ENGINEERS' FORUM

VOLUME 38 - No. 4

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ENGINEERS' FORUM

LETTER FROM THE EDITOR

Season's greetings, readers! The staff at Engineers' Forum Magazine is thrilled to update you with some exciting stories from this past semester. Our production team has once again delivered top quality work for all of you and we will continue to do so in further issues. This issue of our magazine focuses on some of the most exciting projects and important programs going on here at Virginia Tech.

Reporting on the lively VT community is always stimulating for us with countless stories emerging constantly across all departments. This issue of Engineers' Forum uncovers four stories on the innovative work and developmental efforts going on at the university. Alex John's article is featured first, in which he covers VT's latest achievements in drone research. VT recently unveiled a "drone cage" for safe and meaningful drone research. Arianna Krinos is back with another article in this issue covering the State of the University address delivered by our president back in September. It was announced that we will be letting go of the nearly decade old "Invent the Future" tagline in the midst of other important changes being brought to the table.

Our new writer Jessica Deters follows up with an inside look on the engineering education department. She got to speak with Dr. Jennifer Case, the new department head and former chemical engineering professor at the University of Cape Town in South Africa. Lastly, our graduating writer Sean Pili sat down with some young computer science majors working on an application for holograms on the Microsoft HoloLens. Their goal is to make more realistic holograms by having them interact with the surroundings of a HoloLens user.

We at Engineers' Forum are elated to announce the success of our second round of our student awards program. Because of the success granted to us by our readers and providers, we have allocated funds to award students involved in projects made up of primarily undergraduate student with an engineering orientation. This semester we received applications from around 30 teams and will be discussing the winners in an article in our next issue. Look out for that news and other inspiring stories coming out of Virginia Tech in the February issue of Engineers' Forum.

Editor-in-Chief,

Zeyad Zeitoun

Zeyad Zeitoun

On The Cover

Photo: Kyle Vandervelden

Pictured is the drone used in search-and-rescue efforts. The team working on the research projected tested flying it in Lane Stadium.

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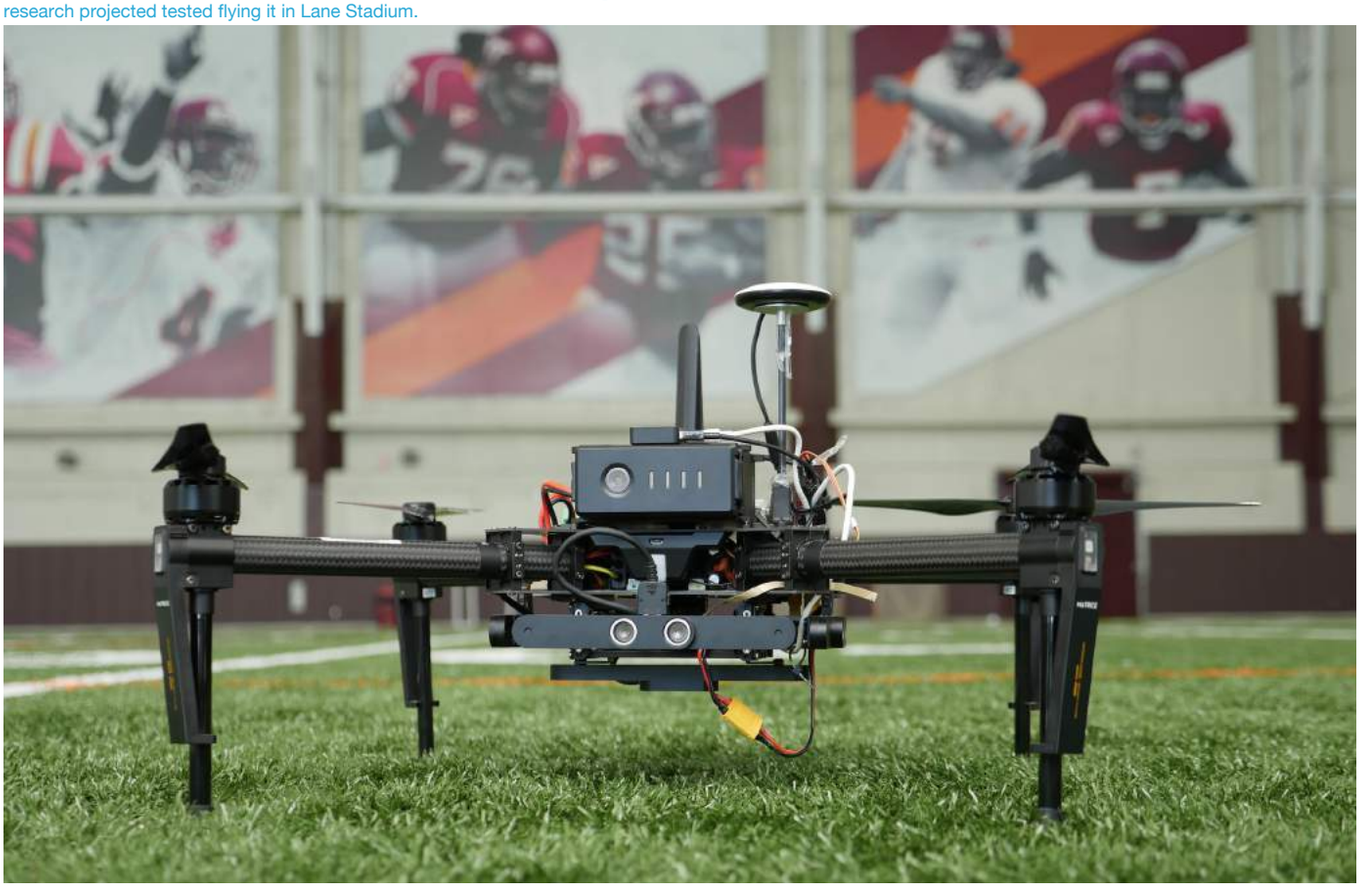
Pictured is the drone used in search-and-rescue efforts. The team working on the research projected tested flying it in Lane Stadium.



VIRGINIA TECH'S LATEST ACHIEVEMENTS IN UNMANNED AERIAL VEHICLE RESEARCH

ARTICLE: ALEX JOHN
PHOTOS: KYLE VANDERVELDEN

Many governmental organizations and educational institutions are considering new methods to improve practical applications of these drones in everyday scenarios. Existing innovations include using drones for photography, delivery systems, and public safety. As current technology improves going forward, so does the applicability of drones.

Among the institutions working in this field is Virginia Tech, which is at the forefront of this scientific research and is a nationally recognized test site for aerial vehicles by the Federal Aviation Administration. In the last two years, the institution has conducted multiple studies including the impact of drone-human collisions and the integration of aerial systems into power-line inspections.

Pictured are the professors – Dr. Ryan Williams, Dr. Nathan Lau, Dr. Nicole Abaid, and Dr. James McClure – who are currently working on the project. They conduct their work in Whittemore Hall.

One of the more recent research projects – conducted by assistant professor Ryan Williams in the Bradley Department of Electrical and Computer Engineering, assistant professor Nathan Lau in the Grado Department of Industrial and Systems Engineering, assistant professor Nicole Abaid in the Department of Biomedical Engineering and Mechanics, and computational scientist James McClure who works with Advanced Researching Computing at Virginia Tech – uses drones to aid search-and-rescue efforts. Search-and-rescue scenarios require the police to inform the local population to organize search teams. The teams dispatched consist primarily of volunteers with few professionals – many of these individuals rely on following certain patterns or behaviors that missing people in immediate danger exhibit.

Missing people tend to follow behavioral patterns that can be used in coordination with the drones' ability to maneuver over large territories to help locate the individual. Robert Koester, a search-and-rescue specialist, documents in-depth analysis of these lost person behaviors – indicating probability of detection maps and general directions that would be applicable to the drone and search-and-rescue team. In many cases, Koester's research in the field serves as a starting basis for search-and-rescue efforts.

The professors working on the project are in the preliminary stages of developing new tools and methods to aid dispatchers. Potential upgrades include the optimization of search-and-rescue assistances, such as dogs, to fully-fledged autonomous systems. In mountainous terrains the drone, equipped with a thermal camera, would be able to assist the dispatch team and navigate the rough landscape with ease.

Currently, they hold their meetings in the lab located in Whittemore Hall. The professors meet on a regular basis and are planning on conducting several tests within the near future.

Drones can also be used to form a mesh network, which transmits and receives data to and from command centers, allowing for a temporary communication network to be established between search drones in areas with no available networks. The largest constraint in this situation would be the battery-life of the drone. Using the drone as a Cell on Wheels (COW) is another viable method that would provide short-term cellular coverage to dispatch teams looking for lost individuals in relatively desolate areas. A COW is a low-cost portable system that can be deployed with relative ease to act as a communication network in areas that receive no cellular coverage.

In addition to its many drone research projects, Virginia Tech recently constructed a $1.2 million drone cage, which is located near the Oak Lane Community and the Duck Pond. The facility, known as the “Unmanned Aerial Vehicle (UAV) Netted Facility,” has an approximate length of 300 feet, a width of 180 feet, and height of 80 feet, making it one of the largest of its kind in the United States. Researchers and students use a lab located next to the cage to make modifications to their drones and do regular maintenance. Virginia Tech’s goal with the cage is to provide a space for students and researchers to safely test their drones.

Pictured is the controller that is used for navigating the drone and the drone in the background.

The intention is to provide a space for students and researchers to perform testing and prototyping on their drones.

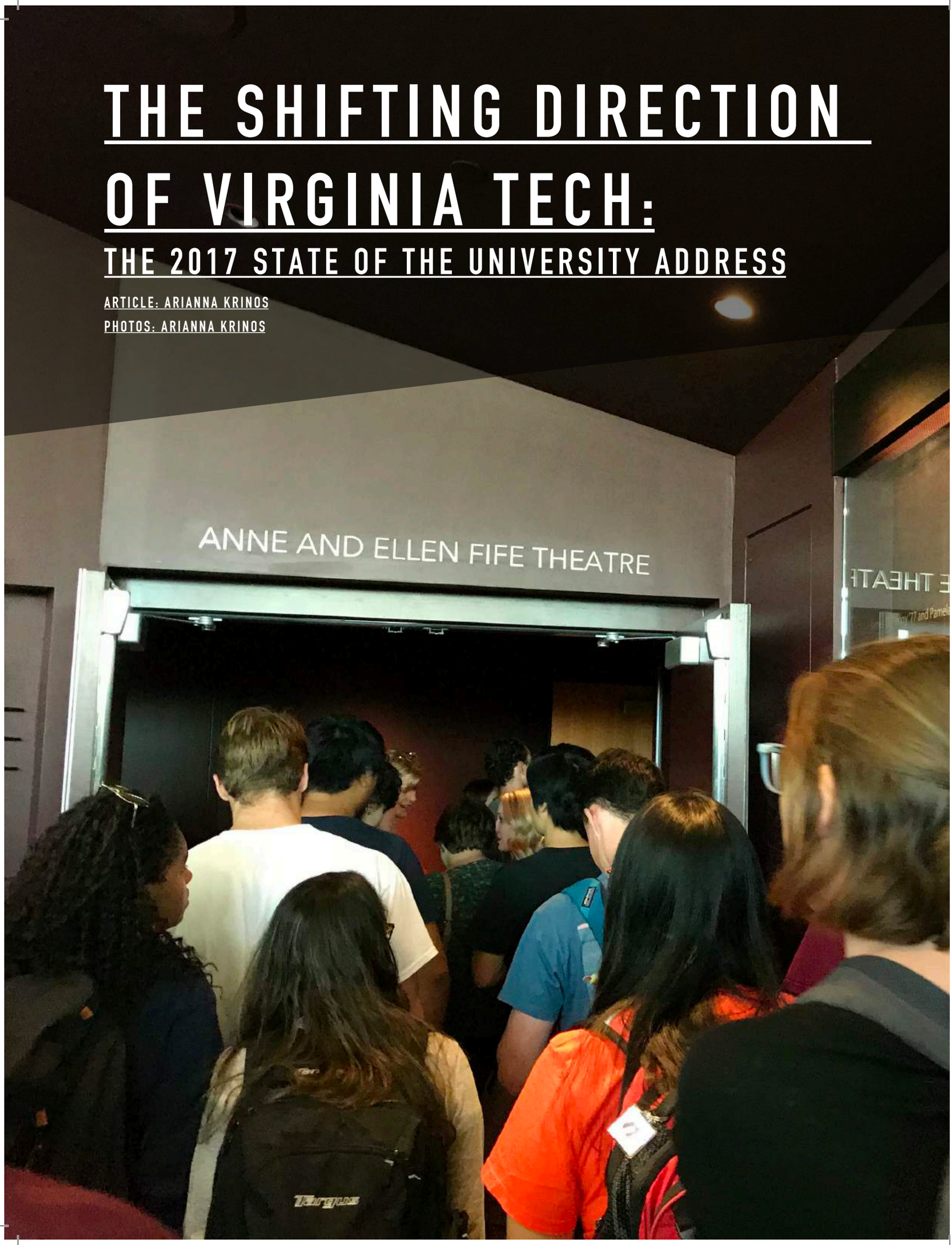
Drone experimenting currently has legal consequences, which are established by the Federal Aviation Administration. The facility, however, is considered an indoor space, so laws regarding drones in public settings are not entirely applicable. Having a space to effectively test drones under various weather conditions will allow for cutting-edge innovations in the field. While the use of drones and testing facilities in unmanned aerial vehicle research is growing in popularity, Virginia Tech has established its dominance in the field by continually making unprecedented breakthroughs.

The drone cage was recently developed in September. It is approximately 300 feet long, 180 feet wide, and 80 feet high.

THE SHIFTING DIRECTION OF VIRGINIA TECH:

THE 2017 STATE OF THE UNIVERSITY ADDRESS

ARTICLE: ARIANNA KRINOS
PHOTOS: ARIANNA KRINOS



(Left): The first group of attendees make their way into the Anne and Ellen Fife Theater. All viewers were offered a copy of the Virginia Tech Brand Book and a decal bearing the new academic logo.

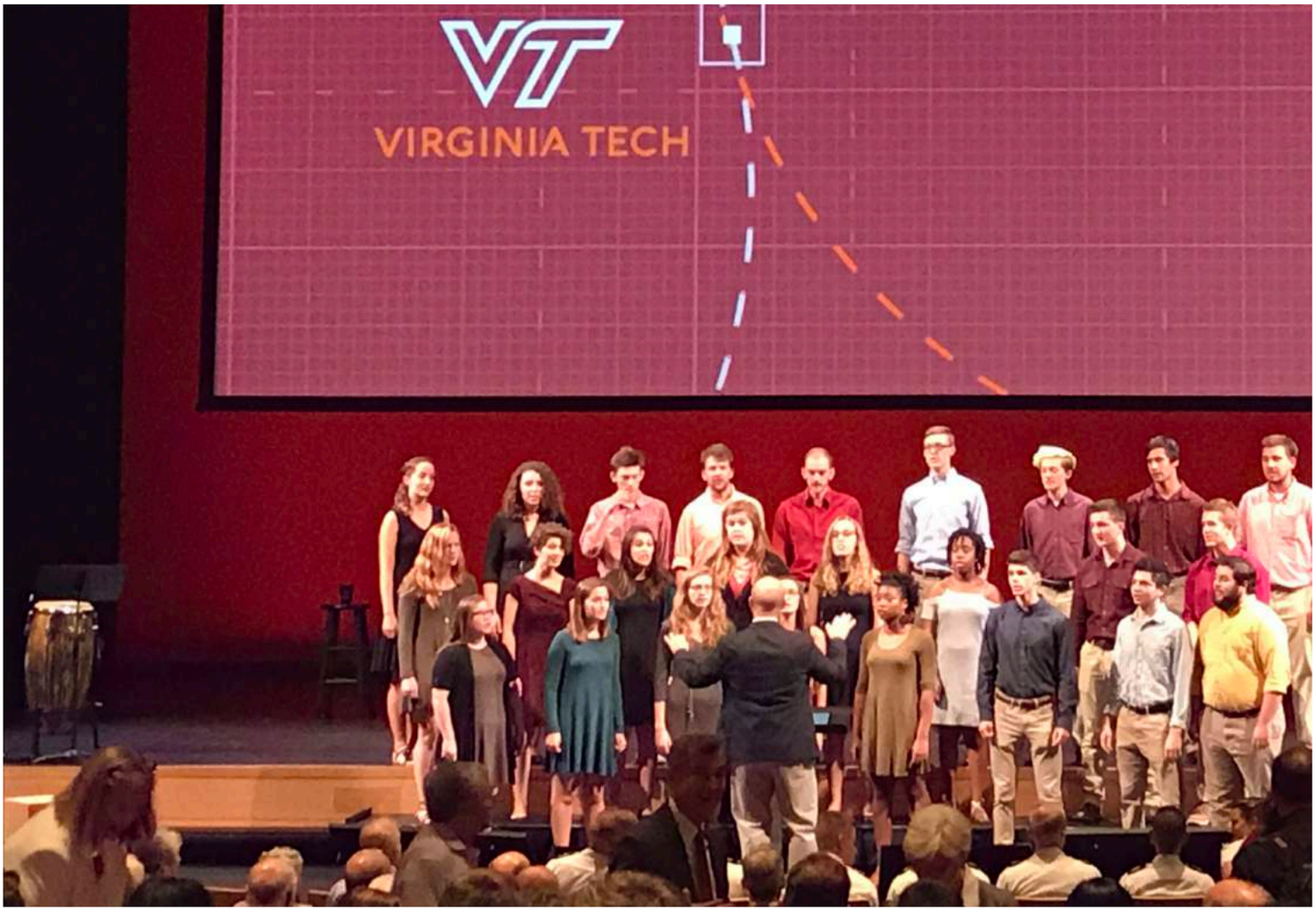
(Below): Members of the Virginia Tech Corps of Cadets assemble at the front of the Fife Family Theater. The slideshow behind them depicts elements of the newly framed Virginia Tech academic experience.

On Friday, September 29, the Anne and Ellen Fife Theater, located in the Moss Arts Center, filled for President Sands' 2017 State of the University Address. On the heels of several announcements about changes within the university, most notably a new logo and schoolwide campaign, the address offered students, faculty, and affiliates of Virginia Tech the opportunity to hear explanations and plans from the leader of the campus. President Sands started his annual State of the University address tradition last year as an extension of the Beyond Boundaries initiative, which he launched in 2015. Each fall, the address is made fully accessible to members of the university and the larger Blacksburg community.

Entering the auditorium, the shift in tone was already apparent; displayed slides sported the new graph paper design adopted by university websites and announcements. Geometric patterns moved across the projector screen, and new Virginia Tech campaign promotions soon filled the room with modern and engaging sounds and images. Despite the new accents and futuristic feel of the presentation, something was noticeably absent: Virginia Tech's nearly decade old "Invent the Future" tagline. In its place is what has been described as a brand campaign. While the university's website notes specifically that the phrase is "not a tagline," Virginia Tech now operates under a new driving philosophy – a "platform" – called "Claim your Role."

Sophomore computer engineering major Suhani Pant said that the announcement disappointed her. "I remember when I first came here, knowing that Virginia Tech's tagline was "Invent the Future" made me feel empowered, as if I would be equipped with all of the necessary knowledge and resources to forge change

A Virginia Tech student group provides a musical performance prior to the event. Students, faculty, and visitors fill the Anne and Ellen Fife Theater at the Moss Arts Center.



through engineering," Pant reminisced. "I think that the tagline brought a sense of mission and camaraderie because it was something common to all students."

Despite the changes, Sands emphasized that the university's strengths in, "art, engineering, design, natural resources" would continue to be priorities as the university launches into a new phase in its history. He noted Virginia Tech's leadership in these domains, particularly on the international stage, such as tap water safety in hurricane-afflicted areas.

The president nodded to Julia Ross, the new dean of the College of Engineering, and touted five new "destination areas" intended to link disciplinary research with "cross-cutting" ideas. One of these areas is centered on data analytics, driven in no small part by the Department of Computer Science in the College of Engineering, in addition to leaders in the Pamplin College of Business and the College of Science. Sands specifically noted a unique course offered in the fall called "Data in Our Lives: Critical Thinking with Data," and emphasized the ongoing opportunity for Virginia Tech to take a leadership role in a rising era of big data. Sands emphasized that Virginia Tech is ready to take on such challenges, and that doing so will enhance the visibility and respect the university garners.

The president also made sure to discuss the future of Virginia Tech's physical infrastructure, including changes like the disappearance of the traffic light at Southgate Drive. Sands reassured the audience that Virginia Tech would retain a "small-campus feel with all of the advantages of scale." Simultaneously, however, Sands mentioned the addition of 500 university professors—noted in the destination areas alone—and the expansion to "30,000 [undergraduates] by 2023." It was emphasized that Virginia Tech is growing beyond the epicenter in Blacksburg. This expansion includes a new "Health Sciences and Technology campus" in Roanoke, the site of the present Virginia Tech-affiliated Carilion School of Medicine (VTC SOM), which Sands noted will join the official university ranks as Virginia Tech's ninth college in 2018.

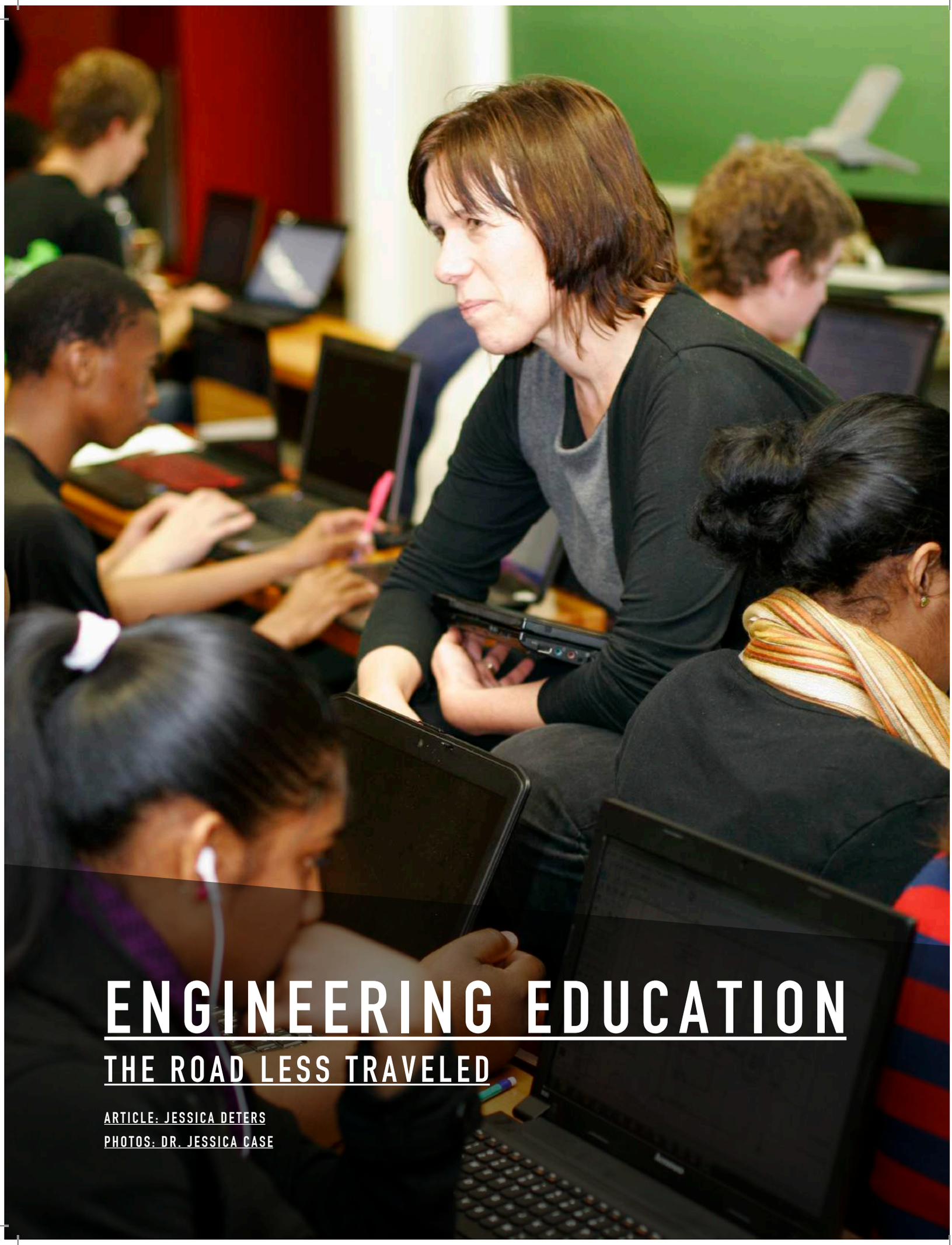
Sands took the opportunity to show off certain research activities in which the university has invested, incorporating comments from Dr. Deborah Kelly, a research professor and cancer researcher at the VTC SOM and Carilion Research Institute. He weaved in telecommunication with a group at the Virginia Tech campus in the National Capital Region (NCR) as well, underlining the increasing relevance of this remotely located campus. The president praised former Virginia Tech leadership for the NCR outpost, and called it an "urban living lab" for the main campus in Blacksburg.

Even during the forward-thinking address, however, ongoing concerns of the student population were evident. A group of students stood early in the speech to protest perceived support

of a Nazi sympathizer employed as a graduate teaching assistant at the university. Sands quickly turned the confrontation into an opportunity to underscore the position of the university against discrimination and its united stance on promoting safety and compassion for its students.

Similarly, engineering students continued to buzz about the shifting focus of the school as it adopted a self-described branding campaign. Whispered comments about the new Virginia Tech logo and tagline could be heard, and engineering students seemed to have strong opinions about the loss of "Invent the Future." Many students, however, were unfazed by the news, and were optimistic about the university's fresh look.

Senior Justin Herget, a computer engineering major in the College of Engineering, commented that, "While the tagline will be missed, Hokies will always be there to invent the future, tagline or not." Reminiscent of Sands' forward-looking remarks, this sentiment conveys the purpose of the State of the University Address: as Virginia Tech changes, students and faculty should take the opportunity to learn and grow in parallel. Engineering students and faculty should strive to find their place in this new era in the university's history.



ENGINEERING EDUCATION

THE ROAD LESS TRAVELED

ARTICLE: JESSICA DETERS
PHOTOS: DR. JESSICA CASE

(Left): Jenni Case is pictured working with students at the University of Cape Town. Case was previously a professor of chemical engineering at the South African institution. Photo courtesy of University of South Africs

(Below): Case posed for the camera during a course at the University of Cape Town. Case's South African background brings a global perspective to the VT Engineering Education department.

The engineering education department gathered at the beginning of the fall 2017 semester to wish new department head Dr. Jennifer (Jenni) Case a happy birthday. As the traditional "Happy Birthday" song ended, Case remarked that in South Africa, where she was raised and had just moved from to Blacksburg, there were two extra verses sung in two different languages. Case sang the second and third verse to the room of engineering education faculty, advisors, and graduate students, highlighting the opportunity for international engagement that Case brings with her to the department.

Case, a leading scholar in engineering education research, moved from her previous role as a professor in the Department of Chemical Engineering at the University of Cape Town, South Africa. She said that Blacksburg is a relatively soft landing.

"Americans are famously friendly and open, and I'm very grateful for that," Case said. "I think Virginia Tech is a great institution--very collegial and supportive. The days haven't felt so much as challenges but fascinating."

That fascination stems from Case's long held interest in engineering education in the U.S. Case described how engineering education and her own research interests in that area developed around the same time.

"From the 1990s, the federal funding for engineering education and engineering education research increased dramatically, related I think to shifts in geopolitics following the end of the Cold War. That's what really gave rise to departments like this. I started my own work in engineering education in the 90s, so I was interested to see the US come onto the scene with such force and, in a way, dominate that scene."

The force Case describes led to the creation of Virginia Tech's Department of Engineering Education with a graduate doctoral program in 2004. The department is one of only a handful in the U.S. and is one of the longest standing programs in this field. Having a dedicated department for engineering education helps Virginia Tech maintain its status as a leader in the field.

Engineering education synthesizes work that has long been done by individual researchers in various disciplines. But, what do engineering education researchers research? Well, it is not as straight-forward as it sounds. At first, it would seem engineering education researchers develop better ways of educating engineers. While this is correct, it does not fully capture the depth and interdisciplinary nature of the research area. Research interests in engineering education range from student learning to engineering ethics to increasing the presence of STEM in K-12 to broadening participation in engineering and more.

"Engineering education research is truly interdisciplinary, which is challenging, but also an exciting place to be," Case said. "At one level, our interest is around teaching and learning in engineering degrees and how we can improve that. A lot of funding and focus has been around making engineering degrees better fit the requirements of the professional world and trying to stop the wastage that there is in system, that is, the many students who come into study engineering who do not graduate as engineers.

"There's also the issues of who comes to study engineering and how we can broaden the pool of applicants. These may seem like efficiency questions, like with more effort we can do things better. But education is such a complex phenomenon, and so doing it better is not a simple question. It's not like putting different fertilizer on the land or taking a different medicine that makes you better. It does more than justify a research area. And like any research area, the application of its findings is not straightforward."

Research methods in addition to the questions asked in engineering education are distinct from those found in traditional engineering disciplines. Engineering education research is conducted with methods and ways of viewing the world reflected by those in the social sciences.

"Engineering education research is about research in the social world," Case said. "The methodologies and epistemologies that you learned in your undergrad are not directly applicable.

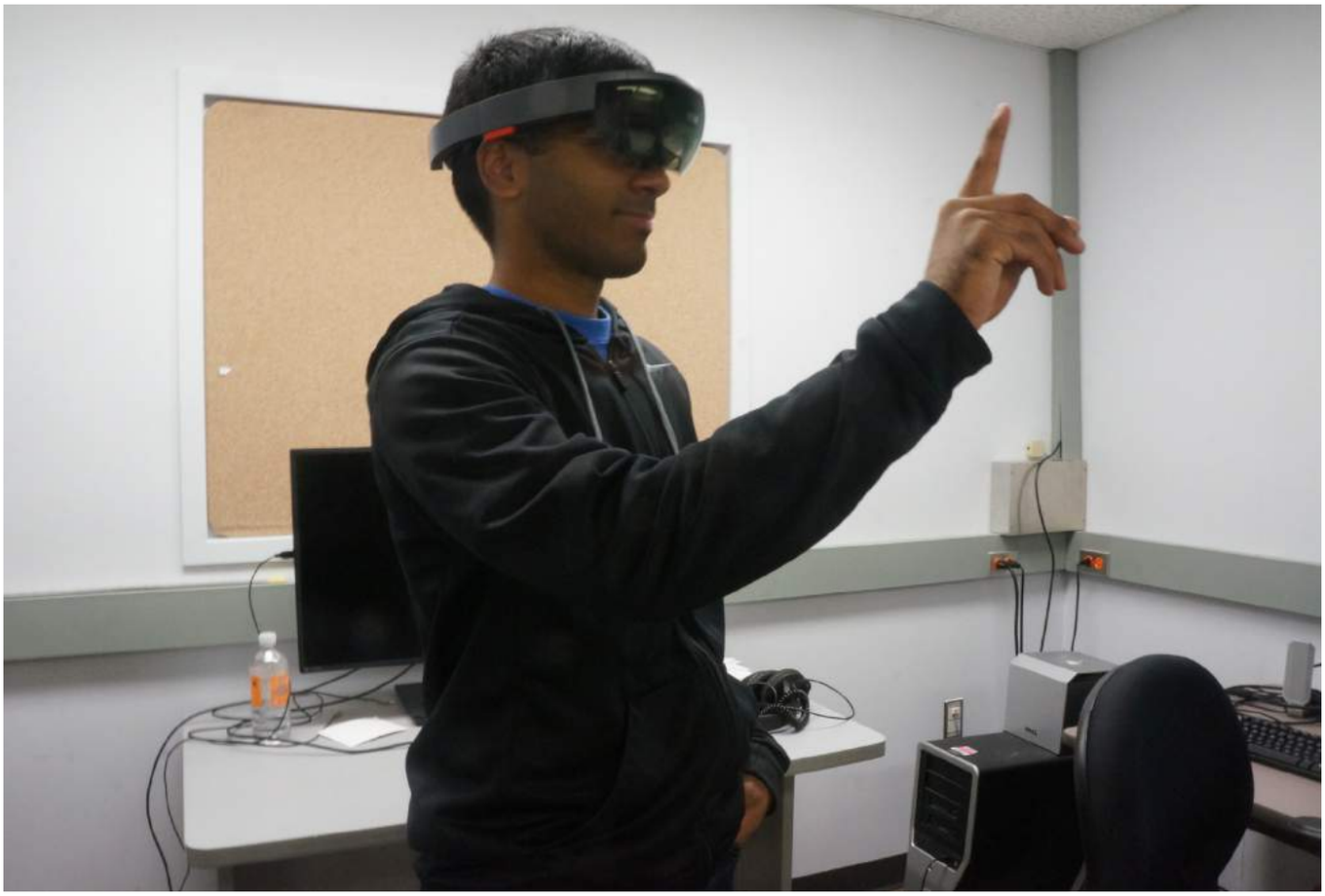
"It's not an easy route," Case added. "An easy route is to go into an absolutely straightforward area of technical research with a big lab, well established procedures and a nice recipe for a PhD. You're not going to get that in Engineering Education. If you come in here with an engineering degree, bachelors or masters, you're going to have to shift gears entirely into a different research area."

To add to the challenge, Case said that while there are many great job opportunities in this area, it's not necessarily the most direct route into a standard faculty position.

However, the research that emerges from engineering education directly impacts today's and tomorrow's engineers. Current classroom designs and curriculum are shaped by engineering education research. Programs to attract kids to STEM are designed and informed by engineering education research. And initiatives to educate engineers ethically and socially often emerge from the work of engineering education researchers.

Altogether, Case said, "for people who want the road less traveled, this is a really exciting department."

Sophomore Computer Science major Raghu Srinivasan (Left) is currently interacting with holograms on a Microsoft HoloLens device to test a script he wrote.



UNDERGRADUATES DEVELOPING REALISTIC HOLOGRAMS FOR THE MICROSOFT HOLOLENS

ARTICLE: SEAN PILI

PHOTOS: SEAN PILI & VAMSI MANNE

This December, a group of four undergraduate researchers at Virginia Tech's Cognitive Engineering for Novel Technologies (COGENT) lab hope to publish an application for the Microsoft HoloLens to the Windows store. Their application will allow the augmented reality device to quickly and accurately detect spatial objects to make for more realistic interactions between the holograms and the user's surroundings.

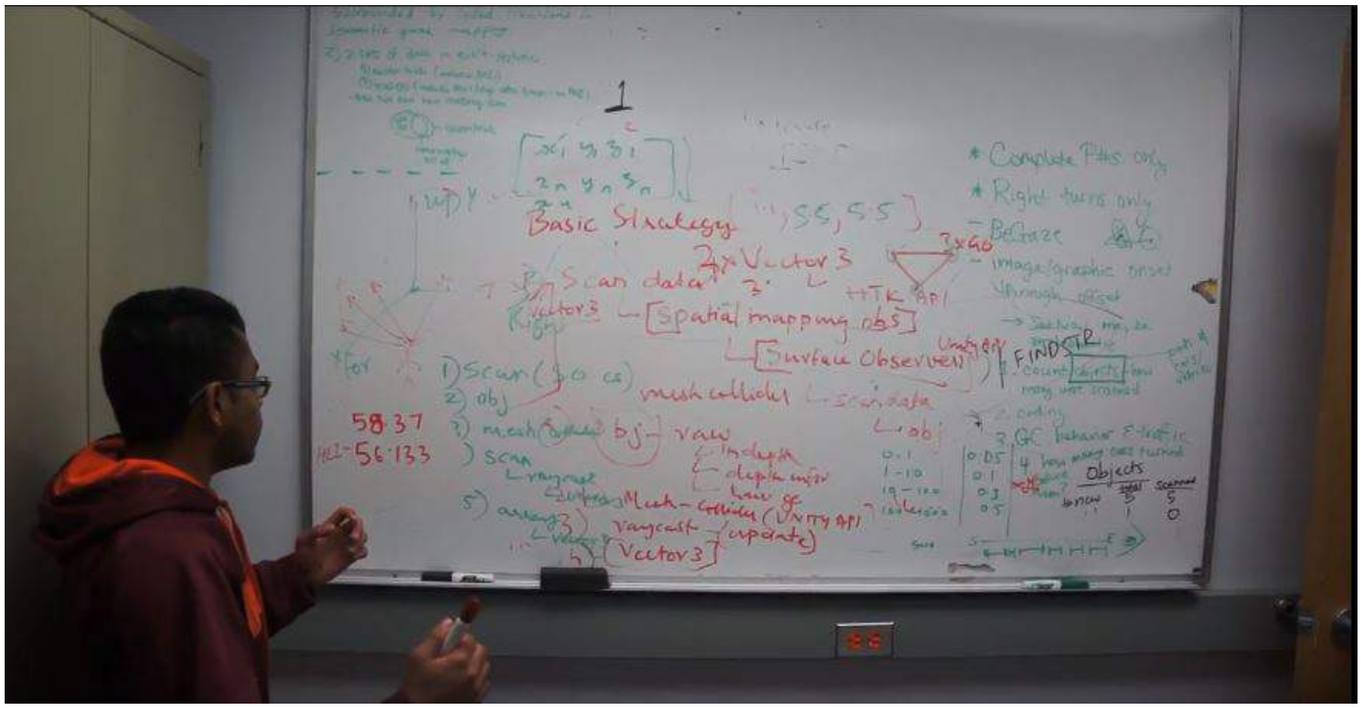
The team reports directly to graduate mentor Vineeth Kumar, an Industrial and Systems Engineering master's student, and is officially supervised by Dr. Joseph Gabbard from the ISE department. Dr. Gabbard is the winner of the 2015 Microsoft HoloLens Academic Research Grant that supplied him with the HoloLens Development Edition device being used for testing.

After scanning the user's environment (indoors only due to time constraints), the HoloLens application processes that information, i.e. the positions and dimensions of floors, ceilings, walls, tables etc. to more appropriately decide where to place holograms. Further, the application will make sure that whatever holograms the HoloLens displays conform to the laws of physics so they appear more realistic to the viewer, which in essence is the science of persistent registration.

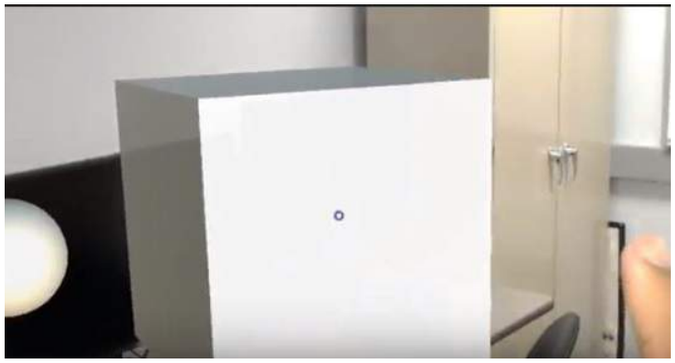
Team member Vamsi Manne, a computer science sophomore described this aspect further.

"Let's say you have an object, and if you want to place it on a real physical space [like a table], you have to make sure the physical

Sophomore Computer Science major Vamsi Manne explains the logic behind how he intends to extract coordinate vectors from spatial objects and planes scanned by someone using a HoloLens and how to use them to identify the positions of walls, floors ceilings and other spatial objects as well as calculate how far apart they are relative to each other and the device.



Screenshot of a video demonstration of the dynamic resizing of cube and sphere holograms via the HoloLens device that was coded in C#.



properties of the object coincide with those of the table… You have to make sure it doesn't cross to the other plane so it seems realistic to the user."

Computer science sophomore Raghu Srinivasan added, To bind these holograms to the laws of physics, Manne,

"[Any hologram displayed by the HoloLens] has to recognize the physical features of the object that it's on. So… if it's a ball on a slanted table then the ball should begin to start rolling down the table."

Srinivasan and the rest of the team are developing an algorithm in C# that will map the HoloLens' surroundings and lay a mesh on top of all of the surfaces it detects, which then returns each surface's xyz-coordinates so the HoloLens can calculate the distance between its user the surfaces.

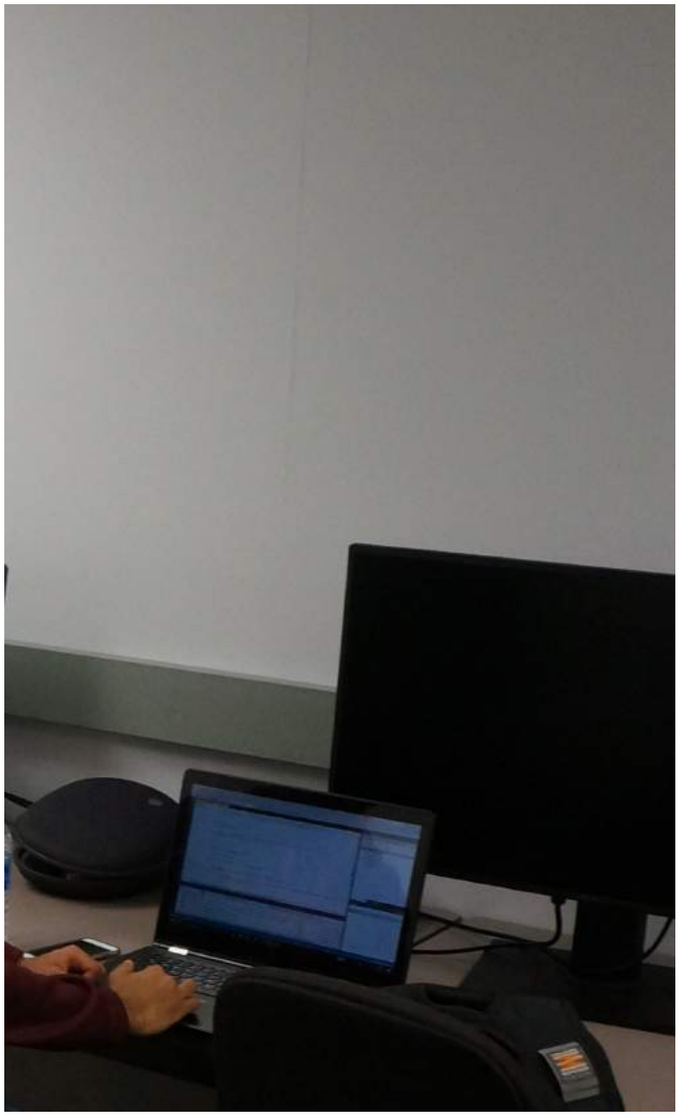
Currently, the team's goal is to find the extremities in the z-plane of a HoloLens' surroundings to find ceilings and floors, as well as in the xy-plane to find walls. Manne works on a sub-team focused on correctly identifying ceilings and Srinivasan works on a sub-team focused on correctly identifying floors and walls. They said there is significant overlap in their individual projects so they collaborate often.

It is important to note that although they are writing their application in C#, the team is using two other softwares to develop their app; Unity3D (a software used to create objects that will eventually be projected by the HoloLens) and Visual Studio (which will allow those objects to interact with each other) are used to create the holograms, model the holograms' physical properties, view the holograms' interactions, and test the code they wrote.

The team recently experienced a small victory when they finished writing batch code to automate the lengthy loading of custom settings that one must select to open projects in Unity3D, Visual Studio and ultimately, the HoloLens. They are now perfecting their mapping and object/plane identifying algorithm. Once they finish that, they will focus more on modeling the physical properties of the holograms that they have been testing.

"Right now if you are using the HoloLens and looking around, it will map it [the room] out for you but it doesn't recognize [the positions of the] ceilings or floors. We are [currently] trying to identify each feature in an environment."

Manne elaborated on the importance of their application as being the first step in creating more realistic holograms.
The team has no specific use case for their application as they are currently focused solely on developing it before the end of the semester. That being said, since it is intended to help the HoloLens understand its environment so that it can create more realistic holograms for any future use case, it is still a very pragmatic project that, when completed, should provide a solid foundation for many future task-specific applications.



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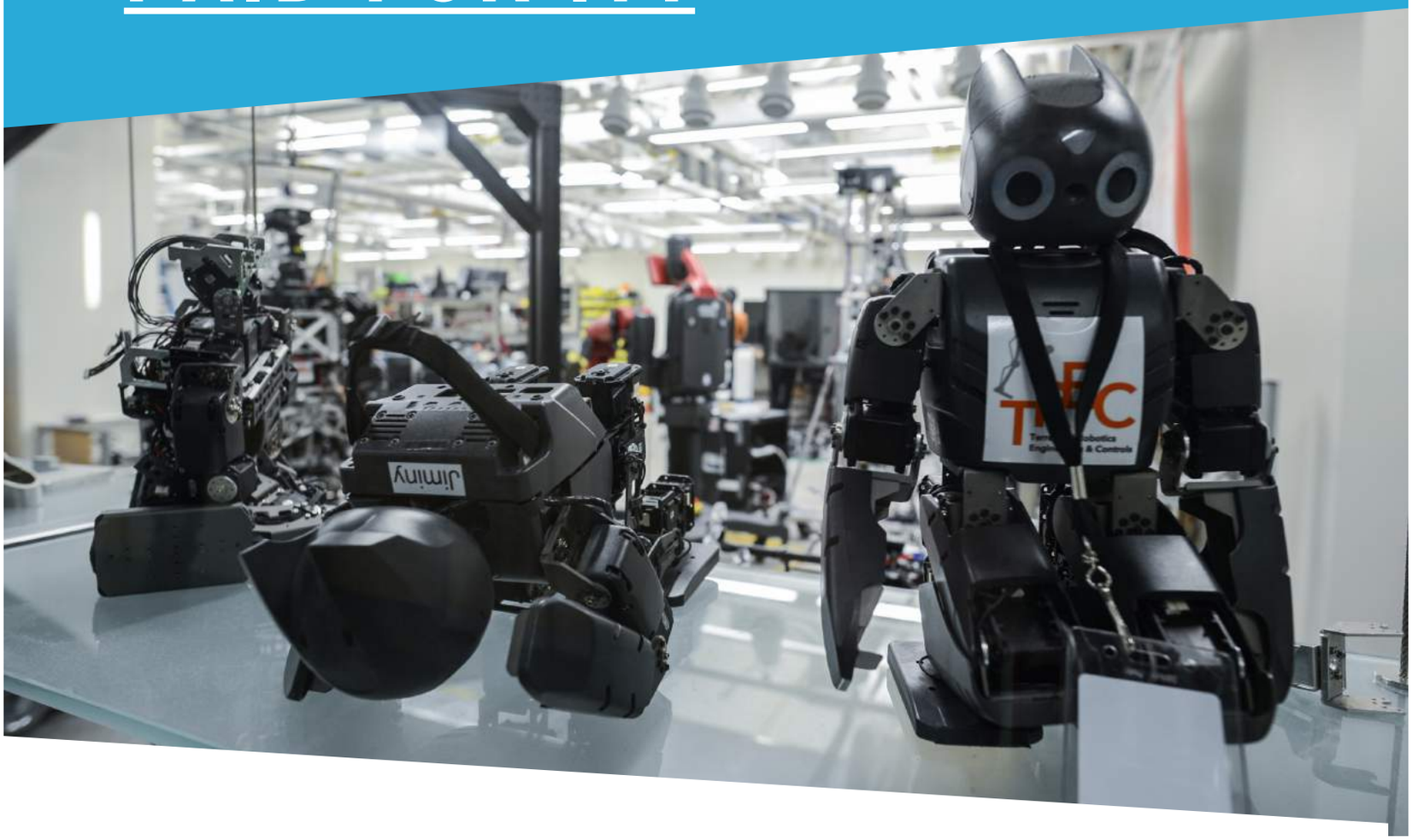

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