TOP OF THE CLASS

The University of Pittsburgh's Swanson School of Engineering was an early adopter of engineering simulation, using ANSYS software for decades to train students in industry-standard practices — while also accelerating faculty research efforts. Swanson's Dean Gerald Holder discusses the evolving role of technology in meeting future education and research challenges.

By *ANSYS Advantage* Staff

ANSYS ACADEMIC ADVANTAGE
ANSYS.COM/81CLASS

The Swanson School of Engineering at the University of Pittsburgh combines the traditions of the city's industrial past with a forward-looking perspective that focuses on innovations in areas such as bioengineering, alternative energy and sustainability. More than 2,600 students major in one of six traditional engineering topics — or focus in a multidisciplinary area such as civil engineering and chemical engineering or manufacturing systems engineering.

With proximity to the world headquarters of ANSYS — and an engineering school named for ANSYS founder John Swanson — the University of Pittsburgh was an early adopter of engineering simulation software, in both the classroom and research lab. Under the guidance of Gerald D. Holder, who has been the U.S. Steel Dean of Engineering since 1996, Pitt's Swanson School has grown in its adoption of advanced technologies that make the work of engineers faster and more cost-effective — without sacrificing accuracy.

Dean Holder recently spoke with *ANSYS Advantage* about the challenges and opportunities he envisions for the future of engineering education. Based on his unique perspective as leader of a top U.S. engineering school, Holder had much to say about the way technology has shaped, and will continue to influence, engineering classrooms and academic research laboratories.

Both ANSYS and the Swanson School are committed to providing engineers with the skills and toolsets they need.

During your tenure as dean, what are some of the biggest changes you've witnessed in engineering education?

More than any other single factor, technology has changed our entire world over the past two decades — and we certainly feel its enormous impact in engineering education. It has dramatically altered both our labs and our classrooms. For example, simulation software has always been one of the key tools for an engineer, but today its speed and power have improved markedly. Not only have these technology improvements greatly accelerated what our researchers can accomplish, they have also democratized specialized tools like ANSYS, making it possible to put them into the hands of more students and research teams.

Today, more than at any other time in Swanson School's history, technology is an essential part of our curriculum and physical environment. We have more than 750 workstations loaded with ANSYS software across our classrooms, student labs and research facilities. Close to 100 percent of our students work with ANSYS in the classroom as part of their hands-on instruction. All our buildings are wired for high-speed, high-volume data transmission so we can support numerically large simulations and other computing tasks. We have created some flipped classrooms in which students watch lectures remotely then spend classroom time working more actively on hands-on problem-solving.

Now we have created a director of technology position to ensure that the Swanson School stays ahead of technology trends, allowing us to give students the skills they will need in the workplace. We have a 95 percent success rate in placing our graduates, which reflects our close connection to industry and partners like ANSYS — and this provides us with a better awareness of the knowledge and experience that employers are looking for. Hands-on technology expertise is increasingly a vital part of the skill set that our graduates need.

Do you see any downside to all the technology in the college classroom today?

I think the only potential danger is that students can rely too heavily on advanced tools like ANSYS software that do all the work for them. At the Swanson School, we make sure that students understand the basic mathematical and physical principles that underlie engineering simulation. Our curriculum covers all the traditional engineering topics, providing that solid foundation, before introducing computer-aided design and verification tools.

There's no doubt that ANSYS can streamline and accelerate design and experimentation. It can also dramatically amplify the work of engineers by allowing them to consider thousands of design variations, instead of constructing one prototype of a single design and running repetitive physical tests. But engineers also need to set the right parameters and define the right conditions for their simulations — which requires a deep understanding of math and science. Even as technology improves and makes an engineer's job easier, we can't lose sight of providing a strong fundamental engineering education.

Technology is an essential part of our curriculum and physical environment.

What is the biggest challenge confronting U.S. engineering programs today — and how is Pitt responding?
Worldwide, we've seen an explosion in the growth of engineering graduates. In 1996, there were approximately 50,000 B.S. degrees awarded. Today, that number is more than 90,000. Much of that growth is happening in Asia.

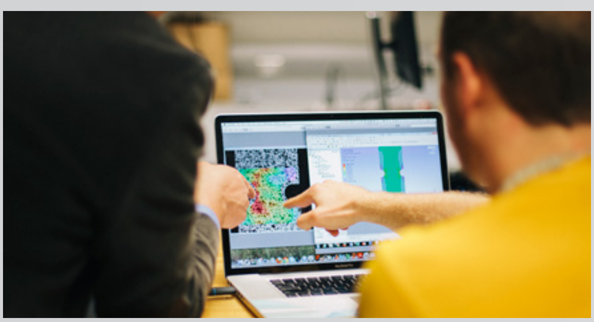
For the Swanson School, that means two things. First, we must attract more international students at the undergraduate level and become more recognized in the global engineering community. About half of our graduate students come from outside the U.S., but we need to recruit more heavily overseas for our undergraduate programs.

Second, we must join forces with other universities to increase enrollment here in the United States in science, technology, engineering and mathematical (STEM) topics. President Obama has challenged American universities to graduate 10,000 more engineering majors per year. Certainly the advanced technologies in our classrooms, our leading-edge research, our close partnership with industry leaders like ANSYS, and our collaborations with corporate partners are helping to make the Swanson School more appealing to students. Our strong recruiting efforts, especially among women and under-represented minorities, are helping to increase our enrollment.

For urban schools like the University of Pittsburgh, however, growth itself can be a challenge. We are landlocked, with no real physical space to expand. To address this obstacle, we're currently undertaking a $150 million renovation of our 40,000-square-foot engineering building. This facility upgrade will not only help us attract new students, but it will provide space for our increased enrollment as we support President Obama's STEM education goals. We're taking this challenge very seriously.

The Swanson School has always had a strong focus on cooperative education. Why is this concept so important?
About 60 percent of our undergraduates complete a cooperative education experience before they graduate, and that's a statistic we're very proud of. As much as we try to prepare students for the real world

Measurable Impact in the Classroom



▲ Use of simulation in the classroom increases students' familiarity with simulation software — which they will need to use on the job after graduation — and makes them more thoughtful designers.

In his Mechanical Measurements II course at the University of Pittsburgh, Assistant Professor Mark Kimber uses ANSYS Mechanical to teach juniors and seniors the principles of stress measurement across complex parts geometries.

"In applying basic stress equations to a complex part for tension, compression and bending, we can theoretically assume that no geometric irregularities exist in that part," says Kimber of Pitt's Department of Mechanical Engineering and Materials Science. "But in the real world, it is nearly impossible to design a product without allowing for some changes in the cross sections of its materials. For example, some parts must have holes drilled to allow for rivets or bolts to attach to other components. Any materials discontinuity, such as a hole, alters the stress distribution — causing stress concentrations that can affect material wear and, ultimately, product performance."

in our classrooms, there's really no substitute for working side by side as part of a cross-functional engineering team that's trying to solve actual customer problems.

We've found that there are many benefits of being a working engineer as an undergrad. Our co-op students typically are exposed to complex problems that involve multiple disciplines, because that is increasingly the way engineering teams work today. They get the opportunity to apply technology tools like ANSYS software in a higher-value way. They form relationships and make connections that will benefit them later. Overall, we find that students who participate in co-ops have higher grade point averages and earn higher salaries upon graduation. We believe very strongly in the program.

How would you describe your relationship with ANSYS?

We have always had a terrific relationship with ANSYS. Over the years, the company has been many things to the Swanson School. Obviously, ANSYS is a supplier of industry-standard software tools that our students will need to use in the workplace. Through its flexible licensing agreements developed for academia, ANSYS has allowed Pitt to create hundreds of workstations loaded with its software across our classrooms and labs.

In addition, ANSYS has been a strong supporter of our cooperative education

We have a 95 percent success rate in placing our graduates.

To create a hands-on learning experience, Kimber first has his students experimentally measure a machined part with geometric complexities. They manually calculate the areas of stress created by material irregularities, such as notches and holes, using the experimental data.

Next, after learning the basics of numerical modeling, students recreate the part geometry in ANSYS Mechanical. They repeat their experimental measurements and calculations in the virtual world to test the accuracy of their manual work. In addition, the flexibility of ANSYS software enables the students to assess a discrete number of new geometry variations. As they change the size or placement of a hole, they can immediately see how stress loads distributions change across the complex part.

"ANSYS provides a user-friendly, graphic way to understand exactly how different stress loads conditions result from the smallest geometry choices," Kimber explains. "I could talk about stress equations for hours, but ANSYS provides an immediate way to see and understand the effects of stress distribution on a real-world product specimen. This experience not only increases my students' familiarity with simulation software — which they will need to use on the job after graduation — but I believe it also makes them more thoughtful designers."

According to Kimber, ANSYS Mechanical is a popular tool in his classroom. "Because my courses are aimed at upper-level engineering majors, we are dealing with complex topics. At times, students complain that the subject matter is becoming too difficult," he notes. "I never hear any complaints about ANSYS software; every student enjoys working with it. Using ANSYS Mechanical is a very positive experience for my students, and it really opens their eyes to the possibilities of virtual design."

program for over two decades. Since 1990, more than 200 Pitt undergrads have worked at ANSYS as co-ops, and today there are at least 30 full-time employees at ANSYS who began their careers as co-ops.

ANSYS has also been an important source of philanthropy and support through its founder, John Swanson, who earned his Ph.D. in applied mechanics from the University of Pittsburgh in 1966. His generous financial support led Pitt to name its engineering school for John in 2007. But, equally important, John is generous with his time in visiting the campus and mentoring our young engineering students. He is obviously an inspiration to the next generation of engineering innovators.

Although John Swanson retired from ANSYS in 1999, our relationship with ANSYS remains very strong today. We are both committed to providing engineers with the skills and toolsets they need to do their jobs faster, more cost-effectively and more efficiently. As I look toward the future of engineering education, I am grateful that the Swanson School can continue to rely on our close partnership with ANSYS to accomplish our shared objectives.

Small Scale, Enormous Benefits

Pitt's Kevin Chen applies ANSYS Mechanical in support of his leading-edge research aimed at understanding the microstructural properties of silica optical fibers used for a range of telecommunications and sensing applications. Chen is an associate professor and Paul E. Lego faculty fellow in the Swanson School's Department of Electrical and Computer Engineering.

Chen's innovative work with ANSYS software has been supported by a Faculty Early Career Development (CAREER) award from the National Science Foundation, which provided more than $420,000 in funding. Highly prestigious and highly competitive, CAREER awards honor junior faculty members for their outstanding accomplishments in both research and teaching.

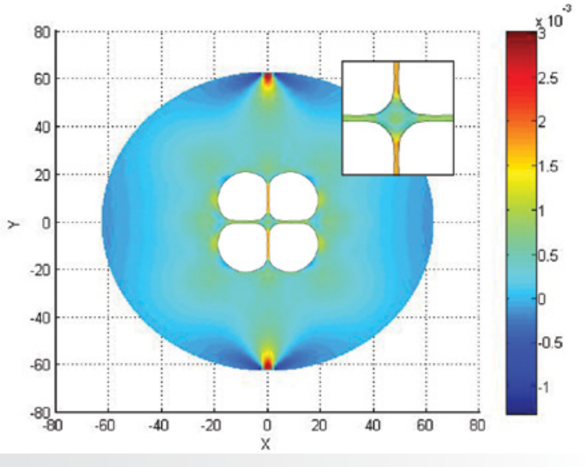
While many engineers use ANSYS Mechanical to assess the structural strength of materials for large civil and mechanical applications, Chen is breaking new ground by applying simulation software at micro and nano scales. In his fiber optics laboratory at the University of Pittsburgh, Chen and his research team conduct micro- and nano-mechanical structural analysis of silica fibers that are only 125 microns in diameter.

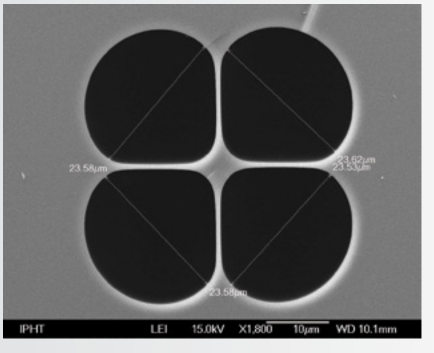
"When silica fibers are used for telecommunications and fiber optical sensing applications, their performance is inherently limited by their structural properties, most notably their response to physical stresses," notes Chen. "To make these fibers mechanically highly robust beyond solid silica (for telecommunication) and sometimes highly susceptible (for sensing applications) to external environments, we are engineering them with microstructured airholes that distribute stress to the core of the fiber in an optimal way, given a particular application."

Chen uses the finite element analysis (FEA) capabilities of ANSYS Mechanical to simulate stress distribution across these tiny fibers with even tinier holes (10 to 100 nanometers). According to Chen, ANSYS software is his tool of choice because of its ability to build an ultrafine mesh that replicates both the airholes and the fiber core in a time- and cost-effective manner.

"Because optical fibers are produced in batches of thousands of meters at once, trial and error is not a feasible solution for making manufacturing improvements," explains Chen. "We need to accurately predict the fibers' performance characteristics before we commit to an expensive production run. ANSYS Mechanical allows us to do that.

"As my research team changes the shape, size and orientation of airholes, we ask ourselves, 'Will this provide a 10 percent improvement in fiber strength — or a 10-fold improvement?' ANSYS software enables us to answer these types of questions and to quantify our design modifications with complete confidence," Chen says. "We could not accomplish our important research without simulation software such as ANSYS Mechanical."





Microstructures in silica fiber and response to external stress