THE UNIVERSITY OF TEXAS AT AUSTIN
TEXAS ADVANCED COMPUTING CENTER

# Building Skills that Count

## Supercomputing curriculum helps students gain advanced computing knowledge essential to research

TACC research associate and Parallel Computing professor, Kent Milfeld, lecturing.

"I worked as a structural engineer for eight years," said Ben Urick, a mechanical engineering doctoral candidate at The University of Texas at Austin. "In industry, I understood that I needed to obtain certain advanced computing skills, as that's where the practice of engineering is headed."

"Advanced computing" is a term to describe the practice of using special-purpose, high-end computer systems to solve computational problems in science, engineering, and business that cannot be calculated on a typical desktop computer. The phrase also encompasses the special skills required to use these systems effectively.

"Anyone looking to do relevant computational work today in the sciences and engineering must have these skills," said Urick.

To address this fundamental need, the Texas Advanced Computing Center (TACC) created a unique curriculum of courses for undergraduate and graduate students at The University of Texas at Austin. Offered through the College of Natural Sciences Division of Statistics and Scientific Computation, undergraduate students can complete coursework to earn a Certificate of Scientific Computation, while graduate students finish a Portfolio in Scientific Computation.

In each course, TACC scientists and researchers teach students the essential skills for advanced computing. All of the courses offered through TACC are counted toward this certification, with one course specified as a core requirement, even if no other TACC courses are taken.

"TACC has some of the finest researchers I've ever met," Urick attested. "Having them as instructors for these classes was incredible."

The certificate program premiered in the fall of 2008, but TACC staff members have been teaching these courses since 2005. TACC Director Jay Boisseau and senior TACC scientists began crafting short classes at the center to train new employees in the essentials of advanced computing. These courses soon evolved into university courses.

In 2009, the university received a generous grant from the Chevron Corporation to continue to prepare students, many of whom will become researchers, to utilize advanced computing technologies and to distribute the curriculum broadly.

To maintain a personalized instructional environment, classes are limited to 30 students, including both undergraduate and graduate level students. The majority of students come from chemistry, biology, computer science, geosciences, mathematics, and physics. However, the number of students from the Cockrell School of Engineering is steadily increasing — mostly from electrical, computer, mechanical, and aerospace engineering — and liberal arts students are beginning to enroll from the economics and government departments, as well.

The program starts with Introduction to Scientific Programming which provides students with the basics of programming in the FORTRAN and C (C++) computer languages, which dominate supercomputing. In the subsequent courses, students advance their programming capability and advanced computing systems knowledge by writing complex codes that run efficiently on supercomputers.

Students say learning from instructors who use the classroom concepts in their research brings a different level of comprehension to the classroom. "We live and breathe on these machines each day, and see all the problems that people have," laughed Kent Milfeld, a TACC research associate and one of the professors of Parallel Computing for Scientists and Engineers.

Co-teachers for Parallel Computing for Scientists and Engineers, Kent Milfeld and Lars Koesterke, in front of the Ranger supercomputer.

The courses integrate instruction, assignments, and application. The professors encourage feedback and questions during and after every class.

"The lecturers have the skill and knowledge necessary for students to master the standards while also making it far more interesting than expected," chemistry student Matt Welborn commented. "They contribute a strong understanding of the subtle details and pitfalls of each method."

Beyond classroom instruction, students have the opportunity to use what they are learning on the state-of-the-art equipment available through TACC. For example, Parallel Computing students start working on Ranger, one of the most powerful supercomputers in the world, during the second week of class.

"I don't like to stand there for 75 minutes just preaching," says Lars Koesterke, who co-teaches the Parallel Computing class. "We try to keep the students engaged."

Students are entering a competitive labor market today, and having extra credentials on their resumes will put them ahead of the pack. The certification is the equivalent of a minor, and employers recognize the value of this practical knowledge.

Student Ben Urick 'virtually' resting on a rock in Manchu Picchu as displayed on Stallion, at the ACES Visualization Lab

As Brad Armosky, TACC's Education and Outreach Coordinator, explained, "Your transcript basically says: not only did I get an undergraduate degree, but I also have exceptional capability to use more powerful computers than most students in my major have ever used."

"We have 20 students currently pursuing the Certificate," said Jennifer Duthie, specialist in the Department of Statistics and Scientific Computing, "and one who has finished the program and received the Certificate."

The Graduate Portfolio Program in Scientific Computation, with TACC classes as core requirements, will commence in the fall. Feedback from students has been positive. They say they found the classes relevant to their fields and research. "These courses have been indispensable and vital to my work," Urick agreed.

"The instructors cared about making the class great," physics student Alex Hawk said. "They replied to emails thoroughly, stayed after class to answer questions, gave lively, well prepared lectures, and even connected me to a molecular dynamics specialist at TACC."

The scientific computing classes are listed in The University of Texas at Austin's course catalogue every fall and spring semester. They can be found under the search query field of "SSC" as upper division classes. Seating is limited, so register early.

"I think UT students are incredibly lucky to have these classes available to them, and with it the use of TACC resources," said Urick. "It really is a fantastic situation, unique from anywhere else."

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