, \$79,957 (pending).
- Rosson, M. B., **Studies of scenario-based design**, (Software grant from Quasar Knowledge Systems, for 4 licenses of QKS SmalltalkAgents) \$1,600 (funded).
- Shaffer, C.A., Carroll, J.M., Campbell, J.B., Hauenstein, N., and Hertl, B., **Integrating Statistics and Models Across the Social Sciences Curricula**, FIPSE, \$295,000 (pending).
- Shaffer, C.A., Carroll, J.M., Campbell, J.B., Hauenstein, N., and Hertl, B., **Integrating Statistics and Models Across the Social Sciences Curricula**, NSF, \$347,760 (declined).
- Watson, L., Ribbens, C., Rosson, M. B. and Kamke, F., **Environment for Modeling of Transient Effects in Processing of Polymeric Composites**, submitted jointly to NSF and USDA, \$320,445 (pending).
- Williges, R.C., **Guideline for Speech Recognition Technology in Automotive Control Systems**, Delco Electronics, \$59,500, (funded).
- Williges, R.C. and Rosson, M.B., **Usability Evaluation of Electronic Connectivity in the SUCCEED Coalition**. NSF, \$40,000, (funded) with an additional \$40,000 extension for the next year pending.

Service:

- Jack Carroll, Nominating Committees for 1996 Kyoto Prize in Advanced Technology (the Inamori Foundation, Tokyo, Japan)
- Jack Carroll, Nominating Committees for 1996 (Twelfth) Japan Prize (Science and Technology Foundation of Japan)
- Jack Carroll, British Joint Councils Initiative in Cognitive Science and Human-Computer Interaction (June 2-8, 1996)
- Jack Carroll and Cliff Shaffer, National Science Foundation Education Technology Workshop, sponsored by CISE and EHR directorates, 29 September - 2 October, 1995, Vienna, VA

Infrastructure-Related Degrees Awarded:

Brian Amento, MS, *Coursework-only option*.

Anders Bertelrud, MS, *An Object-Oriented Simulator for the VSE*

C.A. Bussi, Ph.D., *Intelligent Vehicle Highway System Information Display for in-vehicle Routing and Navigation System*

David DeVaux, MS, *A Tutorial on Authorware*

David Hines, MS, *Computerized Simulations for Geography Instruction: Sense of Place*

Stuart Laughton, Ph.D., *The Design and Use of Internet-Mediated Communication Applications in Education: an Ethnographic Study*

Xiangdong Liu, Ph.D., *Analysis and Reduction of Moire Patterns in Scanned Halftone Pictures*

Vickie Riggins, MS, *An Exploration of internet Access Methods - A Medical Case Study*

William Kenneth Schmidt, MS, *A History Base for the Blacksburg Electronic Village*

Jun Yang, MS, *SWAN -- A Data Structure Visualization System*

Infrastructure-Related Degrees in Progress:

Ghaleb Abdulla, Ph.D., *Digital Library and Web Scalability through Characterization and Modelling*

Brian Amento, Ph.D., *Developing and Evaluating New interaction Techniques for Virtual Environments*

John Raley, MS, *Issues in Undergraduate Programming Performance*

James Begole, Ph.D., *Collaborative Visualization*

Jose Castillo, MS, *User-Assisted critical Incident Identification for Remote Usability Evaluation*

George Chin, Ph.D., *Participatory Design of Project-Based Science Education in a Networked Environment*

Joe Cochran, MS, *Critical Factors in Spatially Displayed Hierarchical Databases*

Joseph Gabbard, MS, *A Taxonomy of Usability Characteristics for Synthetic Environments*

A.W. Gellatly, Ph.D., *Guideline Development for the Implementation of Speech Recognition Technology in Automotive Control Systems*

M.E. Hacker, Ph.D., *Optimization of Small Group Decision Making During Implementation Planning*

Susan Keenan, Ph.D., *Product Usability and Process Improvement Based on Usability Problem Classification*

John Kies, Ph.D., *Empirical Methods for Evaluating Video-mediated Collaborative Work*

Neill Kipp, Ph.D., *Document Structuring Style for a Digital Library of Theses and Dissertations*

Michael McGee, MS., *Development and Validation of a Measure for Side Effects Experienced in Immersive Virtual Environments*

Cortney Martin, Ph.D., *Usability of WWW-Based Digital libraries*

Will Mitchell, Ph. D., *Effects of Locus of Control and Embedded Questions on Behavioral-Attitudinal Change and Knowledge Gain in a Computer-based Interactive Video Environment*

Lucy Nowell, Ph.D., *Psychophysical Foundations for User Interface Design*

Ray Reaux, Ph.D., *Process for Encapsulating Cognitive, Behavioral, and Constructional Representations in Human-Computer Interaction Object Artifacts*

Randy Ribler, Ph.D., *Visualizing and Modeling Categorical Time Series Data*

Joseph Riess, Ph. D., *Information Management on the World-Wide Web*

Michael Snow, Ph.D., *Charting Presence in Virtual Environments and its Effects on Performance*

Joseph Shaw, MS, *Combination of Multiple Queries and Retrieval Methods for Improved Full Text Information Retrieval*

Lucio Tinoco, MS, *History Management in Collaborative Courseware*

Bill Wake, PhD., *A Model and Interface for Documents with Multiple Views*

Mei See Yeoh, MS, *Scaffolded Examples for Teaching Object-Oriented Design in the Java Language*

Visitors:

Michel Bezy, IBM, September 1995

J. Cachiones, IBM Vice President, July 1995

Su Shing Chen, NSF, October 1995

Ben Shneiderman, April 1996, Diggs Scholar Speaker

Randall Smith, SunSoft, April 1996

Thomas Kuehme, Siemens, January 1996