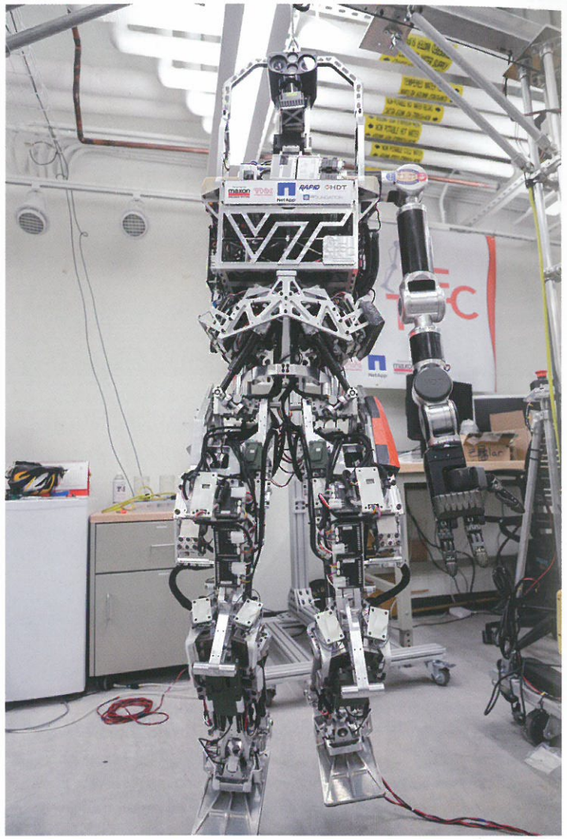
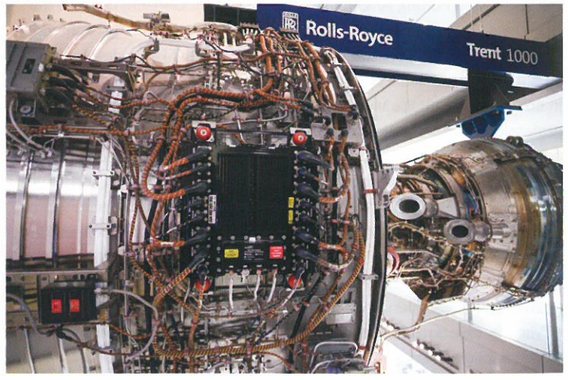
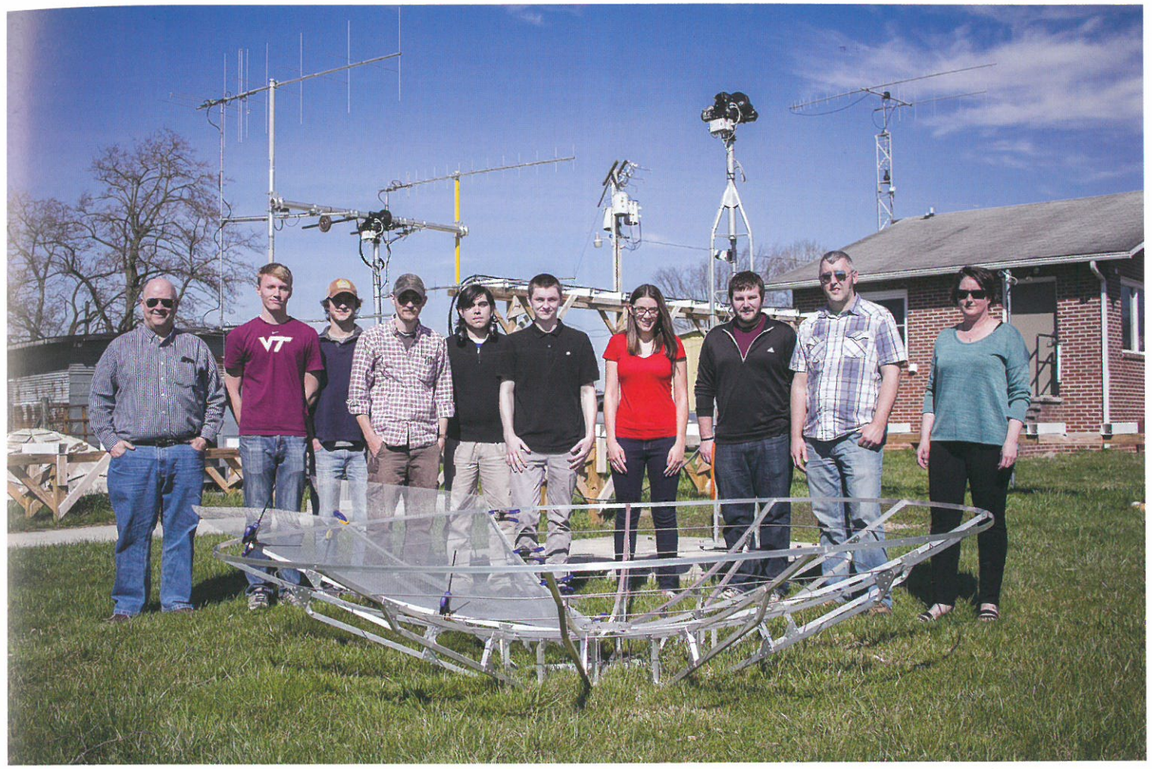




Intricately designed robotics are pictured at the TREC (Terrestrial Robotics, Engineering and Controls) Lab in Goodwin Hall, as well as the donated Rolls-Royce Trent 1000 Jet Engine that hangs over the lobby. The TREC lab is a flagship of the engineering projects underway in the building.

Featured in this edition of the magazine is the reimagined Biocomplexity Institute of Virginia Tech. Under the College of Science umbrella, the Biocomplexity Institute is dedicated to medical research as well as "ultra-scale biomedical data analysis, interpretation, and simulation." Outside of these institutes, the Virginia Tech Corporate Research Center (CRC) is an organization that is more well-known to students and has more ties to industry than the rest. Located in a 230-acre ground near the Virginia Tech campus, the CRC is business-driven, housing nearly 200 different companies focused on Research & Development. Unlike the previously mentioned institutes, the CRC doesn't have a concentrated area of research. A multitude of commercial tasks and problems are addressed by the companies at the CRC with the help of Virginia Tech's perpetual resources. The goal of the CRC is to assist these companies in achieving their goals while simultaneously proliferating Virginia Tech's influence and reputation in industry. Also, the CRC provides Virginia Tech students with a chance to get involved with practical research and become familiar with the professional research setting. Just discussing the aforementioned individuals and institutes comes nowhere close to covering the breadth of Virginia Tech's work outside the classroom. The university has been and remains a national leader in innovation and will continue to break ground and make headlines in the future.



Left to right: Dr. Bob McGwier, Colin Mussman, Anthony Wolosik, Zach Leffke, Keith Tiemann, James Biggs, Kayla Brosie, Seth Hitefield, Kevin Sterne, Sonya Rowe

GEO MISSONS: CLASS OF 2017

Article Sean Pili **Photos** James Shackleford

Virginia Tech's Hume Center for National Security and Technology is designing and building a payload to be sent into space on a satellite built by Millennium Space Systems, a government contractor working with the Hume Center. The payload will place a software defined radio (SDR), donated by the Rincon Research Corporation, that will provide 24/7 emergency communications to the United States via amateur radio broadcast into geosynchronous orbit.

Zach Leffke, one of the Hume Center's two system engineers and main designer of its command station said, "[Our project] is the frontrunner to be the first [amateur] radio payload in geosynchronous orbit over North America"

The project was initiated by Dr. Robert McGwier, the Hume Center Director of Research and a research professor with the Bradley Department of Electrical and Computer Engineering in the College of Engineering, who said, "The idea [of residing in geosynchronous orbit] is to look from way up high, never go out, never be destroyed. Hurricane Katrina can't knock down all of the [area] communications, terrorists can't knock down all the communications in New York City…."

"[The radio] is highly reconfigurable so we can change the nature of the radio by uploading new apps," Leffke said. The radio's re-configurability will allow for debugging, updates and increased longevity over the duration of its (currently undetermined) tenure in space.

"[The SDR] is the 'brain and heart' of the payload. But it is a low power device that does not have everything you need for a full payload. So, we have to design and build antennas, amplifiers, frequency converters, filters, [and other necessary components for the radio to work in space.] The additional radio frequency (RF) components you need to connect to the radio is called the 'RF front end.' The AstroSDR will plug into the RF front end to make the full payload," Leffke explained.

Top / Kevin Sterne next to the mount for the 3-meter dish that will be part of the command station. **Bottom /** The geosynchronous mission is still in the design phase: the parts shown are for cable trays to run cables from the ground station to the antennas.

"SPACE IS UNFORGIVING. MY JOB IS THAT OUR PAYLOAD CAN SURVIVE IN SPACE"

Left / Seth Hitefield (left) and Anthony Wolosik (right) view their team's progress remotely from the Hume Center's Control room. **Right /** Zach Leffke (plaid shirt) and Colin Mussman (VT shirt) moving the 3 meter dish into position.

The Hume Center team is composed of academic faculty (Dr. Jonathan Black), research faculty (Dr. Robert McGwier, Leffke and project manager Sonya Rowe), graduate students Anthony Wolosik, James Biggs, Kayla Brosie, Ryan Banks and Seth Hitefield, and undergraduate students Keith Tiemann and Colin Mussman.

The role each member of the team was assigned for the project is shown below.

Leffke and Kevin Sterne, system engineers, both took on the role of systems engineers for the mission's payload design and construction. "Kevin and I manage the work of the students and make sure everybody stays on the same page," Leffke said.

The hardware oriented portion of the project was taken on by Banks, who said, "I focus on the RF front end design for both the transmit and receive chains of the payload. We need amplifiers, filters, couplers and a splitter; that's what I'm planning to contribute with my background in RF and microwaves."

Brosie's involvement with the project was software-oriented:

"[I'm] in charge of the communications architecture that goes on the SDR. When the user terminals transmit [I make sure] they can actually communicate properly with the spacecraft and then [the spacecraft] can transmit back down and relay its message to those who need it."

Dr. McGwier mentioned:

"Kayla and I will design a way to protect the running software from radiation signal event upsets. We do that by providing error correcting memory. When a program is run on a computer it's brought in from memory. If my word coming in has an error, our hardware will automatically correct it before it goes into the computer."

Hitefield dealt with a wide variety of tasks:

"[I'm] Helping Zach design all of the networking software and all of the networking that makes the system automated." "I also do a ton of software radio work so I support other people like Kayla with issues she may run into."

In addition to networking and software work, Hitefield also did cyber security work on the project to authenticate, identify and encrypt the payload's communications data.

Leffke added:

"[There's] always a tradeoff between security and overhead (super secure but horribly inefficient.) [Seth is] trying to figure out how to [secure the payload communications] in the best way that is the most efficient."

Biggs' job is to essentially 'space proof' the project:

"Space is unforgiving. My job is that our payload can survive in space, [conduct] radiation analysis, thermal analysis, conduction analysis and analysis on the payload in general.

Tiemann oversaw powering the project:

"My job is to grab power from our host satellite payload and be able to distribute it to the rest of the components in our payload."

Colin Mussman is an undergraduate specializing this semester in ground station systems and operations that will benefit the geosynchronous payload mission.

Anthony Wolosik's job is to make sure the project's components are structurally sound.

"I'm in charge of the overall mechanical design of everything. [I] make sure [that everything my teammates are contributing to the project is] safe and secure onto our host payload."

Left to right / Zach Leffke, Kayla Brosie, Anthony Wolosik, Seth Hitefield. Leffke gives out instructions pertaining to the construction of the 3-meter dish for the command station.

Dr. McGwier said this regarding his and Dr. Black's roles in the project:

"Our job is to provide all of [the students] guidance when they do all the work."

It is important to note that once the payload is finished, none of the members of the Hume Center team will be able to operate the payload from the command station because by law amateur radio is only allowed to be operated by volunteers.

Enter AMSAT (the radio Amateur Satellite Corporation.) The Hume Center developed a partnership with AMSAT. Their volunteers will take over operating the payload on a day-to-day basis with one caveat, according to Leffke:

"[AMSAT] doesn't necessarily have the experience we have here in terms of reconfiguring the payload. You can wreck it and then you're done. Reloading the thing… will either be done [remotely] through Rincon or through the Virginia Tech ground station [via student volunteers.]"

Dr. McGwier said:

"We are creating a 'control alt delete' radio and switch. If the computer goes crazy… I have a radio that listens for a signal… control alt delete. [That signal] reboots it"

AMSAT volunteers are currently building user terminals (satellite dishes approximately the size of those used by satellite TV customers) that will be used to receive information from the payload and transmit it to hand-held radios, both of which will be distributed across the United States for emergency communication purposes.

FEMA has verbally, though not financially, backed the Hume Center and AMSAT on their endeavors.

Leffke said:

"[FEMA has said that] if we build it, they will use it.

McGwier on his plans after the geosynchronous payload mission is complete:

"We don't want this to be last one, we're going to learn more"

ARIANNA KRINOS **JUNIOR, GENERAL ENGINEERING**

ENERGIZING YOUTH FOR ENGINEERING:

VIRGINIA TECH'S SOCIETY OF WOMEN ENGINEERS

Article Arianna Krinos **Photos** Kirby Koch

The members of the Society of Women Engineers (SWE) chapter at Virginia Tech are no strangers to stereotypes, but they have refused to allow those typecasts to define their college experiences. Instead, many have transformed what others view as adversity into among their strongest assets. Many of the women sought out SWE in their first semester of college, and have carried their involvement through their time at Virginia Tech. On Feb. 22, participants in SWE's educational outreach division attended Kids' Tech University, an event held at Lane Stadium to expose children to the pursuits of Virginia Tech-affiliated and other local groups in the realm of science, technology, engineering, and math. The group of female engineers set up their version of the marshmallow challenge for the kids, allotting spaghetti, tape, and a marshmallow to the budding engineers. The challenge? Build a structure stable enough to balance a marshmallow on top, attach the marshmallow, and hope that it survives judging. A dry erase easel served as a leaderboard for the participants, most of which left the activity proudly beaming.

Society of Women Engineers' president Hannah Roth joined SWE as a freshman to meet other women to which she could relate. She was selected as webmaster in her first year, became vice president as a sophomore, and has been leading the club since junior year. A computer science major, Roth added to the problem solving abilities common to computer scientists and those in traditional engineering disciplines. Roth believes the marshmallow challenge is a "cheap, simple, and fun way" to introduce engineering to children, particularly young girls. She mentioned that in the TED talk which explains the marshmallow challenge concept, it is mentioned that kindergarten-age children have been known to outperform adults. Roth remarked that SWE members "have actually seen this the couple of times [they have] done [the challenge]," an optimal way to fuel a child's interest in engineering and technology.

Outreach co-chair Amanda Carol, a junior industrial and systems engineering major, mentioned that she sees the marshmallow challenge as "all about processes and working in teams," offering insight into deciphering where to start, the brainstorming process, and execution. Moreover, Roth suggested that it educates kids about the business side of engineering, and the value of teamwork. Mary Carome, also a co-chair of SWE's educational outreach division, shared many of these thoughts regarding the message SWE was hoping to convey to potential future engineers. She mentioned that it is essential to "get [engineering] in the back of their minds early" by introducing them to a design challenge complete with "restrictions and constraints" which can be done in teams and "associates engineering with something fun and exciting—not boring." Carome spoke fondly of her own path towards engineering, citing that, as a kid, she liked K-NEX, LEGOs, and blocks, and as she

Top / Hannah Roth, SWE's president models a club t-shirt. **Bottom /** Amanda Carrol (left), the education outreach co-chair, and Hannah Roth (right) respond to students attempting the challenge.