Promoting New Partnerships

Initiatives in Digital Technology Program supports advancements in interdisciplinary research

In May 2005, the Digital Technology Center (DTC) funded its second round of DTC Initiatives in Digital Technology Program projects.

The DTC selected projects based on their fit with the key elements of its mission: to promote interdisciplinary collaborations to advance research in digital technology, to act as a gateway for industry to connect with University expertise in areas related to digital technology, and to expand educational opportunities.

The DTC launched the grant program in 2004 to encourage collaborations that advance research in digital technologies. Several of the projects bring together faculty and industry partners, and almost all projects involve interdisciplinary partnerships among University researchers. A brief description of the projects follows.

Computer-Aided Protein Crystallization Design

Victor H. Barocas, Biomedical Engineering; Jeffrey Jay Derby and Jennifer A. Maynard, Chemical Engineering and Materials Science; Caroline M. Wilmot, Biochemistry, Molecular Biology, and Biophysics; and Paul W. Todd, SHOT Inc.

X-ray crystallography allows researchers to conduct structural analysis of biomacromolecules, especially proteins, but creating a crystal of sufficient size and quality to perform the crystallography is challenging. In this project, researchers will develop a multi-scale model of protein crystallization, with the objective of generating a computer-aided crystallization design tool that will help the structural biologist to more easily grow a high-quality crystal from a native or engineered protein.

Relational Database for Experimental Mouse Management

Peter B. Bitterman, Medicine; Danhua Fan, Microbiology, Immunology, and Cancer Biology; and Yunsha He, Computer Science and Engineering

As a mammalian model organism, the mouse can play an important role in research, but most laboratories use an ad hoc approach to tracking mice during breeding, husbandry, and experiments. In this project, researchers will build a relational database to track mice from the time of receipt or birth to their experimental destination. They will use three laboratory protocols that involve approximately 500 mice to develop the database, which offers the potential to improve experimental mouse care throughout the University.
Reasoning to Predict Fate of Chemicals in the Environment
Lynda B.M. Ellis, Laboratory Medicine and Pathology; Lawrence P. Wackett, Biochemistry, Molecular Biology, and Biophysics; Philip Judson, LHASA, Ltd.; and Joanna Jaworska, Proctor & Gamble, Brussels

How will chemicals react in the environment? With the majority of the more than 10 million identified chemicals untested, chemical fate increasingly will be predicted computationally. In this project, researchers plan to add reasoning capabilities to a protocol system that the co-principal investigators already have developed. The project also involves collaborations with Proctor & Gamble and LHASA, Ltd., including funding from Proctor & Gamble to support a workshop for experts.

Wireless Sensors and Estimation Algorithms for Interface Pressure Measurement in Clinical Plaster Cast Applications
R. Rajamani, Mechanical Engineering; and William Robbins, Electrical and Computer Engineering

This project focuses on the development of small-sized battery-free wireless interface pressure sensors to monitor the skin surface pressure inside a cast. Such a device could help prevent Compartment Syndrome, a complication that occurs as a result of swelling in a cast and can cause serious nerve injury and other damage. It also offers other biomedical applications, including preventing pressure sores. The project involves design and fabrication of the sensors and experimental evaluation.

Computer Tools for Gene and QTL Mapping Analysis
Yang Da, Animal Science

Quantitative trait loci (QTL) affect health and production traits in agricultural species, and its study may help researchers improve the ability to map complex genes in humans. In this project, researchers will develop a computer package to implement new statistical methods of data analysis for QTL mapping, as well as applying and integrating graphical user interfaces to the research, development, and application tool that will help facilitate education and research in gene QTL mapping.

Computer Vision Methods for Understanding Turbulent Flows
Ellen K. Longmire and Ivan Marusic, Aerospace Engineering and Mechanics; and Nikos Papanikolopoulos, Computer Science and Engineering

Turbulent flows impact all kinds of industries—the environment, aerospace, transportation, energy, and chemical processing, for example. As part of this research, an interdisciplinary team will develop computer vision methods to identify important features within turbulent wall-bounded flows. They will explore and demonstrate novel analysis tools for the study of turbulence, which in turn can be applied to gain insight into the dominant structures in wall-bounded turbulence.

Exploring Temporal Collaborative Filtering to Support Behavior Change
John Riedl and Joseph A. Konstan, Computer Science and Engineering

How do people’s tastes change over time? In this project, researchers will explore the temporal dimension of collaborative filtering. People use collaborative filtering as a way to find information, products, and services. Largely ignored in the past, the temporal dimension may offer important implications for systems in supporting behavior change among users. The project also involves collaboration with Unilever Corporate Research.

Indoor Navigation Aids for Visually Impaired People: Developing Cognitive and Computational Foundations
Shashi Shekhar and Loren Terveen, Computer Science and Engineering; and Gordon E. Legge, Psychology

Technological navigation aids offer the potential to improve the mobility of people with visual impairments, who face challenges in navigating indoors. In this project, researchers will apply knowledge from various disciplines, including reviewing existing research and solving related problems in cognitive science and computer science. They will integrate the results to develop a prototype of a computational navigation aid.

Client-Server Tools for Combining Biological Ontologies, Genome Sequence Comparisons, and Evolutionary Data
Nevin Dale Young and Steve Cannon, Plant Pathology; and Elizabeth Shoop, Math and Computer Science and Engineering

In the past 10 years, researchers have identified hundreds of genomes, resulting in the development of many new kinds of analytical tools, including several different types of software. In this project, researchers are building on their previous work in developing related software. They will work to extend and integrate software applications, which will improve the ability of users to view data in context.
Tracking the User Perspective

The Usability Services Lab offers state-of-the-art facilities and equipment to understand software designs from the user perspective.

A volunteer web site evaluator begins an assignment to navigate the web in search of a specific piece of information. At the same time, a barely noticeable new addition uses reflections from the evaluator’s eyes to track and record where the evaluator is looking on the computer monitor.

After the evaluation session, the eye-tracking data offers the opportunity to see the web site through the user’s eyes with much greater detail and accuracy than the user would be able to tell observers.

The latest addition to the Usability Services Lab, eye-tracking equipment offers a state-of-the-art approach to better understanding user reactions to web navigation, searches, and task completion.

Product of collaboration

Collaborations played a critical role in both the implementation of the usability lab in October 2002 and in the addition of the new eye-tracking equipment in April 2005.

Several years ago, the Digital Technology Center (DTC) and the University’s Office of Information Technology (OIT) started exploring possibilities for a facility in Walter Library to support the study of human-computer interaction and user-centered design. Understanding its potential application to diverse disciplines, several academic units joined the collaboration: the Department of Computer Science and Engineering, the Department of Rhetoric, the School of Journalism and Mass Communication, and the School of Kinesiology.

DTC Affiliate benefit

The usability lab offers the University administration a facility to test designs for enterprise administrative software and academic units a place to advance related research and to help students learn. In addition, members of the DTC Affiliates Program are able to access the usability lab for a reduced fee.

“In the usability lab, designers have the opportunity to see users try out their designs, so that the designers can make revisions that will improve the usability of the software,” says Alice de la Cova, manager of Usability Services.

In 2004, DTC Affiliate Thompson Legal and Regulatory took advantage of the member benefit when it conducted a study at the usability laboratory. For companies without internal usability consultants, the usability lab offers both the facility and Usability Services staff expertise to complete usability evaluations. There are also possibilities for joint projects in the lab between University faculty and industrial partners.

Newest feature: The eye-tracker

The eye-tracking equipment adds additional capabilities to the lab and offers a more sophisticated tool for evaluating human responses to online solutions.

Recognizing the potential of eye-tracking for research and industry applications, the DTC awarded a grant for the eye-tracker purchase to Joseph Konstan, computer science and engineering professor. OIT matched the DTC funding and provided staff resources to complete the purchase and implementation of the new equipment.

Eye-tracking produces a rich set of data for analysis. The usability lab’s eye-tracking data may be used to generate a gaze plot, which includes numbered circles that indicate the sequence of eye fixations as the evaluator looks at screen locations and the length of time that the evaluator looks at a given spot. A “hot spot” map summarizes the greatest frequency of eye fixations for a group of evaluators.

Education and outreach

University classes are also visitors at the usability lab, where students learn about usability studies and projects. In addition, the lab periodically hosts open houses and conducts tours.

For additional information on the usability lab or to arrange a tour, contact Alice de la Cova at a-del@umn.edu.
Games take front and center

GRAVEL grants further interdisciplinary game research

A home where games are serious business, the Game Research and Virtual Environment Laboratory (GRAVEL) continues to attract University of Minnesota faculty and students who are interested in researching the applications and implications of digital game environments.

As a joint project of the Institute for New Media Studies, the Digital Technology Center (DTC), and the Digital Media Center, GRAVEL explores the structure of game and virtual reality environments, striving to gain a better understanding of their implications and applications.

In 2005, GRAVEL awarded its second round of research grants. The GRAVEL Seed Grant Program encourages diversity in scope and discipline and succeeds in drawing interest from a variety of areas.

“One of the real intentions of the grant program has been to connect experts and build a community,” says Nora Paul, institute director. “It has been very successful in that way.”

The grant program supports faculty as they develop promising research ideas in some aspect of digital game, simulation, or virtual reality development, use, utility, social implications, or innovative applications. Faculty may use results in subsequent proposals for additional external funding. The DTC helps fund the grant program.

“We couldn’t do the grant program without the support of the DTC,” says Paul. “The DTC has been both a great partner and a thoughtful mentor throughout the whole evolution of GRAVEL.”

The following projects received funding as part of the 2005 GRAVEL Seed Grant Program.

### Gaming Technology to Increase Pediatric Patient Compliance with Asthma Medications

**Christine E. Bartels, Richard H. Pham, Pharmaceutical Care and Health Systems**

Improving the ability of pediatric patients to make proper use of their medication can help prevent missed days of school and hospitalizations. In this project, researchers will develop and test a new tool to educate patients—a simple computer game. The project includes development of the tool, pre-testing, and analysis of the impact of the gaming technology on asthma pediatric patient education.

### A Survey and Examination of Game Authoring Software

**Brad Hokason, Design, Housing, and Apparel**

Games offer a powerful tool for learning. This project focuses on the use of game authoring systems in education, communication, and design, with the goal of integrating game authoring programs into research and educational processes. Researchers will examine a number of software packages, develop demonstration games to show the capability of game authoring systems, share results, and apply software as part of a department course.

### New Capabilities in Research on Motion Sickness in Games and Virtual Environments

**Thomas A. Stoffregen, Kinesiology**

Motion sickness doesn’t just happen in the air or on the sea. Many users of simulation technology report bouts of motion sickness. Such an impact can limit the effectiveness of simulation and virtual environment systems. In this project, researchers will develop a new basis for conducting research related to motion sickness that results from video games and virtual environments by creating an animated graphical representation of the oscillatory motion to test predictions of the postural instability theory of motion sickness.

### Investigating the Use of Computer Game Technology in Robot Training

**Richard Voyles, Computer Science and Engineering**

This project involves the application of commercial gaming virtual environments to the tricky task of training robot operators. To take full advantage of robot capabilities, operators need to learn a new set of skills, which include interpreting sensor data and recognizing the robot’s capabilities and limitations. Simulation games offer the potential to improve this type of training.
The spring symposium of the Safety, Security, and Rescue Research Center (SSR-RC) opened with plenty of action, thanks to support from the Tampa, Fla., police department.

Tampa’s SWAT team participated in a mock search and rescue exercise of a hijacked bus that demonstrated applications of technologies for homeland security and emergency response, such as sensors and cameras for monitoring the situation.

The simulated exercise helped underscore to law enforcement and other government representatives at the symposium the powerful potential of new technologies, says Richard Voyles, University of Minnesota SSR-RC site director, associate professor of computer science and engineering, and Digital Technology Center (DTC) faculty member.

“We wanted to show local and national law enforcement the ways that these existing technologies can make a difference in emergencies,” says Voyles.

In just about a year, the newly formed SSR-RC has already succeeded in attracting partners and pursuing research that supports the application of robotics and related technologies to practical safety and security situations.

The SSR-RC developed from existing ties between the DTC distributed robotics faculty and the research team at the University of South Florida.

DTC faculty developed the Scout, a small and smart robot that troops can use as a surveillance tool to check buildings before entering them in urban conflicts and that also proves valuable in rescue operations and other emergencies. The University of South Florida research team also was exploring the use of robotics in emergency situations.

The two institutions decided to submit a proposal for a research center that included industry co-sponsors. In summer 2004, the National Science Foundation approved the proposal.

Current SSC-RC members include the DTC and Center for Transportation Studies at the University and three industrial members, Architecture Technology Corporation, Par Systems, and Alliant Techsystems. In addition, several other organizations have expressed interest in joining.

The Minnesota SSR-RC site is working on two research projects. One involves improving the ability of robot teams for subterranean exploration, where researchers are looking at ways to make teams of robots better at getting in, around, and out of tough areas and to synchronize their behaviors.

In another project, their research supports the development of a glove-controlled device to improve the safety and effectiveness of robot operators in hazardous environments. A wearable control offers much more flexibility than the current more cumbersome laptop box. “We are working to build control activation into the glove in a transparent way,” says Voyles. Researchers recently filed for a provisional patent application on the wearable joy stick.

Voyles anticipates additional collaborations with industry. By participating in the SSR-RC, industrial members are in a good position to take advantage of commercialization rights, he says.

“This is a different model for the research agenda,” says Voyles. “Companies play a role in choosing the projects that are funded for the work that we do. We want to help bring research into application by working with companies to offer help for first responders.”

For information about the SSC-RC, contact Voyles at voyle002@umn.edu.
The Digital Technology Center (DTC) has worked hard to establish relationships with industry that offer benefits for all. In large part, the DTC was founded to help Minnesota strengthen its leadership in digital technologies and bolster the state’s economic stronghold in related industries.

A May 15, 2005, Pioneer Press story explored the ways that the DTC is helping fill an increasing gap in industrial research and development (R&D). The headline for the story read: “Tech Firms Reach Out for Research: U’s Technology Center Illustrates How More and More Companies Rely on Universities—Not Their Own Labs—For Research and Development.”

Tighter economic times have forced companies to cut back on their R&D efforts and to focus their R&D on producing market applications in even quicker timeframes. “As the tech sector consolidates and budgets tighten, companies are looking outside their laboratories for new inventions,” the article says. “Meanwhile, schools like the University of Minnesota are tuning their own research institutions to harmonize with industry. The University’s Digital Technology Center is a prime example.”

The DTC brings together more than 35 faculty experts from diverse disciplines, all of whom share an interest in digital technologies and their potential to fuel future breakthroughs. We encourage participation by industry and offer the flexibility of different options to participate. In a few short years of full operation, the DTC has established relationships with more than 35 organizations and reached many other organizations.

As a result, DTC faculty members are able to pursue the cutting-edge of digital technology issues, and industry is able to benefit from a wider understanding of those issues and to translate that understanding into potential applications that can help their businesses.

The DTC enjoys support, not only from growing numbers of faculty and companies, but also within the University. Steven Crouch, who became dean of the Institute of Technology in January of this year succeeding H. Ted Davis, has cited the DTC as a model for such collaborations and is supportive of our continued work.

This issue of the DTC Bulletin includes some examples of our collaborations with industry and the ways that the DTC attracts additional funding from other sources. For example, DTC faculty, along with colleagues at the University of South Florida, received funding from the National Science Foundation to establish the Safety, Security, and Rescue Research Center (SSR-RC).

As part of its mission, the SSR-RC works in partnership with member companies to help advance application of the latest technologies for rescue and emergency operations (see story on page 5). In addition, the SSR-RC conducts demonstrations of technology that help first responders and other public officials see the application’s value.

The DTC also supports interdisciplinary research and joint projects with industry through its Initiatives in Digital Technology Program (see story on page 1). This year, several projects involve industrial partnerships, and the vast majority of projects bring together researchers from different disciplines to find new solutions.

There are many ways that we will continue to build relationships with industry—through our formal programs and research collaborations and through our outreach efforts. We hope to achieve our mission and more. As the article points out, “If programs like the Digital Technology Center are successful, proponents say, they can give an extra crank to a state’s economic engine by creating well-paid jobs and opportunities, perhaps even new, undreamed-of industries.”
This summer, the Digital Technology Center (DTC) again hosted a group of talented undergraduate students for the 2005 Bioinformatics Summer Institute.

As part of the institute, students from throughout the country attended workshops and worked in faculty labs on research projects. They learned firsthand about the growing fields of bioinformatics and computational biology.

As one of a few such programs nationwide, the DTC received funding from the National Institutes of Health (NIH) and the National Science Foundation (NSF) to run the institute from 2003 through 2006. The NSF and NIH funded the institute as a way to increase awareness about fields.

The participation of 18 faculty members from areas as diverse as chemical engineering, mathematics, laboratory medicine and pathology, biochemistry, plant biology, and computer science and engineering makes it possible to offer students an impressive array of research projects. Students also received a thorough overview of bioinformatics.

The list below highlights the 2005 students, their faculty advisors, and projects.
**DTC welcomes new faculty**

This fall, two new faculty members joined the DTC. Tian He, assistant professor of computer science and engineering, received his Ph.D. in computer science from the University of Virginia. His research interests include wireless sensor networks, distributed systems, and real-time computing. Mohamed Mokbel, assistant professor of computer science and engineering, received his Ph.D. in computer science from Purdue University. His research interests focus on database systems.

**DTC hosts October events**

On Oct. 3, the DTC, the Institute of Technology Development Office, and the Office of Business Development at the University of Minnesota hosted the Minnesota High Tech Association’s (MHTA) fall networking event.

On Oct. 6-7, participants of the Wireless Cities… Community Context Conference will explore the use of wireless networks to improve existing community services. The DTC, Digital Watershed, and the Institute for New Media Studies are sponsoring the conference.

On Oct. 19-21, the DTC will welcome the IEEE Fifth Symposium on Bioinformatics and Bioengineering. The symposium features Stuart Kauffman of the Institute for Biocomplexity and Informatics at the University of Calgary.

For information about DTC events, visit www.dtc.umn.edu.

**Minnesota Technology Day Camp Attracts Young Students**

Middle school students from the metropolitan area enjoyed a weeklong introduction to technologies at work. The Artificial Intelligence, Robotics, and Vision Laboratory (AIRVL), the National Science Foundation, and the DTC sponsored the Minnesota Technology Day Camp, held Aug. 22-26, to help increase interest in technology among youth. During the week, 15 students participated in a variety of activities, taking pictures with digital cameras, creating a simple circuit board, handling and programming robots, and developing Powerpoint presentations, among other tasks. They also experienced demonstrations of robots, computer vision, and virtual reality.

Faculty participants included DTC faculty Nikos Papanikolopoulos and Maria Gini from computer science and engineering. Participating U of M graduate students were Kelly Cannon, program coordinator; Monica LaPoint, Nate Bird, Katie Panciera, and Hairini Veeraraghavan. Camp students were Hakeem Ayinde, Luis Barrera, Dominique Farrar, Mike Harrison, Monica Herzog, Sinthia Laparra, Samary Matos-Bonilla, Ana Rodriguez, Alicia Simon, Ben Ubani, Chidike Ubani, Sarah Ubani, Vasiliki Papanikolopoulos, Jorian Wulf, and Justin Wulf.

Learn more at www.home.earthlink.net/v~mntechdaycamp/.