Research in Distributed Collaboration

Design and Evaluation of the Collaborative nanoManipulator

Department of Computer Science **University of North Carolina at Chapel Hill** **March 2001**

The Challenge

At UNC–Chapel Hill, a multi-disciplinary team is designing, implementing, deploying, and evaluating a distributed collaborative version of an interface to an atomic force microscope—the nanoManipulator (nM). When scientists using the nM are working face to face, their social interactions and physical activities are natural and visible to each other and there is single-user control of the scientific instrument. In distributed collaboration, all aspects of social and physical interaction must be provided via technology and the instrument control must support simultaneous access by multiple users over the network. To create effective systems for distributed scientific collaboration, we first studied what the scientists expect from collaboration and then identified and implemented technology to meet those requirements. Our goals include building an effective system for distributed collaboration and gaining an understanding of the impact that distributed access to scientific instruments has on the scientific process and its outcomes.

Study participants collaborating in the same location.

The Approach

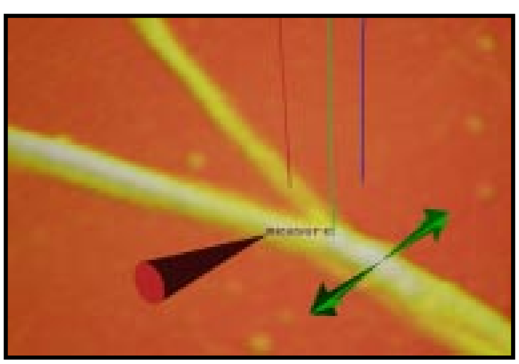
The technical diversity of this research demands an interdisciplinary approach. Participating in the research are professors and students from several departments at UNC–Chapel Hill. Information Science leads the needs assessment, user interface design, and evaluation projects. Computer Science has developed the distributed nanoManipulator (nM) and leads the network performance projects. The team has scientist-users in three physical sciences departments who provide design requirements and participate in ongoing evaluation of the system.

Identifying Needs

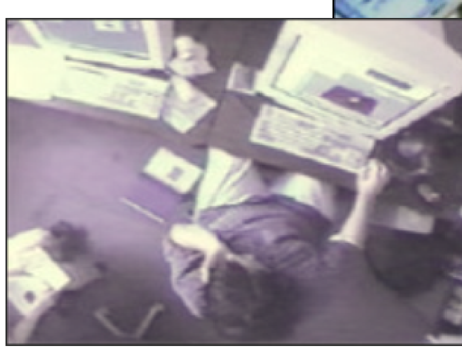
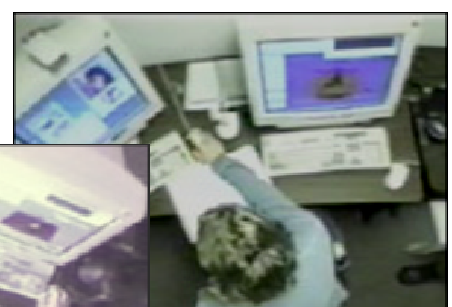
We first conducted an ethnographic study of how scientists collaborate when they are face to face. Thirty observations and twenty-six interviews were conducted with the physical scientists to help identify their social, physical and scientific needs during collaboration. Some of the needs identified included support for communication on several levels ranging from awareness of who is in the room to the ability to share physical objects, such as models.

Designing and Building the System

Data from the observations and interviews were synthesized and used as the basis for the design of the distributed system. Tools to support communication include video conferencing software, two cameras, and a telephone. Tools to support the science include a version of the nM that has been modified to support distributed collaboration and analysis and report generation applications that are shared using NetMeeting™. Important features of the collaborative nM interface are: dual cursors that allow users to see their collaborators' focus of



Dual cursors for awareness of collaborator's focus.

Study participants collaborating distributively.

attention; shared and individual workspaces that allow scientists to break away and work privately when they want to; and optimistic concurrency control that eliminates explicit floor control for most operations. We created a local Internet2 speed network between users' sites on campus to improve performance and to allow us to investigate congestion control algorithms.

Test and Evaluate in Experimental Setting
Twenty pairs of junior and senior science students worked together once face-to-face and once distributively to complete a lab report using the nM. The sessions were observed, videotaped and logged. Following the sessions, each participant completed a questionnaire and was interviewed. Preliminary analysis shows no significant change in the quality of the science over the two conditions; the study identified no "show-stoppers" with respect to continuing system development and evaluation.

Research Directions

The collaborative nM is currently deployed and in use in three departments at UNC–Chapel Hill: Chemistry, Gene Therapy, and Physics. With the increasing use of the system by scientists, network performance and lag management research is underway. We continue to make changes to the system as users gain experience with it and suggest improvements. The ethnographic study of the tool's use and the effect it is having on both the collaboration process and the science of the collaborations is ongoing. We hope eventually to determine whether the lessons learned from developing a distributed collaborative system for science can be generalized and applied successfully across discipline domains.

Project Leaders

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Related Research

The nanoManipulator Project:
http://www.cs.unc.edu/Research/nano

Research Sponsor

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Recent Publications

Sonnenwald, D., R. Bergquist, K. Maglaughlin, E. Kupstas-Soo, and M. Whitton. "Designing to Support Scientific Research Across Distances: The nanoManipulator Environment," *Collaborative Virtual Environments*, E. Churchill, D. Snowdon, and A. Munro, eds., London: Springer Verlag, March 2001.

Hudson, T., M. C. Weigle, K. Jeffay, and R. Taylor. "Experiments in Best-Effort Multimedia Networking for a Distributed Virtual Environment," *Proc. SPIE Multimedia Computing and Networking*, 2001.

Hudson, T., D. Sonnenwald, K. Maglaughlin, M. Whitton, and R. Bergquist, "Enabling Distributed Collaborative Science," *ACM 2000 Conference on Computer-Supported Cooperative Work*, Video Program, 2000.