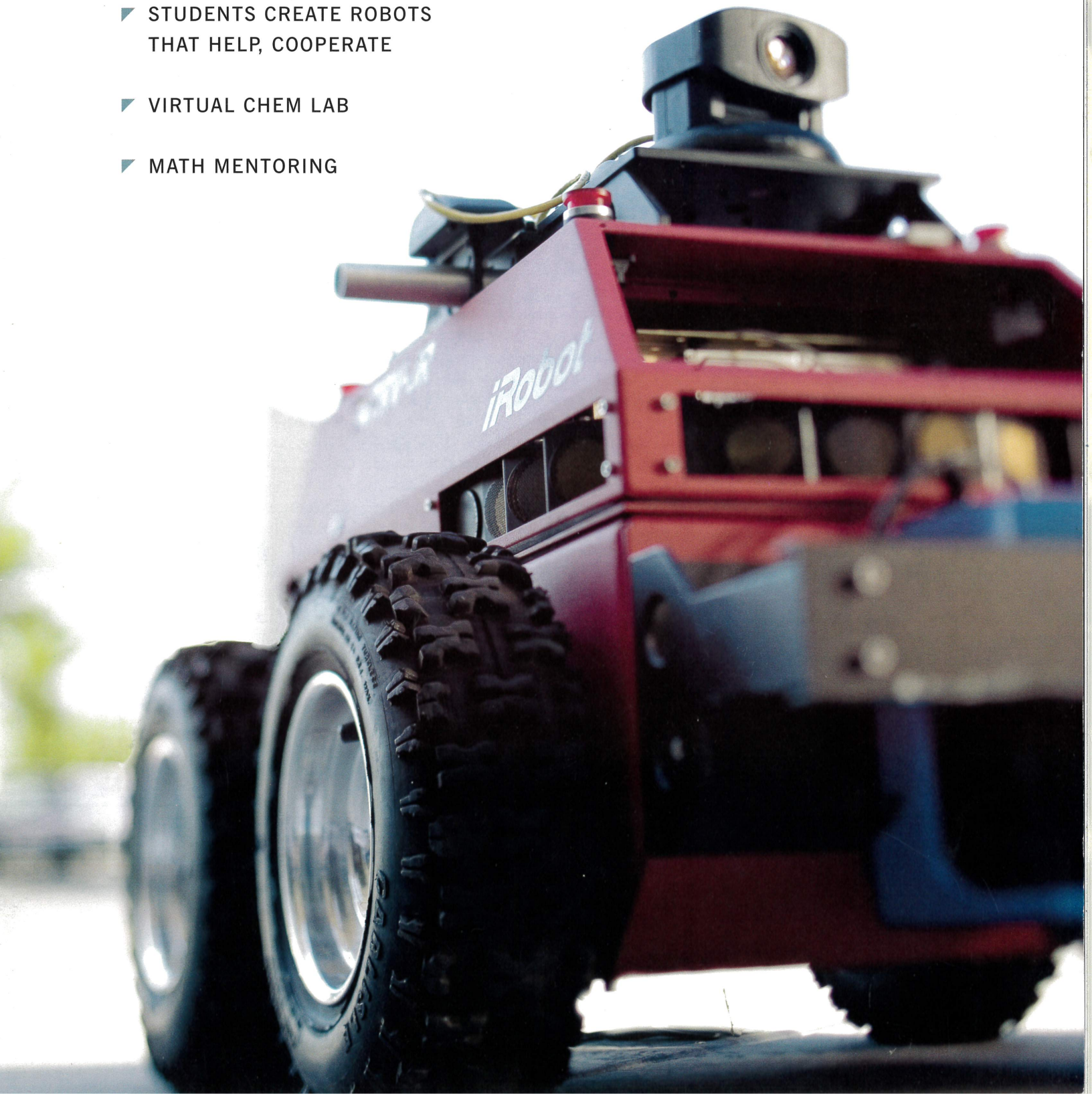
FRONTIERS

BYU COLLEGE OF PHYSICAL & MATHEMATICAL SCIENCES • SPRING/SUMMER 2006

- STUDENTS CREATE ROBOTS THAT HELP, COOPERATE
- VIRTUAL CHEM LAB
- MATH MENTORING



DEAN'S MESSAGE

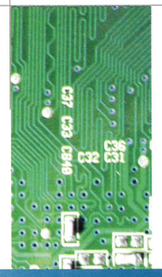
GREETINGS, AND WELCOME TO ANOTHER ISSUE OF *FRONTIERS*—OUR FOURTH. WE SINCERELY HOPE THAT YOU ARE ENJOYING THE MAGAZINE. Because of the wide-ranging diversity of the College of Physical and Mathematical Sciences, we cannot promise that every article will interest every reader, but we trust that you will find something in every issue that brings back memories of your university experience (fond ones, we hope), excites you about work being done in your major department, or brightens your day in some other way. *Frontiers* is for you, our alumni and friends, and so we are interested in your suggestions. If you would like to propose an idea that you think would make the publication better, please e-mail us at *college@cpms.byu.edu* or drop a note to me at the College of Physical and Mathematical Sciences, N-181 Eyring Science Center, Brigham Young University, Provo, UT 84602. And if you are new to our mailing list and would like the previous issues, let us know.

We take this opportunity to acknowledge the key contributions of Howard M. Collett, who has been our editorial director for the previous issues of *Frontiers*. We became aware of Howard and his publishing company early as we considered starting a magazine for our alumni and friends, and he eagerly began working with us to iron out the concepts and decide just what we wanted *Frontiers* to be like. It is safe to say that, without Howard or someone like him, we could not have accomplished the professional level we've achieved with this publication.

Change is inevitable, and as we prepared for this fourth issue, an opportunity came for Howard to join LDS Philanthropies and assist with LDS humanitarian services. If we had to lose him, there are few better causes to which he might have gone! His influence and guidance will be greatly missed, but we wish him the best as he pursues a new direction.

Of course, new directions are routine in the academic world, just as they are everywhere else, and in this issue we feature stories about students, faculty, and departments moving in new directions. You will find stories about simulating realistic chemistry experiments on a computer, creating robots that can assist in dangerous search-and-rescue missions, and giving undergraduate students a shot at some challenging mathematical research. We hope you enjoy these and other features.

—Earl M. Woolley



FRONTIERS

SPRING/SUMMER 2006

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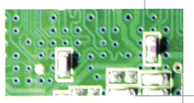


CREATING ROBOTS THAT HELP

By Nicole Seymour

DON'T BE DECEIVED. THAT ROLLING ROBOT BUILT OUT OF SPRINKLER PIPES AND A LAPTOP ISN'T A SIMPLE CLASS PROJECT. It's a cutting-edge research project. Although the idea of robotics may conjure up futuristic images, the future is now for enterprising computer science students, their professors, and colleagues.

Students and professors in the Department of Computer Science are pushing the barriers of innovation in robotics. Through their research students are creating programs to control unmanned vehicles, including robots and mini air vehicles. These robots can be placed in risky situations that might pose significant danger to a person, and they have the endurance to function at a consistent level.

At the same time the students hone their own thinking skills, they are improving the "mental capacities" of their robots through innovative software. The students' work helps robots to both interact with and learn from humans.

Recently their robotics work was featured at the 2006 Human Robotics Conference, chaired by associate professor Michael Goodrich. The research was made possible through BYU funding, as well as through grants from the Defense Advanced Research Project Administration (DARPA) and the National Science Foundation.

The DARPA grant funded the initial stages of the program and resulted in presentations at DARPA-sponsored workshops. As the robotics program has matured, additional funding has come from the Army Research Laboratory and the Idaho National Laboratory. Much of the BYU funding came in the form of Mentored Environment Grants, enabling students and professors to develop new techniques as they have worked together in the lab and the field.

Such innovations require that student researchers create complex computer programs that ease communication between user and computer. User-friendly robots make it possible for search-and-rescue teams, military units, and others to use robots effectively without the human operator being an expert in robotics.

TEACHING ROLLING ROBOTS

Take a virtual crayon, color on an "augmented virtuality" screen to define paths that can be used, and tell the robot, "go there" with a point of the finger. This is all that it will take to navigate a rolling robot. Once given parameters, it will be able to navigate its way "safely" to any given destination. As simple crayon shading defines areas for robots as "safe" and "unsafe," the robots "learn" to make advantageous choices.

Dan Olsen, professor of computer science, is a leader in the field of human-computer interaction, the study of the interaction and perceptual abilities of robots. He says the process of "teaching" a robot and getting it to cooperate is gradual. If a robot is taught too much at once, it will slow down because of overload. Professor Olsen compares machine learning with the way a computer's antivirus program learns what is safe and unsafe.

With this process of categorization or classification, terms like "machine learning" and "augmented virtuality" come into play to make a significant challenge for the developer and a helpful tool for the user. The developers, in this case, have been the students. Under guidance and support from their professors, they have created the software that acts as the robots' brains.

Students typically don't get the opportunity to create extensive programs or software, but Professor Olsen says the students' programming work is real-world experience that is directly benefiting the world.

"There's lots more complexity," he says, contrasting the students' lab work with simulated classroom work. "They have to work much more with other people, and they get to deal with the fact that the robot doesn't always do what they want it to, which is what happens in the real world."

The students' progressive work will allow the Defense Department to have "packable" robots, a technology that can potentially be combined with other robotics research to help military personnel gather information without needlessly exposing themselves to hazards. Instead of a person peeking around a corner, for example, a robot could reconnoiter a potentially dangerous situation. The robots could also survey nuclear power plants at times when it would be unsafe for humans to enter.

UNMANNED AIR VEHICLES

When lives are at stake and time is critical, skilled wilderness search-and-rescue teams need reliable tools to help find lost hikers, injured climbers, and others in urgent need. If the tools are small, highly portable, and relatively inexpensive, so much the better. For this reason, Unmanned Air Vehicles (UAVs) carrying cameras are becoming a helpful tool in the search-and-rescue effort. Students working with this project, under the direction of Professor Goodrich, are focusing their work on making UAVs more intuitive. In creating the design, students have integrated principles from video games, psychology, human robotic interaction, and other disciplines to make the program more straightforward. Says Goodrich, "It's basically a flying camera with really good stability and really good control to keep it from falling out of the sky."

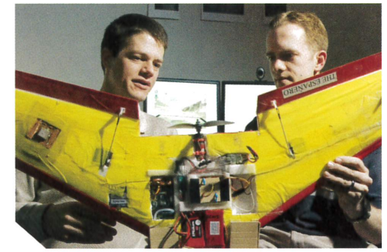
The planes are controlled from a palm-pilot-like screen. In the future search-and-rescue teams could dispatch several of the small aircraft at once. Instead of using physical controls as a pilot would, the users simply drag a virtual compass needle or a wing in a desired direction. Although this may take some practice, it is still very simplified. The monitor shows a simulated terrain model to reveal the plane's location and other data.

To create a computer program for the robot that is more user-friendly, the student developers must put in extra work and careful thought. Students meet weekly with computer science professors, engineering professors, and search-and-rescue volunteers to figure out how they can better tailor the UAVs to search-and-rescue needs.

Mechanical and electrical engineering students and professors Randy Beard and Tim McLain can do certain things to the UAV itself to improve its intuitive performance. Meanwhile, Goodrich and his computer science students manipulate the software in other ways to make it easier for humans to guide the craft.

According to Goodrich, there are three essential items for the project: First, a reliable aircraft that can do sophisticated search patterns while keeping the camera pointed in the right direction; next, stabilization of the camera and positioning of the image on a terrain map or within a satellite image; and, finally, a small platform from which search-and-rescue teams can control the UAV.

Joseph Cooper, completing his first year as a graduate student in computer science, has been



working with robotics for three years. He is developing the interface, i.e., the control panel part of the UAV system. He says he enjoys the fact that he can work in the human-robotics interaction lab, but he also likes work beyond the computer screen—in the field on test runs and in interactions with others—all opportunities that the UAV project affords naturally.

"I have the chance to develop software that will actually be used, as opposed to classroom projects where you develop something so that you get the grade," Cooper says. "I feel like I'm developing something that may really be useful for somebody. It may really save lives." ■

VIRTUAL CHEMLAB

By Ben Carter

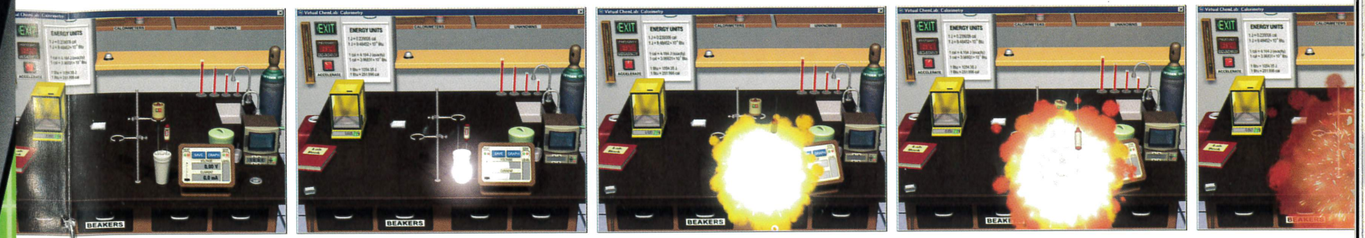
CHEMISTRY STUDENTS AROUND THE NATION ARE ENJOYING THE BENEFITS OF VIRTUAL CHEMLAB, A COMPUTER PROGRAM PACKAGE DEVELOPED BY BYU PROFESSOR OF CHEMISTRY BRIAN WOODFIELD. ON THE MARKET SINCE 2001, THE PROGRAM ALLOWS USERS TO SIMULATE THOUSANDS OF CHEMISTRY EXPERIMENTS WITHOUT ACTUAL CHEMICALS OR EXPENSIVE LAB EQUIPMENT.

More important than reducing expenses and waste, Professor Woodfield says the program provides a bridge between the concepts students learn in the classroom and the application of the concepts in the lab.

"In the real lab, because of time constraints, safety restraints, technique constraints, and liability, you can't let students do whatever they want," Woodfield explains. "You have to give them a very structured, outlined thing to do. So they never are really forced to apply those concepts."

Virtual ChemLab is specifically designed to help students learn the concepts and principles of chemistry in a safe, interactive virtual environment. Woodfield acknowledges that similar programs exist, but this one has an important difference.

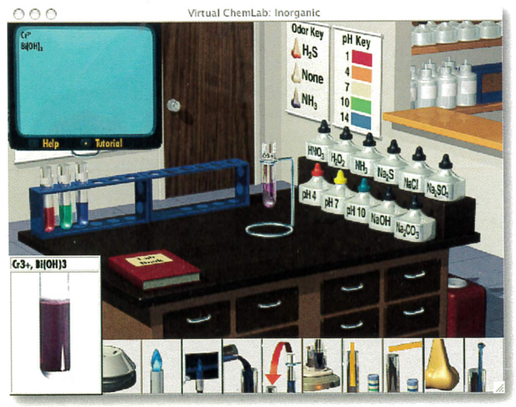
"Previous attempts at simulation have failed because they focus on technique," he says. "But we said, 'No, we're not interested in how students do things; we're interested in why they do things, when they do things, what's the outcome of what they do, and what decisions they make now they've seen the results.'" When students enter the program, they encounter a virtual chemical stockroom where they have to decide which chemicals and which equipment they will need for an experiment. They then must decide the order in which they will carry out the various possible tests. For many of the virtual experiments, the students are shown a photograph or video of the real result of what they just did virtually. Based on these results, they then decide on the next logical step in their experiment.



In its first five years on the market, Virtual ChemLab has been much more successful than previous simulation programs. Woodfield, who often travels to schools to show the program, says about 150,000 high school and college students across the U.S. are using the program this year. Several factors make Virtual ChemLab attractive. As chemicals and chemical waste disposal become increasingly expensive, a realistic simulation that can prepare the student for lab work without using real chemicals is an advantage. Then there is the issue of safety—explosions on the computer monitor are relatively harmless! In addition, because Virtual ChemLab allows the user to leave the "cookbook" behind and explore, it fosters the development of critical thinking.

The success of Virtual ChemLab is not just measured in sales. Early on in the project, Dr. Woodfield and his assessment team conducted a study of student performance in chemistry classes using the program. They saw a 30 percent increase in student scores in Professor Barbara Hinshaw's organic chemistry lab class, where the program has been used for four years. Further studies have shown that, in general, students who learn the concepts taught in their classes using Virtual ChemLab do better on quizzes and final exams. Says Woodfield, "It's a fast, easy way of getting kids to get out of the abstract of the classroom and make it real."

THEN THERE IS THE ISSUE OF SAFETY—EXPLOSIONS ON THE COMPUTER MONITOR ARE RELATIVELY HARMLESS!



The first semester Virtual ChemLab was used students were wary of it, but the next semester they realized how much better they did in their classes because of it. Tristan McKnight, a freshman majoring in biology and a student in Dr. Woodfield's Chemistry 112 class, says he and his classmates recognize the benefits they get from the program. "What I value most about it is that I'm able to do chemistry and learn the concepts without having to waste tons and tons of chemicals," Tristan explains. "It's a nice way of getting to know what's going on without having the constraints of using physical materials."

Of course student involvement with Virtual ChemLab occurs at more than just the user level. Dr. Woodfield had the idea to develop the program in 1993 when he was a graduate student at UC Berkeley, but he wasn't able to start the project until he came to BYU in 1997. Since that time more than 50 students have worked on the Virtual ChemLab project, assisting in its development, writing code, and testing the results. Right now Tristan McKnight's sister, Heather, and fellow student Bradley Moser are helping to develop a version of the program that covers basic concepts in physics.

"We do all of the math behind it," Bradley says. "If you take a ball that weighs 10 kilograms and you hit it with a rocket having 100 newtons of force, what's the motion going to look like? We come up with all of those equations." In addition to programming equations, Heather and Bradley are also looking at the program from a more abstract point of view.

"The other thing we've been working on is just figuring out 'What are students going to want to do with it?' 'What type of questions should they be learning about?'" says Heather. "We're looking at it from an educator's perspective."

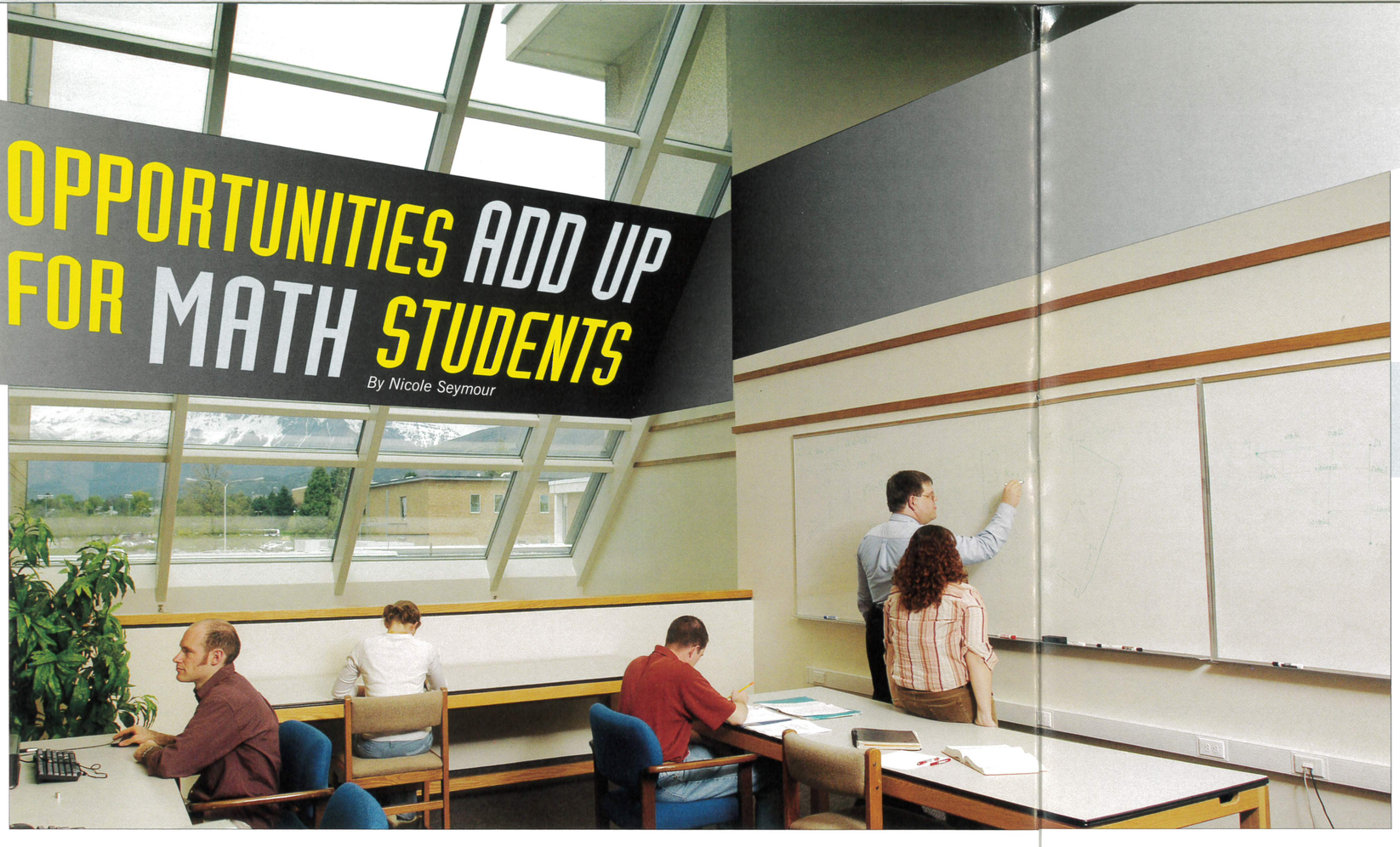
Heather and Bradley used Virtual ChemLab in classes before they were hired to help develop the physics version, and they both say the program has been an essential part of their education. "I love it because it's teaching me the basic concepts again," Heather says. "And I think that's the whole point."

With Virtual ChemLab in use in high schools and colleges, and with a middle school and a physics version in development, Dr. Woodfield's work may well change the way science is taught throughout the country.

"Virtual ChemLab is a lot bigger than what was initially envisioned," says Woodfield. "It has grown and taken on a life of its own, and it consumes a large part of my life." ■

OPPORTUNITIES ADD UP FOR MATH STUDENTS

By Nicole Seymour



UNDERGRADUATE MATHEMATICS RESEARCH AT BYU IS EXPANDING RAPIDLY. ONE REASON FOR THIS GROWTH IS THE INCREASED AVAILABILITY OF COMPUTATIONAL POWER. Whereas just five years ago there were only a handful of research assistants in the Mathematics Department, now more than 40 undergraduates are working with math professors on research that goes well beyond the classroom. This buildup has led to the recent construction of the Math Undergraduate Research Mentoring Lab in the James E. Talmage Mathematical Sciences and Computer Building.

MURM LAB

Nestled between the computer science wing and the statistics and mathematics wing of the second floor of the Talmage Building is a newly created lab where students in mathematics work on research projects. It is known as the Math Undergraduate Research Mentoring lab, the "MURM lab" for short, and is filled with white boards, desks, bookshelves, and computers with advanced computational software. The room functions as a study area where students can work together or alone on mentored research.

"We're really excited about it because our students have a place to work, and it's close enough to the faculty that they can leave their work and come and ask us a question," says assistant professor of mathematics Jeffrey Humpherys. "Before, if they got stuck, they would have to come from home or the library—a lot of walking around just to ask a five-minute question."

UNDERGRADUATE RESEARCH

Research opportunities for undergraduates abound at BYU, and the Mathematics Department isn't an exception. In times past math students needed extensive knowledge and experience before they could contribute meaningfully to real research problems. Math research was the domain of faculty and graduate students. Recent advances in computational software however, have created more opportunities for undergraduates to participate.

Professor Humpherys likens computation to a scientific study through which students can test conjectures until they eventually converge on the right answer. "Computation is to mathematicians what laboratory work is to chemists," he says. In this sense, students can carry out "experiments" by computer in their quest to uncover new insights. "To be able to have undergraduate research is a new paradigm for mathematics," says Humpherys.

It is critical that undergraduate students make the transition from working on shorter problems, which take minutes or hours, to tackling longer, more complex problems, which take months or even years. If students can make that adjustment in their undergraduate years, he says, they are more likely to have success as graduate students.

Undergraduate students assist professors in an array of mathematical research projects. For example, Professor Humpherys, in collaboration with Sean Warnick in the Department of Computer Science, studies the applications of math to economic systems, engineering systems (optimization in business, manufacturing, and engineering), human systems (policy sciences and organizational dynamics), and biological and environmental systems. Their students enjoy doing research because they get to see mathematics as an integral part of the world around them. Their work also benefits the research projects of various other professors on campus, and even the BYU Bookstore. (This group's research can be visited at idealabs.byu.edu.)

Although professors usually determine the research projects in which students can assist, one student, Heather Moore, a junior mathematics major, came up with her own research idea. When she was just a junior in high school, Heather discovered that there was no formula to solve the pattern of remainder periods for prime numbers in the Fibonacci sequence. (The Fibonacci sequence is a mathematical pattern in which the sum of the previous two terms can be added together to make the next number in the sequence. It is also known as "a quadratic linear recurrence.")

> COMPUTATION ALLOWED ME TO ENTER THE WORLD OF MATHEMATICS RESEARCH, AND I HAVE HAD AN AMAZING OPPORTUNITY BECAUSE OF IT.
> —MEGHAN DE WITT

Years after she had struggled with the problem, she realized her college education had prepared her to attempt it again. She brought her idea to the undergraduate coordinator, Professor Rodney Forcade, and he agreed to mentor her. After about eight months on the project, they have interesting results. Soon Moore and Forcade will publish some of their research findings. The fact that she is publishing research is amusing to Moore, who at first was surprised when she couldn't find any published research on her topic. "It's interesting because here's stuff you can't look up because it isn't there yet," she says. "When we publish our findings, others will look *us* up."

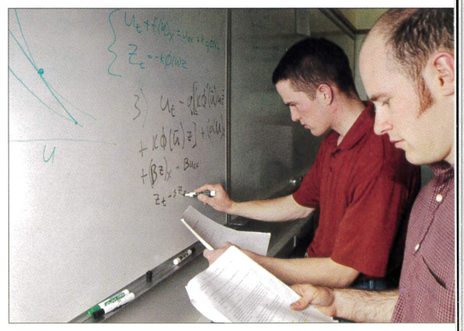
Meghan De Witt is just as enthusiastic about her undergraduate research experience. As a senior graduating with a mathematics degree in August, De Witt has been working with Darrin Doud, assistant professor of mathematics, for the past year and a half. She has used computational number theory to study a mathematical problem known as Serre's Conjecture. She is completing her honors thesis and is also working on publishing her research findings. What's next for her? De Witt will begin a doctoral program at the University of Wisconsin in the fall. Upon completion of the PhD, she hopes to become a university professor.

"Not only have I been exposed to the world of mathematical research and the process involved, but I have been trained in specific areas of math that have motivated me to attend graduate school and continue my research in these areas," De Witt says. She says computational modeling has given her opportunities that have opened the doors to her future.

"Computation allowed me to enter the world of mathematics research, and I have had an amazing opportunity because of it," De Witt says. "I believe the more students who have such an opportunity the better. By allowing more students to do research at an earlier stage, it has encouraged them to continue studying mathematics."

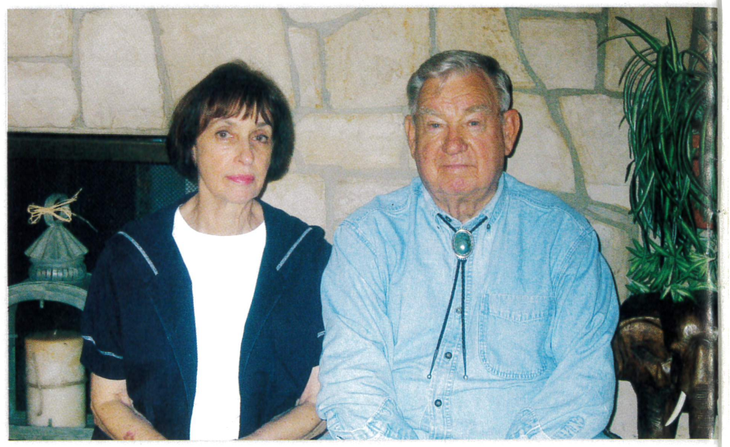
Assistant professor of mathematics Denise Halverson has students assist with her work in geometric optimization. She says that as she has mentored undergraduates, the benefits have flowed both ways: undergraduate mentoring has furthered her own her long-term research goals while also benefiting the students who work with her. "Doing original research gives them a lot of confidence, and they are able to go on and further pursue their education," she says. "Taking on some challenging goals is one of the most valuable experiences an undergraduate student can have."

Professor Humpherys agrees. Whether students are on their way to a career or seeking more education in the field of mathematics, undergraduate research is the best step. "It's great that students at BYU get the opportunity to do research. They're going to go out into industry and get a job or go off to graduate school at some other university—either way they'll be that much better prepared," he says. ■



FEATURED DONORS

James and Sally Elison



WHEN JAMES ELISON FINISHED HIS TWO YEARS AS A RADIOMAN IN THE U.S. COAST GUARD IN 1946, HE DECIDED TO SET OUT FROM OAKLEY, IDAHO, FOR THE UNIVERSITY OF IDAHO TO MAJOR IN ELECTRICAL ENGINEERING. His father thought that BYU would be a better place for him, so Jim changed that part of his plan and came to Provo. Then the other part of the plan changed—he took a general education course in geology taught by Dr. Harold J. Bissell. Says Jim, "He took us on a field trip, and then and there I realized that geology was what I wanted to do."

Jim's professors in the BYU Geology Department of the late 1940s constitute a list of the current Department of Geological Sciences' founders: George Hansen, Harold Bissell, Ken Bullock, and Paul Dean Proctor. (Jim also recalls a favorite chemistry teacher, John Wing, who accompanied them on the geology field trips.) Jim graduated with a BS in geology in 1951, the first member of his family to obtain a BYU degree. In June he met Sally Edwards, a Provo girl who had just received her degree in education. They were married in September of that year, and Jim stayed on at BYU to complete an MS under the guidance of Dr. Bissell.

There followed nearly 20 years with Shell Oil Company, beginning in Alaska, where he did surface geologic mapping and stratigraphy. His 17 moves with Shell included stays in Houston, Texas; Farmington, New Mexico; Durango, Colorado; Los Angeles, California; Salt Lake City, Utah; Seattle, Washington; and Ely, Nevada. Jim quips, "My four children were all conceived in different places than where they were born." His favorite assignment? "Ely, Nevada! We had a great crew, we had the Church—it's always important to have the Church—and we learned to make our own fun out there."

In 1971 Jim left Shell Oil to start his own company, buying old, "stripper well" properties from petroleum companies, bringing them back up to productive levels again, and selling them. Over the years he started and sold three such companies, and the last one, E&B Natural Resources Management Corporation, is still active in Bakersfield, California. He credits the real estate market in Las Vegas with making additional contributions to his success.

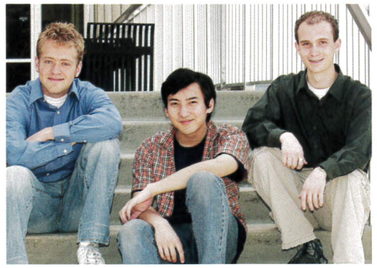
Now residing in Bakersfield, California, Jim and Sally recently made a major gift to the Department of Geological Sciences—a gift that will assist generations of geology students with funding for education. When asked why they decided to give such a generous gift to the university, Jim says, "BYU made the biggest contribution to me, personally, through education." For Jim and Sally Elison, it's all a matter of giving back. ■

CLASS NOTES

Math Students Excel in National Contest

The William Lowell Putnam Mathematics Competition, an annual mathematics contest for undergraduates sponsored by the Mathematical Association of America, consists of a six-hour exam with 12 difficult mathematics problems. The most frequently attained score on the exam varies between 1 and 3 points out of 120, so scoring any points is a significant accomplishment. The results of the 2005 Putnam Exam are in, and BYU's team ranked 87th out of 395 colleges and universities that had a team of three or more members.

Three of our students performed exceptionally well: Edison Yu Yang ranked 149th out of 3,545 students who took the exam. Michael Griffin ranked 175th, and Russell Howes 296th. Yu Yang and Griffin were the only students in Utah to score in the top 200. Congratulations to all 20 students on the BYU Putnam team, and to their coach, Professor Darrin Doud!



BYU Physics Education Program Makes Its Mark

Faculty members returning from the first national conference of the NSF-supported Physics Teacher Education Coalition held March 24–26, 2006, report that BYU has a larger number of physics majors preparing to become high school physics teachers than any other university or college in the nation. Viewed as one of the top programs, physics education is graduating 10 highly qualified physics teachers and six physical science teachers per year. It may not sound like a lot, but it stands out. Part of the success is the enthusiasm and commitment of Professor Duane Merrell, who spearheads the program (see *Frontiers*, fall 2005). In pondering the reasons for the attraction to physics and physical science education, Merrell says, "We really can only infer a reason. It could be that our students are guided by the BYU motto Enter to Learn; Go Forth to Serve. Many students at BYU have completed two years of missionary work for The Church of Jesus Christ of Latter-day Saints. During this service students teach others the values and tenets of the Church, and they find that they enjoy the opportunity to teach. Teaching begins to become a part of who they are."

Top Math Teacher in the Region Recognized

Professor Tyler Jarvis, Department of Mathematics, has been honored with the Mathematical Association of America's 2006 Teaching Award for the intermountain region. This award was given to Professor Jarvis not only for his skill in teaching students to understand concepts and to reason on their own but also for his high expectations of and personal concern for his students. The honor makes him a candidate for the national MAA teaching award to be announced in January 2007. Other BYU faculty who have received this award are Jim Cannon and Wayne Barrett.

Goldwater Scholarship Awarded to Physics Undergraduate

The premier undergraduate award of its type in the nation is the Barry M. Goldwater Scholarship, intended for sophomores and juniors pursuing degrees in science, mathematics, or engineering. Among the 2006–2007 recipients is Jacqueline Jackson, physics major from Anchorage, Alaska. Her work with Professor David Allred in the Department of Physics and Astronomy aims to determine the oxidation states of uranium in thin films that are being developed as reflecting surfaces for X-rays and extreme ultraviolet rays. Jacque plans to graduate next April and pursue a PhD in physics. Commenting on the Goldwater Scholarship, she says that the award gives her confidence that she can "get in to the graduate schools that specialize in my field. This is a very prestigious scholarship and I feel lucky to have been given such an honor."

Aboard the Vomit Comet

Four BYU undergrads recently did a physics experiment aboard NASA's Vomit Comet, an aircraft that produces weightlessness by following steep climbs with a 25-second free fall. The four, Nathan Powers, Matthew Turner, Jacob Campbell (all physics majors), and Krystle Farnsworth (a mechanical engineering major), performed experiments on particle levitation in a laser beam to determine whether the effect depends on the presence of a gravitational force. The particles remained suspended in the laser beam during free fall, showing that, whatever causes the effect, it does not depend on gravity. The team works under the direction of Professor Justin Peatross of the Department of Physics and Astronomy.

Computer Scientist Recognized

Thomas W. Sederberg, professor of computer science and associate dean of the College of Physical and Mathematical Sciences, has been selected to receive the Computer Graphics Achievement Award from the nation's leading professional computer graphics society, SIGGRAPH. Since 1983 this award has been given annually to a single recipient to recognize outstanding achievement in computer graphics and interactive techniques. The award will be formally presented at the 2006 annual SIGGRAPH meetings in Boston July 30 through August 3.

EVERY STUDENT WHO LEAVES THE COLLEGE OF PHYSICAL AND MATHEMATICAL SCIENCES WITH AN UNDERGRADUATE "MENTORED LEARNING" EXPERIENCE IS BETTER PREPARED TO BLESS OTHERS AND HELP THE WORLD SOLVE ITS PROBLEMS. MENTORED LEARNING IS WHAT HAPPENS WHEN A STUDENT WORKS WITH A FACULTY MEMBER OUTSIDE OF CLASS ON RESEARCH CONSEQUENTIAL TO THEM AND TO THEIR SCIENTIFIC DISCIPLINE. Does it make a difference? Here's what one mentored student had to say, and it's pretty representative: "Until you do these things in the lab yourself, you don't really know how to do them—even if you think you understand the ideas." Instead of finding needful employment off campus, the mentored students do real-world research that helps prepare them for their professional lives.

On Saturday morning, March 18, 2006, more than 300 students filled the classrooms of BYU's Martin Building for the college's 20th Annual Spring Research Conference. Over the course of five hours, all 321 students discussed the results of their mentored research in 15-minute presentations, modeled after a typical professional scientific conference. There were 23 sessions running concurrently, featuring students working in physics, statistics, chemistry, computer science, mathematics, geology, biochemistry, astronomy, and mathematics education. Some of these students will refine their work and present it at regional and national meetings. Some will coauthor publications with their mentors.

Our goal is to provide a mentored learning experience for every student in our college who wants to participate. This is, in fact, our top academic priority. Thanks to our alumni and friends, we are getting closer to that goal. At the Spring Research Conference we awarded 28 new "Frontiers Mentorships," funded entirely by donations to the College Annual Fund. The photo above shows recipients and their mentors being recognized at the opening session of the conference. I invite you to visit our Web site (cpms.byu.edu) or to contact Brent Hall at 1-800-525-8074 or *brent_hall@byu* to learn more about how you can help students have this experience. Join with us in opening doors for students.

—Earl M. Woolley, Dean