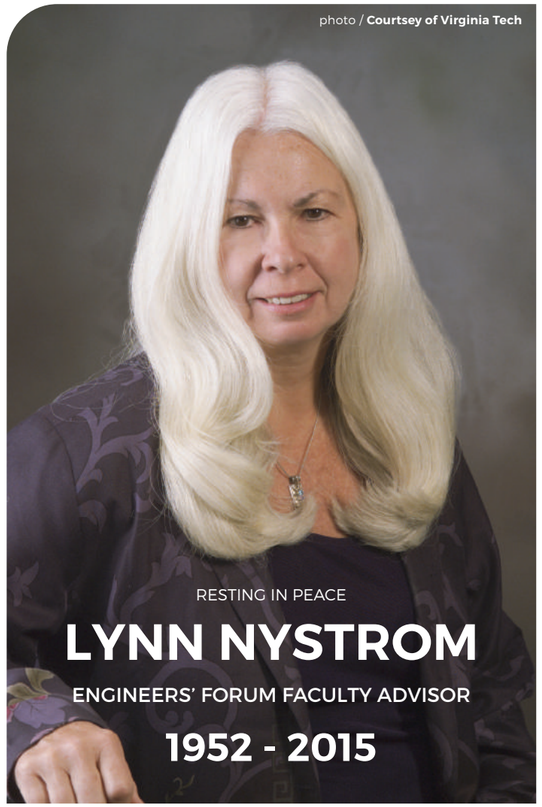
Volume 37 | Number 2 | April 2016

ENGINEERS' FORUM



LYNN A. NYSTROM

of Christiansburg, longtime director of news and external relations for the Virginia Tech College of Engineering and mentor to the hundreds of students and alumni from multiple undergraduate student organizations, died on Thursday, December 3, after her battle with cancer. At her farm, she and her husband cared for horses, stray dogs and cats. She considered a successful weekend one in which she could ride her horse for hours, swim, and entertain family and friends. She was an active member of the New River Land Trust, a local nonprofit dedicated to preserving farmland, forests, open spaces, and historical sites across Southwest Virginia. A native of Pompton Lakes, New Jersey, Lynn is survived by her husband, Lawrence Newman, two step-daughters, Christy and Stacey; stepmother, Juanita Nystrom of Blacksburg; stepbrothers and stepsisters, and several uncles, aunts, cousins and numerous lifelong friends. A Celebration of Life Service will be held 2 p.m. December 16, at the German Club, 711 Southgate Drive Blacksburg, Va.In lieu of flowers, the family is encouraging donations be made to the Student Engineers' Council's Lynn Nystrom Engineering Organization Fund via the Virginia Tech Foundation (https://webapps.es.vt.edu/givingto/academic/gift) or by check mailed to Virginia Tech, Engineering Dean's Office (0217), 3046 Torgersen Hall, 620 Drillfield Drive, Blacksburg, VA 24060. Please make checks to Virginia Tech Foundation, memo line, "Lynn Nystrom Engineering Organization Fund."

SUMEDHA MOHAN

I first met Lynn, when I was a junior in Electrical Engineering at Virginia Tech. I had joined Engineers' Forum as a writer and was attending the first meeting of the semester. Lynn made a strong first impression. She struck me as a no nonsense and a well meaning person, who was always present to guide the editorial board through the tough waters of publishing an independent technical magazine on a college campus. While working first as a writer and then as the magazine's managing editor my acquaintance with Lynn further expanded. As a newbie, I had several questions about magazine distribution and how to increase our readership amongst the engineering students. She patiently answered my questions and provided feedback where she could.

Fast forward 2 years...I was a graduate student and the newly elected editor in chief of Engineers' Forum. It was a big responsibility and I was having a minor nervous breakdown wondering if I would be able to do it. At that time Lynn told me something that I will never forget. She said that she knew that I had it in me to do this. That if I did not then I would never have taken this responsibility.

During the 2 terms as the editor I made mistakes, learnt a lot and made many friends. Throughout this time, I had her support and her guidance. She was a great mentor and a great person.

Lynn, I miss you!

ZEYAD ZEITOUN

My time working with Lynn was unfortunately short-lived; we only interacted on a small number of occasions. However, in that handful of conversations Lynn made me feel like we'd known each other for years and she expressed true care and warmth towards me. She also taught me more about myself than most faculty members could in such a short time. Her work ethic and dedication to the magazine drove me to focus on bettering myself as an academic and a professional. Lynn was an invaluable member of Virginia Tech whose absence hits deep in my heart and the hearts of many at the University. She is gone but never forgotten.

C.A.M GERLACH

When I first met Lynn, she was already struggling with cancer, but her strength and energy still shone through in her interactions with me and the other forum members. Her mind was among the sharpest I've had the privilege of meeting when it comes to journalism, and the cancer made no dent in her considerable fortitude. Without her, I see it as quite unlikely that EF would have kept going throught the years, and hopefully, thanks to her leadership and support, the magazine will have a bright future for many years to come. Given how much I've benefited from my time with the Forum, I owe Lynn my utmost gratitude.

CODY EARLES

As a new member of the Engineers' Forum, I didn't know Lynn very well. In fact I only saw her once, but even then I could tell she captured the attention and respect of everyone in the room the moment she began to speak. I think that fact by itself could attest to the kind of person she was, and the kind of person she will be remembered as.

NAHU DIMITRI

Lynn Nystrom demanded perfection. When I had first become Editor-in-Chief, Lynn began her barrage of questions, asking why I wasn't up to date on this task, or why I hadn't sent her updates on another story. She was a strong willed teacher and has in a sense, effected me more so posthumously.

Following her passing I was in shock. My staff and I were left to run the Engineers Forum magazine without our beloved faculty advisor and I was lost. For a second I had forgotten my training. But as I began to pick up where I had left off, for some reason I had the same urges to quickly gather and compile information just as I would've had Lynn still been around.

Time of length with someone doesn't always determine how much you'll miss someone once they're gone, Lynn Nystrom was one of those few exemplary people. My time with her on this Earth was short, but her spirit still remains, here, through us.

Love and miss you Lynn

SOFIA DAVILA

Since joining the staff of Engineers' Forum Magazine more than three years ago, I have gotten the pleasure of having Lynn Nystrom as a mentor. During this time she gave me the resources and the strength to grow as a leader and as a professional within the magazine. I will never forget the way she and I communicated during meetings across the table just by looking at each other as we heard a crazy article idea, or an opinion that didn't match our own. Lynn always put students first in her life, and she showed us all how to be selfless, even when we may feel that our own problems are more important.

Lynn cared so much about all of us at the Forum, and her absence is felt both at the Engineers' Forum Magazine and as a weight in our hearts. Thank you Lynn for all the years of support and for all that you have left with us as you have moved on to a better place.

EL-SHEBA OKWEI

Lynn's attentiveness as well as her contributions to the EF meeting discussions showed her genuine concern for the welfare of the magazine and the staff since I joined my freshman year. I will always remember Lynn's welcoming smile whenever I arrived for an EF meeting.

ENGINEERS' FORUM

Volume 37 | Number 2 | April 2016

Photo / **James Shackleford** 6

Features

LETTER FROM THE EDITOR

Hello readers! I would like to thank you again all for your continued support of the Engineers' Forum. We have some interesting new articles for you and we hope that you enjoy reading them as much as our writers enjoyed creating them.

Sadly, it has come the time for us to publish the last issue for the 2015-2016 season. This year has been difficult with the loss of our beloved Lynn, but we have continued to work and have fun putting this magazine together for you all.

As always, your fellow Hokies are making waves in the engineering world. From shattering stereotypes to redefining statistics and probability, these students are easily surpassing expectations. Want to know more about engineering research at Virginia Tech? Check out Zeyad Zeitoun's article on VT's College of Engineering research numbers. If you are interested in communications, check out Sean Pili's article about Virginia Tech's Hume Center and its contributions to the field. Arianna Krinos defines what it means to be a woman in a field dominated by men in her article about the Society of Women Engineers (SWE) and Mike Liao explains how the Monte Carlo Methods redefined the understanding of probability in his article about nuclear engineering.

Still haven't had your fill? Check out our blog at http://www.ef.org.vt.edu to read up-to-date stories about engineering at Virginia Tech and do not forget to follow us on Facebook and Twitter for continuous updates about the Engineers' Forum! We thank you for reading this year's last issue!

Nahu Dimitri

Editor-in-Chief,
Nahu Dimitri

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EngineersForumVT

ZEYAD ZEITOUN JUNIOR, CHEMICAL ENGINEERING

THE BU$INESS OF RESEARCH AT VIRGINIA TECH

Article Zeyad Zeitoun **Photos** Aaron Clark

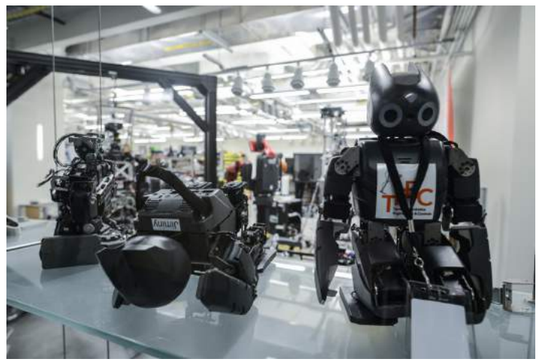
In early March, it was announced that Virginia Tech's College of Engineering has risen to rank eight in the National Science Foundation's (NSF) research expenditures report. In fact, Tech continues to be the only university in the state of Virginia that finds itself in the top 50 of this report. This rise in the rankings is a result of a rise in the overall spending of the University on research programs. After analysis of the 2014-2015 academic year, it was found that the College of Engineering spent $228.5 million on research, up from $214.4 million the previous year. Overall, Virginia Tech spent a walloping $513 million on Research & Development, versus $496 million the previous year. We have only been in the hierarchy of these rankings since the turn of the century. In the year 2000, the University spent a mere $192.7 million on overall research expenditures. This alone is a massive amount of spending, but we have nearly tripled that number since. This substantial expansion enables the institute to diversify its funding allocation to cover all types of innovative exploration.

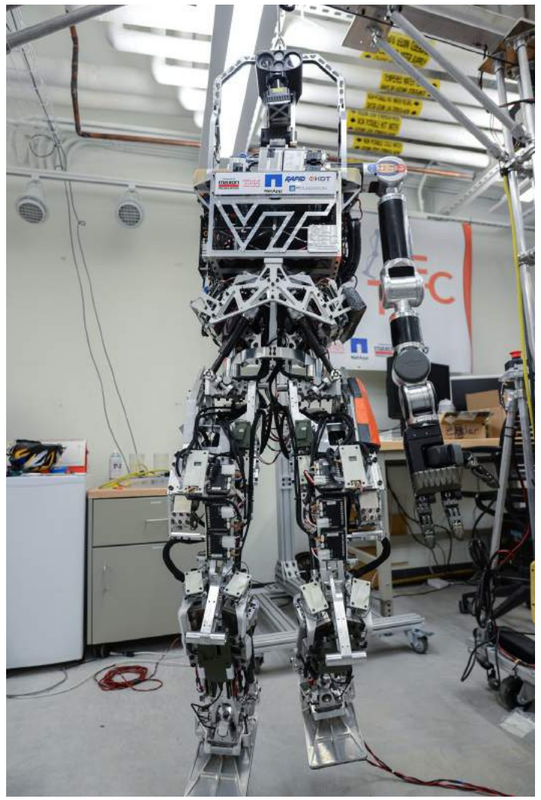
Clearly, the College of Engineering dominates a large amount of the research spending, composing nearly half of the total amount spent last year. This speaks to the fact that nearly one-third of Virginia Tech students are Engineering students. The resources that have been allocated to engineering-related research has placed Virginia Tech at the head of many areas of research. Most recently, a member of the College of Engineering faculty has been on the news after shedding light on the environmental crisis going on in Flint, Michigan. Marc Edwards, a Civil/Environmental Engineering professor at Virginia Tech was called to Flint by a woman who claimed the water quality in her home was unsafe for herself and her children. When she told him the City was ignoring her pleas for help, Dr. Edwards intervened and discovered that she had an extreme amount of lead in her water supply. Having previously lead the way in solving a water safety crisis in Washington, D.C., Dr. Edwards knew that he must be the one to take action in Flint. He went on to uncover that a large number of homes in the city have corroding pipes which contaminate the water supply, putting the lives of thousands of residents at risk of disease. He also actively information from Flint government officials via the Freedom of Information Act, which led Dr. Edwards to also uncover that the local government had been very aware of the problem, but had chosen to do virtually nothing about it. Now, Dr. Edwards and a research team he has assembled at the University have been assembling water-testing kits to deliver to Flint residents so that more people can more easily identify if their home is being affected by this issue. Without the vast resources of the University the team wouldn't have been able to so easily test hundreds of amounts and subsequently design and build the water-testing kits that will potentially save lives in Michigan and potentially elsewhere in the future. However, without the expertise and finesse of Dr. Edwards in responding to this problem, Virginia Tech probably wouldn't be on the front lines of this crisis.

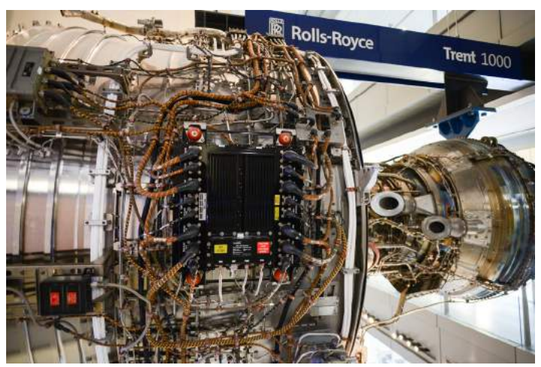
Above & Left / The exteriors of Goodwin Hall, the Biocomplexity Institute, and the CRC are captured in the grouping above. These three facilities are home to an array of important research and development projects underway at Virginia Tech.

Outside of solving current environmental issues, the College of Engineering delves into developmental research to find improvements and alternatives to today's technology and methodology. For example, Virginia Tech has committed extensive funds to vehicle research. In the last edition of our magazine we featured two major automobile-focused research projects currently underway. Two featured writers of the Engineers' Forum, Arianna Krinos and C.A.M. Gerlach, covered the Driverless Car and EcoCAR 3, respectively. Krinos' article highlighted the work of the Virginia Tech Transportation Institute (VTTI) on developing an autonomous vehicle capable of operating in day-to-day scenarios. In conjunction with the Virginia Smart Road, VTTI's spending power and professional workforce has been conducting state-of-the-art research to advance the commercial understanding and potential abilities of such a vehicle. Gerlach's article focuses on the Ware Lab's EcoCAR 3, a project sponsored by the US Department of Energy to reduce petroleum use of vehicles while preserving and perhaps improving the performance and consumerization of hybrid vehicles. The Ware Lab is another fine example of the Engineering prowess our University delivers, with dozens of inventive projects under its wing. These two projects reflect the ability of Virginia Tech's resources to engage its students and employees in real-world practical scenarios.

Despite the fact that Engineering-related research makes up a bulk of Virginia Tech's research expenditure, the establishment focuses on various fields of study. Seven major institutes make up a majority of the work underway in Virginia Tech's name. VTTI is featured in this list as well as several commonly-known institutes. Featured in this edition of the magazine is the reimagined Biocomplexity Institute of Virginia Tech.



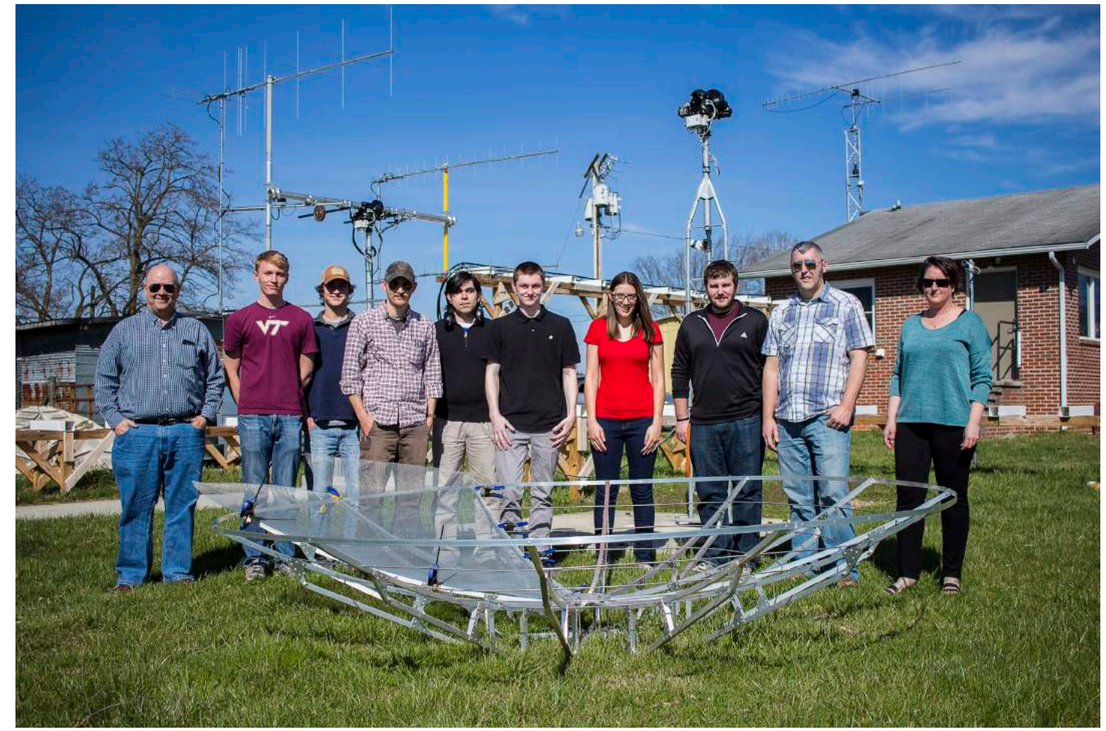




Intricately designed robotics are pictured at the TREC (Terrestrial Robotics, Engineering and Controls) Lab in Goodwin Hall, as well as the donated Rolls-Royce Trent 1000 Jet Engine that hangs over the lobby. The TREC lab is a flagship of the electrical engineering projects underway in the building.

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 at Virginia Tech 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, hosing nearly 200 different companies focused on Research & Development. Unlike the previously mentioned seven 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 change 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.

SEAN PILI JUNIOR, STATISTICS



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

Top / Kevin Sterne pictured standing next to the mount for the 3m 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.

front end to make the full payload," Leffke explained.

The Hume Center team is composed of academic faculty (Dr. Jonathan Black), research faculty (Dr. Robert McGwier, Zach 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 splitter;, that's what I'm planning to contribute with my background in RF & 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: James Biggs, Keith Tiemann (obscured), Zach Leffke, Kayla Brosie, Anthony Wolosik, Seth Hitefield. Leffke gives out instructions pertaining to the construction of the 3m 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:

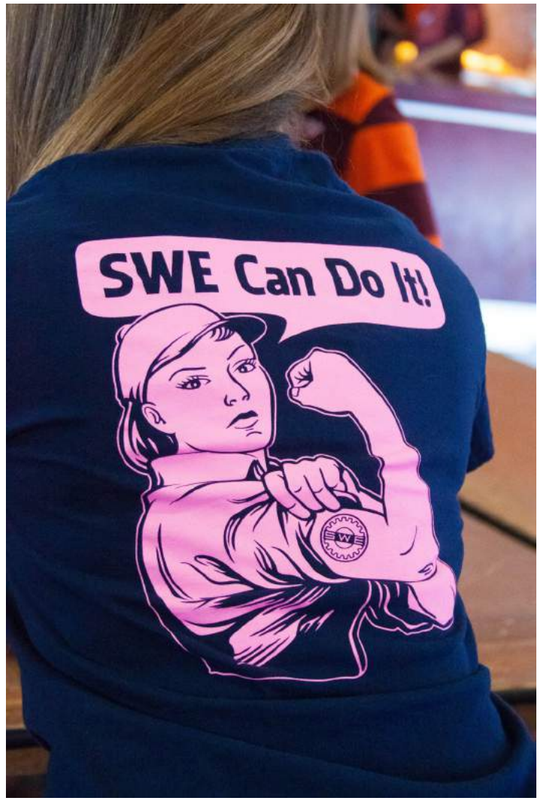
"We don't want this to be last one, we're going to learn more"

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 stranger to stereotypes, but they have refused to allow those typecasts 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 February 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.

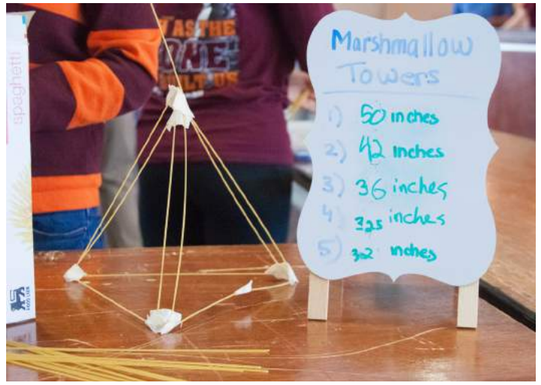
SWE president Hannah Roth joined SWE as a freshman to meet other girls with which she could relate. She was selected as webmaster in her first year, became vice president as a sophomore, and has been leading the club since junior year. A computer science major, Roth nodded to the problem solving abilities common to computer scientists and those in traditional engineering disciplines. Roth believes that 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 Roth, 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

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.

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 got older, she became increasingly interested in math, an affinity which drew her towards pursuing a degree in computer science. This interest was corroborated by a positive high school experience in a programming class with a "very inspiring teacher" that allowed her to "find her passion early on."

SWE members seem to share a belief in the importance of education and educators. A central tenet of the organization, undoubtedly, is to secure and retain the confidence of women endeavoring to succeed in a challenging, traditionally male-dominated field. Through participating in events like Kids' Tech University, SWE hopes to be a part of the paradigm shift which must be introduced early and reinforced often to ensure that future generations continue to move towards gender equality in technical disciplines. Carome mentioned that the mentality of "women in the home" must change for women to be successful; Roth lamented that it was "hard to pick just one" among the many problems facing females interested in engineering, but that "SWE is trying to tell women that they can be in engineering." Carroll, similarly, felt that all too often the general sentiment for girls hoping to pursue engineering is that "that's what guys do," a notion which can be highly discouraging.

When it came to the route of the female engineers to becoming successful engineering majors, all could recall roadblocks which made their accomplishments more difficult to achieve. Roth recollected that she struggled to reach out to others at times when she had questions, because, in a male-dominated class, she often had to look deeper to find people with whom she could relate. Emily Schaphorst, the secretary of SWE and a junior industrial and systems engineering major, remembered that she was not exposed well to engineering principles in kindergarten, and did not feel encouraged to pursue technical fields. It was this experience, however, which inspired her to become involved with Kids' Tech University: she called the event her favorite SWE activity, and feels that it is "important to spread math, science, and engineering to little kids." Carroll asserted that the, "idea still exists sometimes that girls are not as capable as males," but further, that the most difficult aspect of facing life as a female engineer is for her that others can feel that she has an "unfair advantage," which can be a challenge to deal with. This sentiment originates from the idea that women are given an easier time just to even out the gender ratio. The SWE officers mentioned that girls in engineering can begin to feel as though their male counterparts believe they do not deserve the success they generally earn through hard work. SWE members interviewed were also in consensus when it came to the SWE's benefit to their college careers. Despite the roadblocks each girl faces, many described SWE as a community within the university: Carroll stated that SWE had been for her, "a club that made the school feel a little smaller." Roth reminisced that her SWE membership had prepared her to tackle job interviews, explaining that SWE had made two summer internships possible, one at NextCentury Corporation and the other at the Johns Hopkins Applied Physics Laboratory. Ultimately, these women in engineering participate in Kids' Tech University and other education events to give back to an organization which has supported them in their college careers.



Top / SWE secretary Emilie Schaphorst explains the marshmallow challenge.
Bottom / The leaderboard for marshmallow towers created by visitors.

A LOOK AT NUCLEAR ENGINEERING

Article Mike Liao

It's safe to admit that we don't know everything, and so we turn to gambling for answers. Or, at least that's what nuclear engineers do when they utilize the Monte Carlo Methods. The Monte Carlo Methods are a statistical technique used to model complex scenarios and mathematical equations that otherwise would be difficult to simulate or solve. Consider a dice. Basic probability tells us if we roll the dice each number has a sixth of a chance of being on top. If we were to roll that dice a million times and recorded the results, when we should reach the same conclusion. Each number should ideally appear about one sixth of the time. For the dice example, Monte Carlo Methods offers us nothing we do not already know. So, now consider a situation where we don't know much like particle transport. Because we don't completely understand particle motion (i.e. random movements), the Monte Carlo Methods can offer us similar insight. If we let the particle move in a given time interval, we can learn the probability of where it should be after that given time. In a sense, we are "gambling" by repeating the experiment over and over to determine the likelihood of an event. Perhaps now, it comes as no surprise that today's nuclear engineers utilize these methods to determine particle behavior just as the Manhattan Project scientists did seventy years ago.

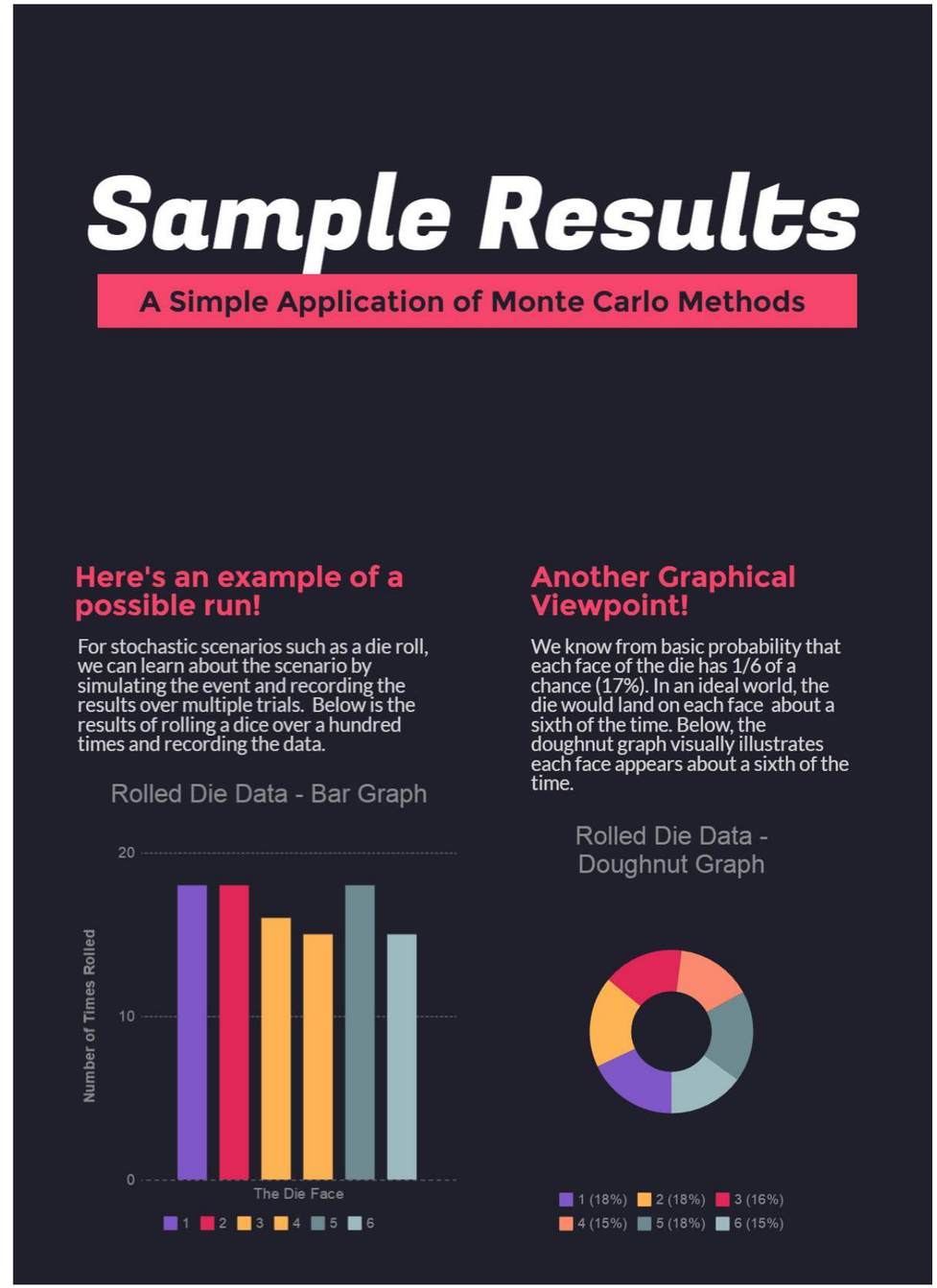
However, Monte Carlo Methods are just a glimpse at the problems nuclear engineers tackle. In today's society, there's a growing need for nuclear engineers as new related fields are being explored. Certainly, it's a well-paid profession with a median salary of roughly $100,000 - according to the Bureau of Labor Statistics. Everyone knows the typical area of a nuclear engineer is nuclear power; however, this is just a small outlook of the several job possibilities such as nuclear security and nonproliferation. While significant different fields, they aim to address a single issue, the detection of radioactive material. For nuclear security, power plants produce radioactive waste generally stored in pools next to the plant. The pressing concern for inspectors is whether

or not the waste is still in the pool and thus implicitly whether or not the waste was stolen. A detector can be used to measure counts released by the waste but the problem here is that the counts measured could be from something else. So, the question becomes how can you determine if the radioactive material is still in the pool without actually checking it. For nuclear nonproliferation, the question is the similar: How can I check what is being transported in and out of the country for radioactive material without actually checking the baggage itself? As more countries develop nuclear capabilities, the need to answer these questions becomes more important. This has also led to growth in another area: nuclear policy with emerging consequences such as the historic Iran Deal of 2015. Aside from security matters, nuclear is being applied to medicine as nuclear medicine. A particular important area is medical physics under which radiation therapy and diagnostic testing fall under. The ability to calculate the correct dosage and precisely apply it requires a strong nuclear background.

The United States has roughly 30 nuclear engineering programs. Virginia Tech is home to one of them. Located within the Department of Mechanical Engineering, the Nuclear Engineering Program (NEP) offers prospective undergraduates masters and doctorate degrees. It is housed in six facilities and has five labs including The Nuclear Science and Engineering Lab (NSEL) in Arlington, Virginia, where the computer code for Monte Carlo Methods are developed. In addition to research on Monte Carlo Methods (advanced radiation transport methods/codes), the program has several other research areas including but not limited to thermal hydraulics and reactor safety, reactor physics, plasma processing and fusion, and nuclear nonproliferation and policy. As with a diverse research spread, it is no surprise the program offers courses in topics like power, nonproliferation, medicine, and policy with external support from other departments such as the Physics Department and Department Science and Technology Studies.

IF WE LET THE PARTICLE MOVE IN A GIVEN TIME INTERVAL, WE CAN LEARN THE PROBABILITY OF WHERE IT SHOULD BE AFTER THAT GIVEN TIME. IN A SENSE, WE ARE "GAMBLING"

Indeed, nuclear engineering is a possible course of study and Virginia Tech offers the resources to achieve it. So, what is the probability that you will consider nuclear engineering as your graduate program? No one can be certain, but the Monte Carlo Methods can certainly determine the overall probability.



A Visual Look at the Die Example

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