Into the Unknown
The Future of Education

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In the late 11th century, a teenaged philosopher named Peter Abelard left his home in Le Pallet, France, and traveled to Paris. At the time, the French capital city was one of the world’s leading centers of thought, and its brightest minds held the philosophy of Realism to be sacrosanct. But Abelard had other ideas.

In a series of oratorical battles, Abelard defeated Realism’s proponents and established his own philosophy, which came to be known as Conceptualism. A few years later, Abelard created one of the first modern schools, where thousands of students listened to lectures, were tested on their knowledge and concluded their studies with a graduation ceremony. That model became the framework of the university, the dominant form of higher education for the next 900 years.
But all that is about to change. Abelard’s once-revolutionary educational model is now staring down an upheaval of its own. A decrease in government funding is making college ever more expensive for students, and a bachelor’s degree hardly guarantees a job. Meanwhile, online resources offer access to much of the same educational content for little to no cost.

In his 2011 book *Abelard to Apple: The Fate of American Colleges and Universities*, Rich DeMillo, PhD ICS 72, former dean of the Georgia Tech College of Computing and now a distinguished professor there, lays out the looming challenge: “Instability threatens most colleges and universities in the United States. Once-reliable sources of revenue are either drying up or being divided among many more institutions. ... Newer, smaller and more nimble competitors collaborate to offer equivalent services at lower prices.”

Those “more nimble competitors” include the likes of Apple's iTunes U, which offers more than 500,000 lectures, all free of charge.

“I think the situation is pretty serious, and I think that for an alarmingly large number of institutions the future doesn’t look terribly bright,” DeMillo says.

With strong headwinds buffeting the world of higher education (click image at left for more), what lies in store for Georgia Tech? Rather than fret about this oncoming revolution in education and take a defensive stance, Tech’s leaders have set the Institute on a path not just to survive, but to flourish.

The foundation of that effort was laid by former President Wayne Clough, CE 64, MS CE 65, who set a goal for Georgia Tech “to define the technological research university of the 21st century.” Current Tech President G. P. “Bud” Peterson incorporated that challenge prominently into Tech’s Strategic Vision, launched in 2010, which set goals for the Institute to meet by its 150th anniversary in 2035.

To Rafael L. Bras, Tech’s provost and executive vice president for academic affairs, that provides clear guidance: Georgia Tech must stay true to its technological and scientific roots, and it must be a leader, not a follower. The goal pushes Tech to reimagine its structure and identity in the midst of the looming changes in higher education. And those changes, Bras stresses, are most certainly coming.

“I know this train has left the station, but I don’t know where it is going, and frankly I don’t know if anyone else knows,” Bras says. “I have no doubt that it will get somewhere, and we sure are going to be ready. Georgia Tech will impact where that train goes.”
To help Tech steer that train, Bras first reorganized the office of the provost. The dean of libraries, Catherine Murray-Rust, is now also the vice provost for learning excellence. Her task is to promote the best pedagogical standards, including through the use of new technology.

In 2011, the Institute also created the Center for 21st Century Universities (known as C21U), which serves as a living laboratory to experiment with education techniques and technologies. DeMillo was appointed the center’s director. He views C21U as a place where researchers can make gambles and ask big questions, a “freeing kind of environment, but very outcome focused.”

Having a robust, flexible portfolio of projects is crucial, because students’ preferences can change almost overnight, DeMillo says. For instance, when he was writing *Abelard to Apple*, surveys of college students showed they preferred print textbooks to e-books. Now, four years later, the current freshman class prefers e-books. The same thing has happened with online courses: students had little interest in them four years ago, but they’re now increasingly popular.

“We have the ability to build different kinds of boats,” DeMillo says of C21U. “And if they don’t float, it doesn’t sink the whole Institute.”

DeMillo also is chair of the new Council of Educational Technology, an advisory group of stakeholders and professionals who report to the provost’s office. The council has been tasked with watching trends in higher education as well as developing and refining ideas researched and generated by C21U, then recommending how to put them into practice. The vice provosts and deans will serve as the operational arm, enacting the new ideas across campus.

Though the undertaking is still in its infancy, Bras says it has proven valuable already. And he knows it will be crucial in the chaotic times ahead.

“Georgia Tech clearly must be an important player in this,” he says. “We have to stay on top of it to live up to our vision of being the technological university of the 21st century.”
Education on Demand

As the Institute looks to the future of education, it’s keeping an eye on its new competitors. One of those is Udacity, founded by Sebastian Thrun, a Stanford computer science professor and Google VP who is perhaps best known as one of the creators of Google’s self-driving car.

In April, C21U hosted a talk by Thrun. He told the crowd about attending a TED talk in March 2011 and listening to Salman Khan, founder of Khan Academy, an online educational resource that offers thousands of video tutorials, interactive assignments and assessments to anyone around the world with access to the internet. Its site boasts that it has delivered more than 160 million lessons.

“My class only reaches 200 people,” Thrun admitted to the Tech audience. “I felt a little embarrassed.”

So he went back to Palo Alto and started working on an online version of his Computer Science 221 course. He filmed detailed tutorials and posted them online. Each video is followed by a quiz that is quickly graded, with an explanation given for each problem. And thus Udacity was born.

By the beginning of the fall 2011 semester, 160,000 students located in 190 countries had enrolled on the fledgling site.

Soon after, Thrun noticed a curious response among the students enrolled in his actual CS221 course: Most of them stopped attending class. When the students reappeared for an exam, they told Thrun that they preferred to watch him on video. They could watch at their leisure, rewind to review difficult points and then visit Udacity’s online forum to ask questions.

“It was a transformational experience to me,” Thrun said. “This [online course] was
having more impact than anything I'd ever done in my life. ... Having done this, it's impossible for me to teach a regular class at Stanford."

Udacity now offers 11 courses, mostly in science and mathematics, all of which are free. It also partners with companies that recruit Udacity's students. Which begs the question: If a student can take a Stanford-quality course for free and potentially find a technology job out of it, why would anyone actually enroll at Stanford?

In a Wired article about Udacity, Thrun predicted that in 50 years perhaps only 10 institutions around the world will still be in the business of higher education. (Currently, there are thousands.) In April, as Thrun addressed the audience of Georgia Tech faculty and students, he softened that stance: "I don't see this as a confrontation."

Bras was less reserved. "It truly shakes to the ground the model higher education has," he says.

The open-course movement represents a sudden and radical change in part because it allows educators to broadcast knowledge to an exponentially larger audience. Currently, Georgia Tech has about 150,000 students and alumni. As Udacity proved, that many people—maybe even more—can and will sign up for a single online class.

"We are talking about incorporating 100,000 stakeholders in a single course, and we will have dozens of those courses online," DeMillo says. "So in one leap forward we will have millions of people that have a direct connection to Georgia Tech."

Open courses could also lead to transformational change in the developing world and other areas where access to traditional educational institutions is limited.

"There is a hunger for education in the world and people out there who just simply do not have the opportunity," Bras says. "To those people who have the discipline and the whereabouts to do this, they can probably get a lot of content [online]. That would be of tremendous social value."

Online education has been derided as too impersonal, but efforts such as Udacity have proven it to be in some ways better than the traditional model of education.

"The comments from [open course] students show they feel an emotional connection," DeMillo says. "So at some level students are connecting with instructors via the technology in a completely different way than we would have imagined."

In fact, one of the core tenets of traditional learning—that face-to-face interaction between teacher and student is critical—is actually of almost no value, according to meta-analysis of education studies. What does matter, the research shows, is timely feedback. And online education programs, with their automated grading, are well suited to providing students with a quick assessment of their work.

Meta-analysis shows that the other most effective educational tool is one-on-one tutoring. Hiring thousands of tutors to accommodate a class roster of more than
100,000 is an economic impossibility for most universities, but tools have developed to fill this need as well.

OpenStudy—a startup created by Chris Sprague, MS CS 04; Ashwin Ram, a computing professor at Tech; and Preetha Ram, an associate dean at Emory College—is one such tool. It’s a social network that allows students to meet online and work through problems in a variety of fields. The site, which launched in 2010, already has more than 100,000 users from 170 countries.

“We were late to recognize the possibilities that these things presented, but over the past four or five months we have moved the Institute to focus now on the potential value of online courses,” DeMillo says.

In July, the Institute made a big leap into the open-course arena as it became a founding member of Coursera, a company that will offer free online classes from 17 member institutions. Tech’s initial offerings through Coursera include Computational Photography, Computational Investing, Energy 101 and Control of Mobile Robots. The courses are open to everyone with an internet connection who registers at coursera.org.

While this is a big step, Institute leaders stressed that more partnerships are on the way.

“We view this partnership as a type of experiment,” said Michael McCracken, assistant dean in the College of Computing and director of online course development and innovation at C21U. “Georgia Tech can watch what is happening in the online course world, see how it evolves and then decide how it wants to participate. We feel that directly engaging in the online course community with our own courses is a more proactive approach to actually learning what is successful and not so successful in developing and offering courses in the massive, open online course world.”

President Peterson said the effort fits perfectly with the Institute’s goals.

“Georgia Tech is committed to using technology and advanced platforms to enrich and expand educational opportunities,” he said. “Through Georgia Tech Professional Education, we already offer courses to more than 25,000 students worldwide. Steps such as this agreement will enable even more students throughout the world to have access to Georgia Tech’s expertise, and help to meet the needs for lifelong learning.”

In this new environment, C21U will develop the prototypes for online courses and Professional Education will take on the task of producing the courses, McCracken said.

The fundamentals of offering online education is nothing new to Tech. The Institute first entered the online course business in 1977, and so Professional Education brings significant experience to bear.

Nelson Baker, CE 80, dean of professional education, said the division will be working “hand in glove” with C21U on the production side, and the key is to ensure that the
online courses maintain Tech’s high academic standards.

Professional Education is going through a reorganization to align itself with the new demands, and that includes hiring an associate dean for learning systems. That position will be focused on new pedagogies and technologies, Baker said.

The professional education team also continues to work closely with corporate partners and individuals to make sure that the classes it offers will help Georgia Tech alumni and other professionals build skills that make them more desirable to employers. “We want to make sure the learning objectives meet the business needs of working professionals,” Baker said. “We do a lot of listening.”

One benefit of the online courses is that they offer an array of data on how students interact with the software and which tools are most effective for learning—numbers that go far beyond the attendance logs and grades recorded in a traditional classroom.

“We will know what makes [students] tick from a learning standpoint,” DeMillo says. “We will be observing learning processes essentially in the wild and be able to draw conclusions on what matters.”

DeMillo is excited by the prospects of online education, but still the question looms: “Once we move to a massive open-course [system], why would people pay tuition?”

Flipping the Classroom

Charles Isbell, a professor and senior associate dean in the College of Computing, says it’s already a challenge convincing students to come to class.

“I’m often surprised at the class before the midterm; ‘Who are these people?’” Isbell says. “They show up for the class before the midterm, the midterm and the class after
the midterm to see how they did. So when everything is online, why should they come to class?"

Isbell, ICS 90, and Cedric Stallworth, EE 90, MS CS 99, the assistant dean of outreach, enrollment and community at the College of Computing, have been trying to answer that question. The goal is to ensure that students will continue to want to attend Georgia Tech, and the challenge is that the in-class experience must have significant added value beyond the simple transfer of knowledge.

One old concept that has been dusted off is the “flipped classroom.” In the traditional model, professors spend class time lecturing, and students use their own time on homework and studying. But in the flipped classroom paradigm, students watch video lectures on their own time and spend class time working through problems in small groups and receiving in-person mentoring from faculty.

Isbell and Stallworth envision the flipped class as an intensive training session that focuses on skill training as well as knowledge transfer.

“Today’s students have no excuse,” Isbell says. “Just start at Wikipedia and go from there. If everything you need to know is out there, that now allows me as a teacher to accelerate their learning more like a PhD program.”

That means posing more challenging assignments and having the time to guide students through the problems in class.

“It doesn’t matter that I have given you more work, because we can now spend three hours a week working together on it in class,” Isbell says. “... With more of the learning out of the classroom, we can now do the more interesting work in it.”

The idea that Tech’s classes might become more difficult might not thrill students, but it is in keeping with the Institute’s history, DeMillo says. Georgia Tech has always prided itself on being a tough academic environment, a school that students don’t just graduate from but survive. And that is part of what makes Tech alumni so successful.

“Employers who hire Tech graduates notice that they hit the ground running,” DeMillo says. “They are competitive. They work hard. They are self-motivated. So there is a kind of toughness that we weave into our programs that serve students well when they leave. You can’t really simulate that [in online classes].”

Isbell says Tech teaches students what they can accomplish when they’re pushed. “We used to say, ‘Georgia Tech: Building tomorrow the night before.’” Or, as Stallworth, who was a starting cornerback for the Yellow Jackets, puts it, “We make white-collar talent with a blue-collar work ethic.”

In addition to reimagining the structure of the classroom, Tech’s leaders are having to rethink what constitutes a class in the first place. One such effort is the Vertically-Integrated Projects program, better known as VIP. It’s the brainchild of Edward J. Coyle, Arbutus Chair for the Integration of Research and Education at Tech and a Georgia Research Alliance eminent scholar.
The three main missions of a university are research, education and service, Coyle says. Though schools may succeed at each of those independently, the three remain mostly discrete entities: Faculty members conduct research with graduate students, they only engage with undergrads through classroom lectures and service projects are mostly separate from both research and education.

“With VIP, we wanted to really pull all of this together and allow everybody to participate,” Coyle says.

Through the program, faculty members and their graduate students serve as advisers for teams of 10-20 undergraduate students. Those students assist with the more practical aspects of faculty members’ research projects and earn class credit for their contributions.

Many teams undertake service projects; DeMillo, for example, advises eDemocracy, a team that partnered with the Carter Center to create mobile technology for election monitors. The system, which prompts monitors on what to look for and automatically sends the observers’ reports to election leaders via whatever network is available, has been used during elections in Egypt, Liberia and the Philippines. One former student involved with the project now oversees it as a member of the Carter Center staff.

“That’s something that’s a real service to the world,” Coyle says.

Undergraduate students can be on a VIP team for up to three years. That allows them to grow in the position and continue to add skills, just as they would in a career. Then, as upperclassmen, the students oversee and train newer team members. Those professional skills are immediately useful once the students graduate.

“People who’ve hired our students said they were four to five years ahead of their peers as far as understanding the professional environment,” Coyle says. “That’s something higher education needs to focus on. We can’t just lecture. We’ve got to produce students who are functional as well as knowledgeable.”

Coyle’s VIP team, called eStadium, developed a smartphone app that delivers automatically updated statistics and annotated video replays to fans during football games at Bobby Dodd Stadium. The students built the app from the ground up and spend game days at the stadium making sure it runs smoothly.

Coyle says he treats the VIP students as if they were his graduate students. They do challenging work, and there’s no question the experience accomplishes something that couldn’t be done by watching lectures on the internet.

Tech has 13 VIP teams and plans to add two to three per semester. Six of the teams have research chairs as advisers. “I consider that the ultimate sign that it’s a success,” Coyle says. “Those people don’t like wasting time.”

Planning also continues on the X-College, a proposed “design your own major” program that would allow students to custom build their own area of study. Programs such as the X-College and VIP prove that Georgia Tech has much to offer beyond
simply the transfer of knowledge, Bras says.

“In the end of the game, success requires more than skills,” he says. “It requires a maturity of thinking that goes beyond skills, and that’s the essence of education. That is why I think people will still pay to come to Georgia Tech.”

Defining the Future

DeMillo had a few reasons for including Abelard’s name in his book title. It made for nice alliteration, and it covered the passage of time from the earliest universities to the present. But DeMillo also chose to call out Abelard because the philosopher was so eager to challenge the status quo.

“He was deliberately tweaking the nose of the ecclesiastical establishment,” DeMillo says. “His success, more than anything else, was due to the fact that he was able to turn a mirror on scholarship of the day and point out the inconsistencies.”

For Georgia Tech to enjoy continued success over the coming decades, it needs to have that same eagerness to challenge itself and its traditional way of doing business, DeMillo says.

The choices are stark: Do nothing and fade into irrelevance or make changes and greatly expand the Institute’s influence. “I am absolutely convinced that the number of stakeholders will grow dramatically over the next 50 years,” DeMillo says. “It will probably be the dividing line between institutions that work and institutions that fail.”

C21U has plans to launch an assortment of projects over the next year focusing on expanding scale, personalizing education and establishing quantitative learning goals. There are no solutions yet, only questions. What kind of institution should Georgia Tech become? What kinds of students and faculty should it recruit? Which of those students will be on campus? What will they learn? What will be the scale of Tech’s
That uncertainty is daunting. But rather than hide from the unknowable future, Georgia Tech is embracing that uncertainty and framing it as a challenge. DeMillo is reassured by the slogan from the Strategic Vision, that Georgia Tech must “define the technological research institution of the 21st century.”

“When I joined Georgia Tech as dean it was a statement; there was a period at the end of that sentence,” DeMillo says. "It was only over some time that people realized that it's not a period. It's an ellipsis.”
<table>
<thead>
<tr>
<th>Article Title</th>
<th>Subtitle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office Space: Feet of Engineering</td>
<td>A Perfect Match</td>
</tr>
<tr>
<td>Buses in a Bunch, No More</td>
<td>Meghan Duffy: Fleas, Please</td>
</tr>
<tr>
<td>All Mapped Out</td>
<td>Lend a Hand to Get Ahead</td>
</tr>
<tr>
<td>Grand Challenges Goes Big</td>
<td>Mike &quot;Taco&quot; Lopez Lives on in Photos</td>
</tr>
<tr>
<td>Yellow Jackets on the Silver Screen</td>
<td>A Mistress of Patience Reflects</td>
</tr>
<tr>
<td>Learning Gerrymandering from the Old Spice Guy</td>
<td></td>
</tr>
<tr>
<td>Undergrad Inventors Shine at InVenture Prize</td>
<td></td>
</tr>
</tbody>
</table>

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