ENGINEERS WHO MAKE A DIFFERENCE

Two innovative thinkers are bringing about internationally viable solutions to transportation and education systems

If your rules are without reason, destroy them

Quality comes first for Driscoll's supply chain group

Cognitive ergonomics in manufacturing

Get peers involved in employee evaluations
Conrad Tucker thinks replacing concepts with experiences will boost education.

Take gravity, for example. You can learn about it the traditional way—via an equation on a blackboard. But Tucker, assistant professor of industrial and manufacturing engineering at the Pennsylvania State University, is working on various forms of augmented reality that could lead to new teaching techniques, both in the classroom and over the internet—not to mention improved operations in numerous business sectors and more personal control over your destiny.

He said when many engineering students recall their education, they remember learning concepts that were difficult to grasp when written on a blackboard. But think about taking students, putting them in a virtual spaceship, enclosing them in a virtual spacesuit and letting them experience how different gravitational levels affect how they move and interact.

"Then you start replacing concepts with actual experiences, and that's what we're trying to do," Tucker said. "And by that you learn the concept by experiencing rather than by being told what the concept is."

Such research led Tucker, who also directs the university's Design Analysis Technology Advancement Laboratory, to being named one of ISE magazine's 2017 Engineers Who Make a Difference. He and his research squads also are working on big data applications and advanced decision-making tools.

"What we're trying to do as humans is make better decisions," Tucker said. "So if you can have a tool, a decision support system that leads you to make more informed decisions, then it's a win-win for everyone."

Tucker said such tools can reach beyond education to manufacturing and healthcare. Already, Penn State teams have used social networks to model the spread of disease and figure out features for the next smartphone iteration. Virtual reality and its sibling, augmented reality and mixed reality, could expand higher education to more people and save businesses billions of dollars in training costs.

Virtual reality pairs individuals with a headset, Tucker said, immersing them in a virtual world with a 360-degree perspective. Augmented reality overlays digital objects into that virtual world—think of Pokémon Go, where players walk around with their phone to capture Pokémon. Mixed reality, a Microsoft term, adds interactivity.

"Under the umbrella of immersion, they're all trying to accomplish a similar task: Give someone a sense of immersion and engagement in a digital experience," Tucker said.

Tucker notes that most current online programs don't have a lot of STEM-based courses (science, technology, engineering and math). Engineering, specifically, requires laboratories and team building.

"It's very difficult to call yourself an engineer if you've never actually physically built something or worked on a team," he said. "And so with that being the constraint, the idea is to give students the sense of being in a laboratory and working and
building prototypes and also working in teams in a virtual sense."

Education costs have skyrocketed while household incomes have remained stagnant, creating a challenge. Virtual reality could help reverse that cost curve. Even traditional students might not have to drive an hour in traffic to attend every class, as part of Tucker’s research aims to determine whether students learn better in traditional brick-and-mortar environments or immersive virtual reality when they engage in similar hands-on projects.

Universities could find the right balance between what requires physical spaces and what can be taught in a more digital sense. And as the technology advances, virtual reality will come at a lower price point than a traditional high-tech laboratory.

"So instead of building a machine shop to teach a lab, for example, now you can re-create an experience in virtual reality and teach students the same concept. At least that’s the vision and that’s where we’re trying to go.”

The same concept applies to the business world. Boeing and NASA are interested in employing virtual reality concepts for training. Immersive learning, similar to simulation flight training for pilots, could teach workers how to install a wing on an aircraft or spacecraft, alleviating the need for multimillion-dollar training facilities.

Applied across the U.S. manufacturing industry, pegged at $2.17 trillion a year by the National Association of Manufacturers, savings could be astronomical. That doesn’t include extrapolating such savings throughout the broader $18 trillion (as of 2015) economy.

"It’s an exciting time to be a researcher," Tucker asserted. "There will be lots of opportunities. This is just a very nascent field, but there’s just so much that can be done to transform the way that we do things.

Safety is another great opportunity for augmented reality. No matter how well-designed the system, people can make dangerous decisions or take anomalous actions. A manufacturing worker might be on his way to turning off or activating the wrong switch, something that triggers danger to fellow employees down the line. Augmented reality headsets could warn workers before they make a mistake—a kanban or visual management for safety.

"So it’s this real-time visual decision support system that is displayed right in front of the operator."

And as in the iPhone example above, some of Tucker’s big data research can help businesses figure out what to include in new products and services.

"So instead of playing that guessing game, why don’t we use data to make more informed decisions?" Tucker asked. "And
you can do that using social network models like Twitter and other open source data modalities to really figure out what people like and don't like.”

If people don't want something, it doesn't make sense to invest capital and resources to go down that path, Tucker said. Sometimes figuring out where not to put money is just as important as figuring out where to spend.

Big data also can help physicians prepare for contagious diseases and personalize healthcare.

Currently, healthcare is a reactive system. Physicians have limited knowledge when a patient walks into the room. Big data can help medical officials view the spread of disease like a weather pattern, allowing them to prepare for the potential problem ahead of time or at least increase staff to deal with an outbreak.

The same applies to one-off events like heart attacks. When the patient arrives, medical personnel rarely know the sequence of events that led to this specific heart attack. But emergency responders can gather data from a Fitbit, an iWatch or a motion capture system from the patient's home.

"Now you can start piecing together the sequence of events that possibly led to that event going on," Tucker said. "And if you start observing those same combinations in a general population, then you've just discovered a new diagnostic tool to help you prevent or provide feedback to a patient before that event happens."

The idea of personalization is taking hold throughout society. Music playlists have replaced waiting for your favorite song on the radio. Online shopping customizes your orders.

In the future, largely because of research by Tucker and others, have it your way will apply to even more aspects of life.

"I see medicine, I see education, I see design moving toward the sense where individuals have more control over their destiny, if you want to call it that," Tucker said. "I have enough systems around me to understand why I'm experiencing a certain pain right now. Or I have enough systems around me to help guide me to what I need to do in this course so that I can learn a particular concept.

"And I think it just makes society as a whole more efficient because it's meeting more of our individual needs."