configurations

January 2004

A Newsletter of the Department of Computer Science and Engineering at the University of Notre Dame

in this issue

CSE Juniors Enjoy Fall Semester in London

Every fall a number of engineering juniors, along with students from other departments, leave campus to spend the semester in London. While in London, computer science and engineering (CSE) students furthered their major studies in fundamental computer science and engineering courses, such as data structures and computer architecture. They also explored the city through theatre, music, and art courses, as well as through the many cultural opportunities available in and around London.

Tucked just beyond the shadow of Lord Nelson's column in Trafalgar Square and near the National Gallery, Notre Dame's London Centre is located in the heart of the city. It is a wonderful place to study computer science and engineering for many reasons. For example, London is just 60 miles from the birthplace of the EDSAC, one of the first stored program machines. It is also 50 miles from Bletchley Park and the Colossus machine of WWII code-breaking fame and just a few miles from the British Science Museum, which houses working reconstructions of Babbage's difference and analytic engines.

Computer architecture and data structures courses are demanding whether taken on campus or abroad, so the students worked hard throughout the semester. The computer courses were taught by a British professor whose early studies involved working on the EDSAC. So along with lecture material, he had a wealth of stories to share.

But, the pièces de résistance of any semester are the final projects. The final computer architecture projects were an impressive set of undertakings which included the design and VHDL implementation of a multiprocessor, the conversion of an accumulator-based machine to a register-based machine, and the implementation of vector instructions to explore a bit of supercomputing. The projects were full of surprises and interesting lessons for both students and instructors.

London was a particularly exciting place to live and work this fall. It started with American David Blaine dangling over the Thames and ended with the President's visit in November. Between the British public's reaction to Blaine's stunt and the political protests that culminated in nearby Trafalgar Square in response to the President's presence, Londoners were more than willing to share their views of America and Americans. Such casual discussions with Londoners are among my most valuable experiences of living abroad for a semester.

Between the cultural excitement of living in a big city, weekend trips to nearby European destinations, and demanding courses, the engineering students successfully mixed life-enriching experiences with learning the fundamentals of their chosen discipline. It was a wonderful program in which to participate.

__Note:__ This article was submitted by CSE doctoral candidate __Sarah Frost,__ a teaching assistant for the computer science and engineering and electrical engineering courses offered in London during the fall 2003 semester.

Like many of the engineering students who participated in the London Program, __Michael Sheehan__ (far left), __Brian McRoskey, Pranati Bansal,__ and __Swati Malik__ (far right) spent a great deal of time in the computer lab of the University's London Centre. The other computer science and engineering majors who participated in the 2003 London program were __Michael Heilman, William Leimkuehler,__ and __Gautam Shewakramani.__

Szulik Visits Notre Dame

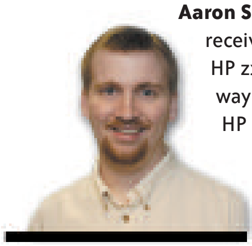
In November 2003 **Matthew J. Szulik,** chairman, chief executive officer, and president of Red Hat Linux presented "Open for Change," a lecture during which he shared his vision of the open source model.

A frequent visitor to the University, Szulik has been leading early-stage technology companies, such as Interleaf, MapInfo, and Red Hat, into global, publicly traded firms for more than 20 years. In 1998, Szulik and Red Hat founder Bob Young developed a shared vision — that the collaborative approach of open source and a great brand could redistribute the economics of the technology industry from vendor to customer.

Today, Red Hat is the leading provider of Linux and open source technology, having developed global partnerships with Oracle, IBM, Dell, Intel, and Hewlett-Packard.

CSE Receives Education Equipment Grant from HP

During summer 2003, the Department of Computer Science and Engineering (CSE) was the recipient of a $120,000 equipment grant as part of the Hewlett-Packard (HP) Itanium2 Education Initiative. Spearheaded by Assistant Professor **Aaron Striegel,** the department received a grant of 6 one-way HP zx2000 workstations, 1 two-way HP rx2600 server, and a HP ProCurve 2524 switch. HP's **Kathy Zerda,** a CSE advisory board member and ND alumna, played a key role in obtaining the grant. The new tanium2 machines form half of the newly upgraded Digital Logic Laboratory on the second floor of Cushing Hall.



Striegel

The machines expose students to state-of-the-art in computers, specifically the Itanium2 architecture. When the machines are not being used for courses in operating systems, computer security, and computer architecture, they will be made available as part of an educational grid. CSE graduate students **Chad Mano** and **Dave Salyers** were responsible for configuring the new machines. Over the next year with an extension of the grant, the department has plans to double the Itanium2 cluster.

2002 CSE Grad Kelly Keegan Serves in the Alliance for Catholic Education Program

At least twice a day, sometimes more, I hear, "Miss Keegan, why do we have to learn this? I'm never going to use <insert math topic> in real life!" As a teacher in the Alliance for Catholic Education (ACE) program and a Department of Computer Science and Engineering (CSE) alumna, I have tried to draw upon my experiences while an undergraduate to answer my students' questions.

For the past two years I have taught Algebra II, Geometry, and Pre-Algebra at Bourgade Catholic High School in Phoenix, Ariz., learning to become a teacher in addition to being an engineer. I will graduate from the program with a Master's of Education, two years of teaching experience, my teaching certificate, and, most importantly, the knowledge of whether or not I am called to teach.

I seem to be both an engineer and a teacher at heart. In my classroom I have discussed the analysis of circuits in relation to imaginary numbers, recursive algorithms and the Fibonacci series, and why a computer program using exponential amounts of memory is not a good thing. I know my students do not completely understand every scenario I paint for them, but I want to ensure that they realize the great extent to which mathematics affects our lives.

I'm completing my second year as an ACE teacher and am feeling much more comfortable being on the other side of the desk. It is a challenge that many long hours in the computer lab prepared me for in several ways. Perhaps the most vital aspect of my education in the CSE department was not that I learned how to manage a database or code a particular machine for automata but rather that I learned how to organize my thoughts, concentrate on a complicated problem, work over an extended period of time to find a solution, and effectively communicate my ideas to others. I made mistakes, and I learned from them. And, I hope to help my students do the same. Rather than scrambling to explain a real-world context to answer my students' queries about when they will need to know a certain topic, I tell them that I am teaching them a way of thinking, a method of solving any problem. This is the engineer-teacher in me. I hope my students leave my classroom with the confidence to approach difficult problems and the ability to apply problem-solving techniques. For myself, I will spend the rest of this year deciding if I want to pursue teaching, engineering, or find a middle ground that somehow incorporates both fields.

Note: *This article was written by* ***Kelly Keegan,*** *a 2002 graduate of the Department of Computer Science and Engineering and current Alliance for Catholic Education (ACE) program participant. Upon graduating from the University, ACE students spend two summers studying in the Master's of Education program at Notre Dame and two academic years teaching in Catholic schools across the country. While teaching, ACE students live with four to seven other participants; together they share the rewards of teaching, encourage and support one another during the challenges of teaching, and provide a much needed service to underserved schools and children.*

Recent Ph.D. Grad Settles in at Georgia Tech

Michael Niemier received his Ph.D. from the Department of Computer Science and Engineering (CSE) in fall 2003 and immediately began a tenure-track faculty position in the College of Computing at the Georgia Institute of Technology.

In spite of transitions such as moving, becoming familiar with a new city, and adjusting to much warmer temperatures — which, according to Niemier is not necessarily a bad thing, he had a successful first semester: writing two National Science Foundation (NSF) proposals, including one as principal investigator, helping to write a larger, college-level NSF proposal, and submitting three papers for publication. Niemier has also begun a collaboration between the electrical and computer engineering faculty at Georgia Tech and is working to help define the College of Computing's role in Georgia Tech's nanotechnology initiative. (Georgia Tech recently received an anonymous $36-million donation for a nano-center with promises of matching funds from the state.)

During spring 2004, he'll be teaching an undergraduate systems class — essentially Notre

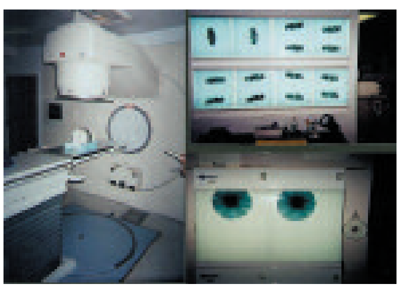
Team Led by Chen Improves Radiation Therapy Treatment Times

Intensity-modulated radiation therapy (IMRT) is a modern cancer surgical treatment technique that delivers a high dose of radiation to a target tumor while minimizing the damage to surrounding normal tissues and critical structures. The delivery of IMRT requires the ability to generate non-uniform discrete radiation dose distributions. Currently, one of the most advanced tools for delivering IMRT is the computer-controlled multileaf collimator (MLC). An MLC consists of up to 80 pairs of tungsten leaves that can be moved to shape the cylindrical radiation beams produced by a linear accelerator (LINAC) machine, which helps generate arbitrary dose distributions.

A typical IMRT treatment is carried out using the following steps:

- Tumor contouring: A computed tomography (CT) scan is performed on a patient, and the locations and contours of the target tumor and surrounding normal tissues are determined based on the CT images.
- Dosage calculation: Based on the tumor contouring information, a discrete dose prescription is computed.
- Leaf sequencing: A set of MLC leaf movements that minimizes the treatment time is computed, based on the prescribed dose distributions, and is transferred to the delivering machine for actual patient treatment.

One of the most challenging problems arising in the IMRT planning process is the leaf sequencing problem, i.e., given a prescribed dose distribution, how to generate a set of MLC leaf movements that faithfully delivers the dose distribution in the minimum amount of treatment time. Minimizing the treatment time is very important, since it will enable hospitals to treat more patients while reducing treatment costs per patient.

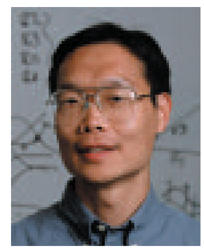


An experiment of the new leaf sequencing software on the Elekta SL20 linear accelerator in the Department of Radiation Oncology at the University of Maryland School of Medicine (left). Film comparisons of delivered IMRT plans produced by the new leaf sequencing software and the commercial CORVUS 4.0 planning system (right).

The computational medicine group, led by **Danny Z. Chen,** professor of Computer Science and Engineering, and consisting of associate professor **Sharon X. Hu,** graduate students **Shuang (Sean) Luan** and **Chao Wang,** and former Ph.D. student **Xiaodong Wu,** has been focusing on solving computational problems arising in medical applications. Computational medicine is an emerging interdisciplinary area, which is a combination of computer science, medical physics, biology, and medical applications.

Collaborating with the Department of Radiation Oncology at the University of Maryland School of Medicine, Chen's research group has developed new leaf sequencing algorithms and new software, called SLS, for IMRT delivery. Unlike previous leaf sequencing solutions, the new algorithms are based on graph theory models and computational geometry techniques in computer science. Extensive experimental studies in medical settings have shown that the new SLS software produces IMRT surgical plans which compare favorably with plans generated by the current most popular commercial IMRT planning system CORVUS and the current best known leaf sequencing algorithm in medical literature. For instance, on the Elekta SL20 series LINAC system used clinically in the Department of Radiation Oncology, Maryland Medical School, the treatment times of the IMRT plans produced by the new SLS software are about 66 percent less than those of the plans produced by the commercial IMRT planning system CORVUS 4.0. The SLS software is now being used clinically in the University of Maryland Medical Center and the Helen P. Denit Cancer Center in Montgomery General Hospital, located in Olney, Md., and has treated about 100 patients, at the rate of about three patients per week.

The research results of Chen's group on this project have been presented in the *45th Annual Meeting and Technical Exhibition of the American Association of Physicists in Medicine* (AAPM'03) and the *19th ACM Symposium on Computational Geometry* (SoCG'03). Journal papers on the research work have been accepted for publication in the *Journal of Physics in Medicine and Biology* and the *Journal of Medical Physics* and have also been invited to the *International Journal of Computational Geometry and Applications.* Comments from journal referees have included:



Chen

- "This is really a showcase for computational geometry. "
- "We can be proud that people from our community do nice work like this! "
- "The authors should be congratulated on writing a very nice paper … "
- "It combines an eminently important practical problem with mathematical ideas for constructing geometric algorithms; this leads to an interesting geometric problem in its own right and still ends up with better solutions for the original practical problem."

Dame's Computer Architecture I course with some operating systems. He is very excited about getting to work with undergraduate students.

Aside from work, he likes Atlanta, enjoys hiking in North Georgia, is looking forward to trips to Savannah and Asheville, N.C., and likes to spend time in Decatur, Ga. He also managed to travel back to three Notre Dame home games last semester. He says that perhaps the two biggest things that he's learned are: "It's virtually impossible to find a time when more than four faculty members can meet, and the traffic in Atlanta is as bad as people describe, but it can be avoided. You just have to be smart about when and where you go."

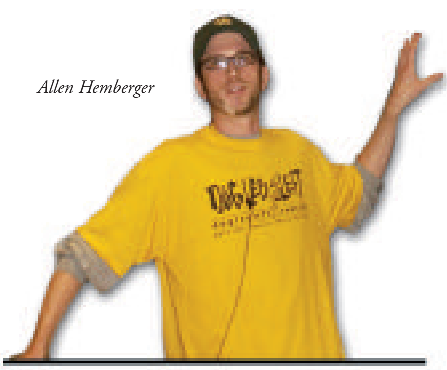
Niemier is a triple domer, having received his undergraduate degree from the CSE department in 1998, his master's in 2000, and his doctorate this past fall. His dissertation, directed by **Peter M. Kogge,** the Ted H. McCourtney Professor of Computer Science and Engineering, focused on systems-level issues related to the quantum-dot cellular automata (QCA) being pioneered by individuals in Notre Dame's Department of Electrical Engineering. QCA represents information in a binary fashion but replaces a current switch with a cell having a bi-stable charge configuration. QCA devices can be realized in metal or with chemical molecules (the current focus).

At present, there is much research under way concerning nano-scale devices geared for computation, but most of the work is device work. By and large, only the simplest circuits and systems comprised of such devices (the desired end result), have been proposed; they have not net been simulated or built. In addition, virtually all existing circuits and systems for emergent devices have been proposed by the device engineers themselves, whose backgrounds lie largely in the physical sciences not engineering. Some of Niemier's and Kogge's overall goals include: comparing projections for implementable QCA to projections for end-of-the-line CMOS in the context of the same system-level tasks, providing an infrastructure for more complex designs as technology matures, and using architecture, systems, and circuits work to help drive device development and achieve working nano-systems in a shorter period of time.

configurations

Nonprofit Organization
U.S. Postage
PAID
Notre Dame, IN
Permit No. 10

University of Notre Dame
Department of Computer Science and Engineering
384 Fitzpatrick Hall
Notre Dame, Indiana 46556-5637



Allen Hemberger

Contacts:

Director of Undergraduate Studies
Professor Ramzi Bualuan
rbualuan@cse.nd.edu

Director of Graduate Studies
Professor Greg Madey
madey@cse.nd.edu

Department Chair
Schubmehl-Prein Professor
Kevin Bowyer
kwb@cse.nd.edu

CSE Graduate Talks about Color and Lighting Effects in "The Matrix Revolutions"

Allen Hemberger received his bachelor's degree in computer engineering and art in 2001. After graduation, he worked on animation special effects for the "Jonah" movie in the Veggie Tales series. He then went on to work as the color and lighting technical director on two well-known movies: "The Matrix Reloaded" and "The Matrix Revolutions." On October 31, 2003, Hemberger returned to the Department of Computer Science and Engineering (CSE) to speak on "The Matrix Engineered: The Technical Foundation of CG Visual Effects." The talk was heavily attended by art majors, CSE undergraduates, first-year engineering students, graduate students, and faculty.

During the presentation, Hemberger gave the audience an insider's view of the special effects world. In short, the visual effects engineers who are responsible for the computer-generated effects in today's big-budget films are not "artists" in the traditional sense of the word. Most can't draw well, and very few are painters or sculptors. Rather, the minds behind mind-bending visuals like a digital Gollum ("The Lord of the Rings") or 100 photorealistic Agent Smiths ("The Matrix") are those of engineers, astrophysicists, and scientists. They paint with numbers, they sculpt with code, and when a director asks to see Neo fly down a street at Mach 3, these minds must engineer a solution that is both artistically pleasing and technically efficient.

Hemberger outlined for the audience how these visual effects are created, from script to screen, while stressing the importance of a computer background to the development of today's visual effects masterpieces. He demonstrated how a digital special effects shot is engineered and assembled from the ground up, discussing techniques in modeling, lighting, texturing, animating, rendering, and compositing. The centerpiece of his presentation was a "sneak-peak" at a five-second clip that he and others have worked on for six months at an estimated cost of $500,000.

He also took time to interact with the audience and describe the academic road that can lead to a career with companies like Industrial Light and Magic, Pixar, ESCfx, Dreamworks, and Weta Digital, including ideas of what courses a student might want to consider taking and what job opportunities exist in the visual special effects industry.

Most importantly, he underlined that a technical background is essential, and that those working in his position would routinely read academic research papers (e.g., from SIGGRAPH and other technical publications) and implement the algorithms for their work.

Though Hemberger was approached by London-based Cinesite to work on the movie "King Arthur," he decided to stay with ESCfx in San Francisco and is currently working on "Catwoman."