Engineers' Forum

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Look inside to check out VT BOLT, Ware Lab's electric motorcycle team p. 12

Letter From the Editor

Hello folks!

I hope everyone is keeping warm as the Blacksburg weather keeps getting colder, Grab a cup of something hot and sit down with another issue of the Engineers' Forum magazine! As always, we appreciate you taking the time to pick up a copy of our publication and see what's happening in the realm of research and science.

If you're feeling adventurous, travel back in time and learn about one of the pioneers of the space industry with Jesus's story about Dr. Sable, a man who is now one of our leaders in power electronics. Visit the frontier of our possible superhuman future with Naomi's article about Dr. Goldstein's research in altering the chemistry of human biology and his study to integrate nanoscale polymer fibers into our physiology.

At first glance, engineering may seem like a somewhat daunting or stringent discipline. In reality, much of what engineers do can be applied to many other areas of research and study at Virginia Tech. For a case study, just look to Nahu's story on the new HABB1 building, whose purpose is to serve as a center of collaboration between engineering and food science! For a quicker read, check out Robel's photo spread showing how several psychology labs apply statistic methods to help understand how humans regulates themselves. Want to learn about supercomputing? See inside with Sarah's story! We also have our continuing Sci-Fi column and our usual Ware Lab correspondence, giving you the latest and most fun picture of science and engineering happening here right now!

We at the Engineers' Forum want you to know that engineering isn't just text books and tests, but rather a collection of interesting stories and incredible new frontiers. If our Hokie motto is to "Invent the Future", then our magazine's motto would be to "Bring the Future to You" through our stories and photo spreads. Thanks again for picking up our magazine, we hope you enjoy!

Coleman Merenda
Editor-In-Chief

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HABB1 Opening Facilitates Interdisciplinary Cooperation

By Nahu Dimitri, a junior in biochemistry

Brian Wiersema gives a tour of the pilot plant in the basement.

An APV HTST (high temp, short time) pasteurizer is used to pasteurize milk or other low particulate liquids.

The spotlight is on the newest building in the College of Agriculture and Life Sciences: the Human Agricultural Biosciences Building 1. Built on the intersection of the Duck Pond and Washington Street, the $53.7 million Human and Agricultural Biosciences Building 1, or HABB1 for short, is the first of four new buildings to be completed to serve the demand for collaborative engineering and food science research.

HABB1 houses researchers from both the Food Science and Technology (FST) and Biological Systems Engineering (BSE) departments. Here, researchers and undergraduates alike are able to deliberate and discuss topics in a variety of open spaces. "People here tackle a bunch of issues, such as synthetic biology, vaccine development, biomaterials and food engineering," said Dr. Ryan Senger, a metabolic engineering and systems biology research professor. "At HABB1, I have easier access to my students and the labs are conveniently placed and interconnected so we can all access and share resources much easier." Indeed collaboration is key for innovation, and the building was designed to facilitate this theme.

One of the signature features of the facility is the open space that gives researchers and graduate students a place for interaction. "There was no open space where everyone could interact at my old building," said Imen Tanniche, a graduate student in biocommodities and biofuel production. "Being separated from our PI's was very frustrating, however at HABB1 we can all talk about things in the lounge." The top three floors give faculty ample room for academic research. Industrial projects, however, are done in the basement.

The basement is comprised of two, level two biosafety labs and the largest university pilot plant in the country. "Having such a large pilot plant teaches students how to use large-scale equipment", Brian Wiersema, the pilot plant manager, said. "Corporations also rent the labs for projects that range from as short as a weekend for short experiments, to large scale projects that last six months." However despite the state-of-the-art equipment and large lab space, Mr. Wiersema was quick to point out what makes this lab so attractive to companies. "The greatest resource we can provide is actually what's upstairs. Corporate researchers can just go upstairs and ask our researchers for help or clarification on certain things."

HABB1 is the template for the future "This is an exciting time for the college," said Alan Grant, dean of the College of Agriculture and Life Sciences. "This new building and future biosciences precinct are going to help the agriculture and life sciences disciplines and industries thrive while looking ahead to the future to solve emerging challenges."

Both BSE and FST departments have experienced large growth in the past five years. In fact, U.S. News and World Report recently ranked the BSE graduate curriculum ninth in the nation among biological and agricultural engineering programs.

Along with having the most modern and cutting-edge technologies, the building has a lot of common area to increase interdisciplinary collaboration and creativity. "By having two departments, researchers, graduate students and undergraduate students under one roof, we will be able to create a synergy among scientists where ideas are shared, hypotheses are debated and the challenges of the world are tackled," said Saied Mostaghimi, associate dean of research for the college and director of the Virginia Agricultural Experiment Station.

Aliens in Liota Space, Part 2

By Vidya Vishwanathan, a sophomore in aerospace engineering

Aliens in Liota Space is a Sci Fi short story column with new parts every issue. Read up on past installments on our website: www.ef.org.vt.edu!

The Kreigerin warrior's grip loosened slightly when the creature from Earth announced that her people had come in peace. Javaan, the leader of the warrior people looked upon her with strong distrust. "How are we to ensure that what you say is true," he demanded. His voice was so thunderous that the Earthlings jumped at his question. He signaled for me to translate his message. As I transmitted his words, I peered into the intruder's white shell to see her face, incredulous at this new form of communication. She hesitated for a second and spoke into her helmet. I was startled to hear another voice, faint and unclear deliver an ambiguous response. Was there another creature inside of her white shell?

She sensed my surprise and whispered, "It's a radio. I'm talking to him." She then motioned in the direction of another panicking Earthling. "We humans do not mean any harm," she said. "We have come for research purposes. We want to learn more about the organisms that live in our universe." She looked over at Javaan for her next announcement, "And to prove our harmlessness, we will show you what we have brought, and how we intend to conduct our research."

"It's a trap," exclaimed a minister.

"Don't listen to them," yelled another.
"We must annihilate them at once before any damage is done to the Liota solar system," asserted a warrior.

Despite the sudden outburst of suggestions, all eyes were on Javaan, eagerly awaiting his decision on the matter.

"Very well," he answered. "We will follow you, but you must answer our questions with integrity and honesty. If we feel for even the slightest reason that you will harm us, you must leave our system without resistance." He then pointed at me and Cetana, the minister of the innovative planet Aviskaraka. "You will both follow me and these humans into their lair," he commanded.

As we approached the mountainous spacecraft, I noticed the humans' odd pattern of movement. They were like springs, leaping into the air and gracefully falling to the ground after each step forward. Were they not very heavy beings?

"My name is Nyla by the way," said the human. I looked around to see if anyone had noticed her speak, but no one had. "I'm Vadaka of the planet Lirementem," I responded. "My people are the translators of the Liota solar system." I flinched. What if I told her too much?

"Please believe us when we say we don't mean any harm," Nyla said. "Humans have traveled through deep space for over three hundred and fifty Earth years to come to your planet. I can't believe our ancestors' dreams are coming true!"

Three hundred and fifty years? That doesn't seem like very long, I thought.

Suddenly Nyla gasped, "Oh! I'm so stupid," she said. "How are you going to breathe in our space shuttle? You can't breathe oxygen!"

The other astronauts stopped walking and looked rattled at this apparent problem. The radio inside Nyla's suit sounded, and she looked up at me. She hesitated to speak, tried to regain her composure and started speaking slowly. "You see, we humans breathe oxygen on Earth, and you seem to breathe an element that does not exist on our planet," she explained. "We are not sure if you will be able to survive in an oxygenic atmosphere, and we cannot take that chance."

What did she mean? Take a chance on what?

She continued, "You need to tell the warrior that for your safety, we cannot take you all around the space shuttle. We will only be able to show you everything in the airlock."

Javaan's suspicion grew stronger as I relayed the human's message. Yet, he braved these suspicions of trickery and allowed us to move forth and hear what they had to say. But, with every step closer to the space ship, I saw that the grip on his sword grew tighter, and a drop of fear rolled down his temple.

The three Liota representatives and Nyla waited outside as the rest of the humans prepared themselves for their upcoming presentation that placed the integrity of their three hundred and fifty year journey on the line. Finally, we were summoned inside. Cetana, Javaan and I cautiously followed the human into her lair. The metal felt cold against my feet and I beheld before me a large white room. The doors began to close behind us, ultimately trapping us in the vacuum chamber.

"As you will not be able to breathe inside our space shuttle, we will show you our research instruments by video," announced Nyla, as she pulled forward a large black rectangle, on which a human appeared. "The astronauts will project onto this screen the various locations within our ship," she said. "Think of it like a virtual tour. I have here some of the instruments that they will show." She gestured to a large blue bag at the corner of the room. "Shall we begin?"

I realized that all this time, I had forgotten to translate her words, and all Javaan and Cetana had experienced was being thrust and locked into an unfamiliar room and spoken to in a strange alien language. I quickly translated the terms of the situation to them. Javaan looked to Cetana, since understanding this new technology was in her realm of expertise. "We shall begin," she declared.

And so began the demonstration. I pronounced words that did not exist in my dictionary and explained processes that had no meaning to the Liota people. Every now and then Nyla would remove a tool from her bag and allow Cetana to inspect it further. There were instruments that ranged in size, some of which fit into Nyla's magical blue bag; the other instruments were accessible only in certain parts of the shuttle. The seminar was arduous and draining, but the safety of Liota was at stake, and so it had to be done. Nyla and the astronauts were succumbing to fatigue. Their voices were getting softer, and their eyes became redder. They were demonstrating a strange behavior of intermittently opening their mouths widely to expel a great waft of air.

Once Cetana's grilling questions had ceased, she looked at Javaan to reveal her assessment. "They do not seem to desire any harm on our system," she informed him. "However, their technology is very new to us, and I recommend that we remain vigilant for it only takes a moment for a situation to go awry."

Javaan processed each word as if he were taking long gulps from his goblet. "Very well," he said. "We shall let them stay."

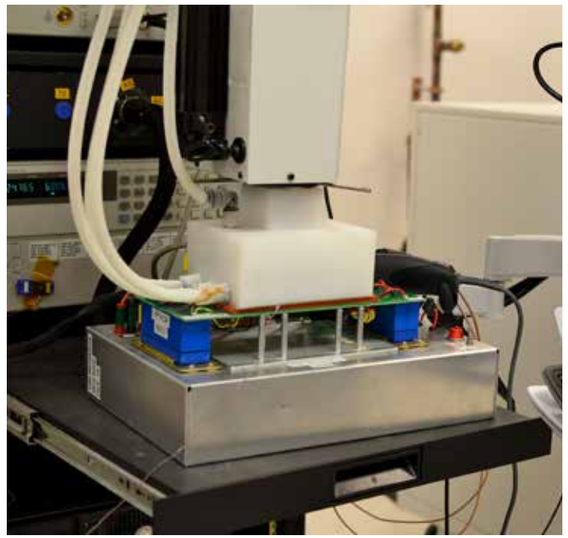
To be continued…

One Man's Dream, Tomorrow's Future

By Jesús Rodríguez,
a senior in electrical engineering

The date is July 20, 1969. The moon landing of Apollo 11 is broadcasting on live TV. An estimated 600 million people are watching, including a young Dan Sable. Although the moon landing was one giant leap for mankind, it was very much a small step for Dan Sable in achieving his goal of working in the space industry. In fact, the moon landing proved to be the most important harbinger of his dream. Fast forward 24 years; another event is about to pave the path for Dr. Sable's career — this time, in the form of a question. Dr. Sable had just finished earning his Ph.D. in power electronics for space applications at Virginia Tech. Before pursuing his Ph.D., Dr. Sable began his studies at the Massachusetts Institute of Technology (MIT), where he earned his bachelor's degree in electrical engineering. After graduating, he began working for the Radio Corporation of America (RCA) in New Jersey, a company that designed satellites. After taking a leave of absence, he came to Blacksburg to earn his master's degree in power electronics for space applications before returning to work.

A few years later, he returned to Blacksburg once again to pursue his Ph.D. While walking down the hallway, Dr. Sable was stopped by Fred Lee, his electrical and computer



An electronic chip is tested with varying temperatures, using a custom built system which runs various tests simultaneously. The system allows for every type of VPT electronic to be placed on the mount using various adaptors.

engineering (ECE) advisor. "Do you want to start a company?" Dr. Lee asked. For an idea he had never thought about, Dr. Sable's response was simple: "Sure, why not?" Up until that point, Dr. Sable knew he wanted to work in the space industry, but had not fully decided on his path to getting there. Viewing this chance as an opportunity to start on his path, making a decision was easy.

Armed with a passion for power electronics, some cash and motivation to develop a better product, Dr. Sable's group rented out a small office in the Corporate Research Center (CRC). One of the group's main inspirations was the negative feedback of the two main competitors in the high-reliability DC-DC power converter industry. They had heard that quality, delivery time and customer support of their competitors was very poor. This motivated Dr. Sable's group to make sure that if they were to make it in that business, they would have to make sure that they could offer better quality, better delivery time and better customer support than the competitors.

Initially, the group did consulting and design on a small scale for various people. After completing more contracts and hiring more people, the group was introduced to Delta

A DC-DC converter, one of the types used for aviation and military applications.

Electronics, one of the largest power supply companies in the world. After taking a license on some of the group's work, Delta Electronics implemented these designs into Dell power supply adapters. After the success of the design, Delta Electronics decided to invest into the group's business. After forming a joint venture, VPT began creating designs, while Delta handled the manufacturing process. Even with all this, creating standard products for the high reliability market still required more work. Because a very rigid set of standards is required to sell to the military and space industries, the process of obtaining the formal qualifications took several years. Because of this, VPT is only one of three companies in the world that is qualified to send their converters into space.

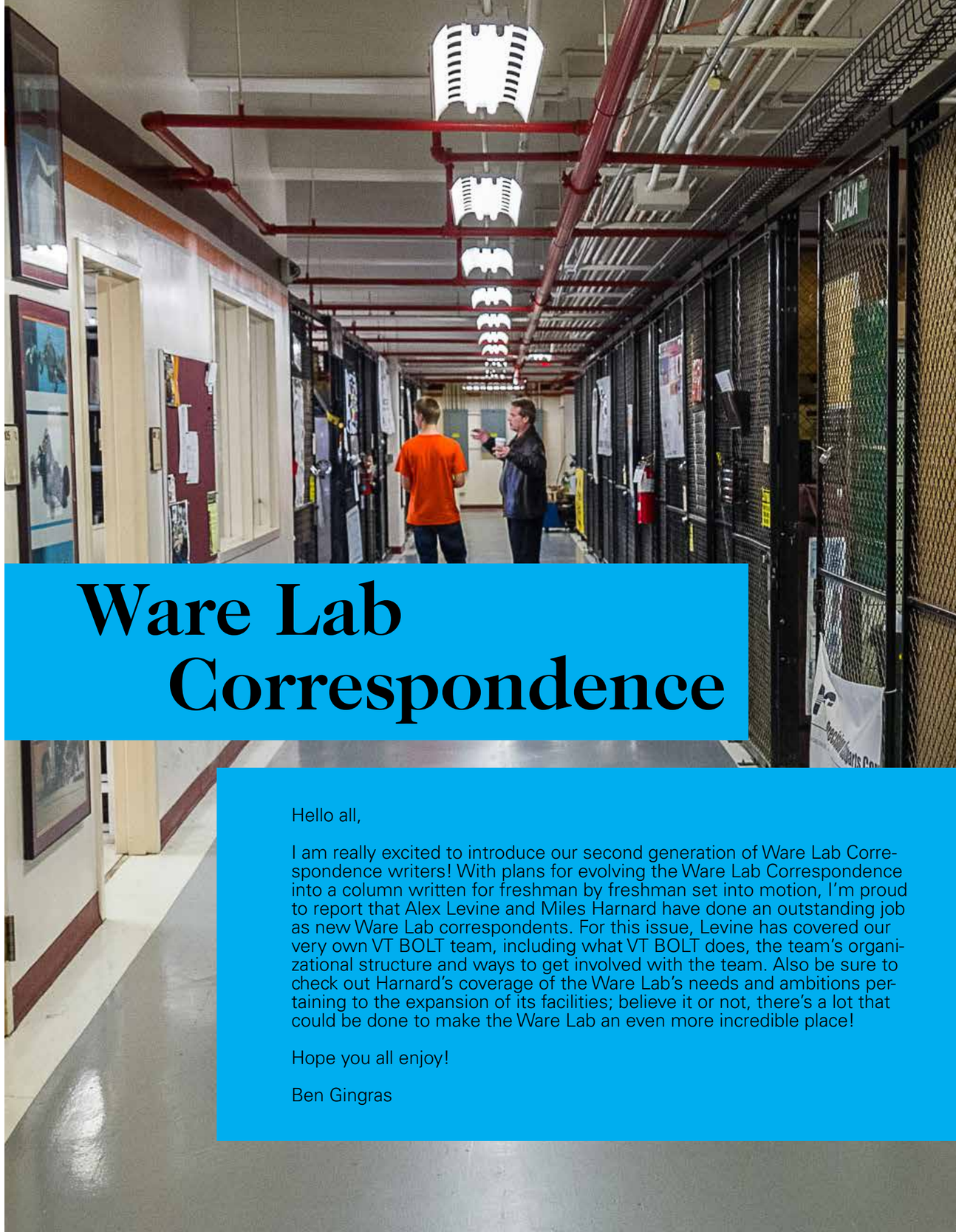
Fast forward to the present day, and Dr. Sable is the CEO of VPT, Inc. With a Headquarters here in Blacksburg, Virginia, VPT is a leader in providing power conversion solutions for use in avionics, military and space applications on a global scale. NASA, Lockheed Martin, Boeing, the United States Air Force and many more organizations have depended on the power solutions provided by VPT. Specifically, VPT offers high reliability DC-DC converters, EMI filters, accessory power products and custom solutions for mission critical power systems.

DC-DC converters are electronic circuits that convert sources of direct current from a given voltage level to another. They can be found in many portable electronics devices such as cell phones, laptops and tablets. Electromagnetic interference (EMI) filters simply filter out the majority of electromagnetic signals that interfere with the system. These devices have been around for many years, which begs the question: what makes VPT's products so special? The answer to this question is that VPT has succeeded in taking existing products and making them better.

VPT has contributed greatly to many successful projects. Some of these projects include the Boeing 777 & 787 aircrafts, the MQ-1 Predator Drone, the Patriot Missile program and many more. Many of these projects include standard VPT components, allowing delivery off-the-shelf. Along with standard products, VPT has also created custom solutions for agencies such as NASA. VPT's operations have not been limited to planet earth. The Indian Space Research Organization's Mangalayaan Orbiter (currently orbiting Mars), NASA's New Horizons (currently en route to Pluto), NASA's MESSENGER (currently orbiting Mercury), the European Space Agency's Venus Express (currently orbiting Venus) and even NASA's Orion, set to launch this coming December, all contain a piece of VPT hardware inside.

With space exploration making a comeback, many new programs will continue to develop. Dr. Sable strongly believes that unmanned missions into space are very important. Because of the high output of results compared to the initial investment (when compared to manned missions), the unmanned missions are proving to be highly valuable. Dr. Sable is currently teaching undergraduate courses at Virginia Tech, something he does simply for the interaction he gets to have with students. In order to do this, he has appointed a president to oversee the day-to-day operations of VPT, while he has assumed the role of CEO.

He also serves as a mentor for many students who have started their own companies at the CRC. As a mentor, he gives students advice on financing, personnel issues and legal issues, as well as advice on starting their own company – something which he believes requires the right mindset, passion, money and the ability to realize a large feat cannot be accomplished alone. Along with these traits, he believes a lot of luck has helped him to succeed, which he is very grateful for. Whether it is through luck or not, Dr. Sable's dream has become a reality that has made an impact on Earth, as well as in space.



Ware Lab Correspondence

Hello all,

I am really excited to introduce our second generation of Ware Lab Correspondence writers! With plans for evolving the Ware Lab Correspondence into a column written for freshman by freshman set into motion, I'm proud to report that Alex Levine and Miles Harnard have done an outstanding job as new Ware Lab correspondents. For this issue, Levine has covered our very own VT BOLT team, including what VT BOLT does, the team's organizational structure and ways to get involved with the team. Also be sure to check out Harnard's coverage of the Ware Lab's needs and ambitions pertaining to the expansion of its facilities; believe it or not, there's a lot that could be done to make the Ware Lab an even more incredible place!

Hope you all enjoy!

Ben Gingras

Ware Lab Expansion: A Peek at the Future

By Miles Harnad, a freshman in general engineering

The hybrid electric vehicleHEVT, clad in all of its sponsors, stays outside of the Ware Lab entrance.

Lab Manager Dewey Spangler recently had to resort to something he never had to do until now: reject student design teams from joining Ware. The popular and successful engineering facility, hosting 14 separate teams of undergraduate students, had reached maximum capacity. Since 1998, while the space available to the lab has remained constant, the number of projects has continually increased —a condition that cannot last.

Fortunately for the lab's future, the second floor of its current building may become available for its use as soon as 2016, as the Corps of Cadets offices currently occupying the space move into the military facilities on the upper quad. This would allow the workshop to effectively double in size and, equally importantly, remain on campus. While any plans for the lab's expansion are not yet official, the possibilities are equally abundant and exciting.

What to do with all the new space? Options include adding more room for existing teams, housing brand new projects, and constructing shared areas useful to multiple design efforts—and as it stands today, the end product will likely involve all three. Some groups will move upstairs, while large teams having outgrown their current allocated spaces, such as VT Baja, Formula SAE and the Hybrid Electric Vehicle Team (HEVT), will then likely expand into newly vacated areas of the downstairs level. At present, VT Baja wants to build two full cars, but at present has barely enough room just to store two, let alone work on them. Formula SAE wants to enter two competitions, and have an electric car as well, but again, space has so far limited such plans. Given more room to work and add members, these already popular teams can continue to grow their potential.

While each team has unique equipment needs and space requirements, a significant portion of these assets can be shared. For example, computers are vital in today's engineering landscape, as superior computer analysis capabilities often separate merely average design teams from those that consistently produce competition-winning results. Presently, for computer-aided design (CAD), all 14 teams must share only six computers. While two more will be installed soon, with so many students working on their respective projects at the same time, such a small number of machines presents a major bottleneck. Some students,

Dewey Spangler shows some of the Ware Lab's past successes that attracted Virginia Tech's favorite bird.

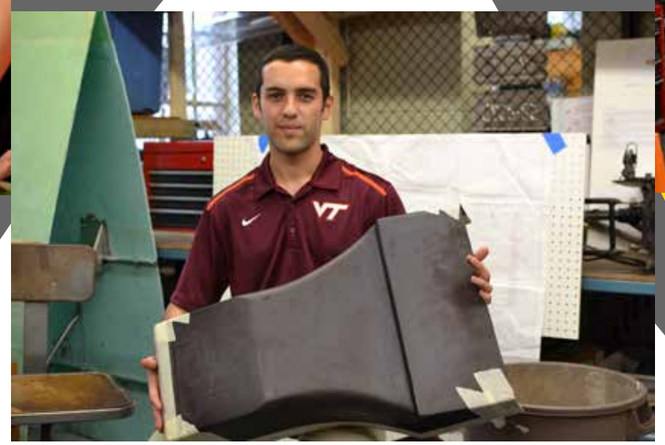
Spangler says, are forced to arrive as early as 6 a.m. to avoid the crowds. The proposed solution? A dedicated CAD lab, to be located on the second floor. The additional space upstairs would host 15-20 computers with the necessary CAD tools, while freeing up more space downstairs for individual projects to use—a "win-win" for everyone involved.

While the new CAD lab appears a vital addition, Spangler also has a bolder idea in mind –an interactive classroom space. This would allow teams to have conferences with sponsors, and serve as an excellent general meeting area. Currently, such meetings take place in Randolph Hall, at some distance from Ware. If they could be held in the lab itself, students would be only seconds away from their work—letting them, for example, quickly retrieve a design component to show a sponsor. The lab already has outreach programs demonstrating the work of its students to over 4,000 people each year, and such facilities added in the expansion may well help this figure grow even further. As another possibility, Spangler has been monitoring the success of the Frith and InVenTs Labs on campus, and wants to employ a similar concept with a second-floor design facility, intended for teams composed entirely of freshman. Locating beginning design teams in the same building as more advanced students would expose the freshman to hands-on engineering and problem solving, allowing them to gain vital experience in designing projects. Additionally, the freshmen would have the chance to observe seasoned teams at work, while older students would have firsthand access to potential recruits for more advanced projects in the future.

There are countless additional avenues for improvement, particularly in diversifying the types of work done at the lab, as a primary goal of the facility is to have a design team representing each engineering department at Virginia Tech. At present, Mechanical engineering maintains a heavy presence, particularly since the workshop contains most of the equipment needed for larger projects such as VT Baja and Formula SAE. Furthermore, Civil engineering efforts, such as the steel bridge, and Aerospace projects including Design, Build, Fly (DBF) and SAE Aero, also account for a large portion of the lab's portfolio. However, the limited size of the current facility stands in the way of including projects from more departments. Spangler says the lab's expansion, with an entirely new floor available for its use, will help open up access to disciplines such as chemical engineering, materials science and mining engineering, among others.

It's an exciting time at the Ware Lab. The facility needs to expand, and will soon have the space to do so. It doesn't need a fancy $10 million remodeling—it will only take about $1 million to make this happen. The space, tools, students and projects are already in place, and all that is needed now is a finalized plan. With the proliferation of intriguing possibilities, only so many can be realized in the new space. But when all the choices are good choices, it's a problem Dewey Spangler doesn't mind having.

Members of the chassis team show a frame concept on SolidWorks.



A tail team member displays the new light-weight tail design.

Members of the 2015 VT BOLT team gather around the BOLT II.

The complete BOLT II is looking at an entire redesign in two years.

Accelerating to Victory: A look into the Ware Lab's own electric motorcycle team, VT BOLT

By Alex Levine, a freshman in general engineering

The Virginia Tech Battery Operated Land Transport (BOLT) team was formed in 2011. Despite being one of the Ware Lab's younger teams, VT BOLT is going places fast. VT BOLT is comprised of 19 juniors and seniors, 15 underclassmen volunteers and a faculty advisor. Every single member has high ambitions for the team. VT BOLT's ultimate goal is to travel to the Isle of Man and compete in the highest level of international electric motorcycle racing. To work up to that level, the team has been participating in smaller American Historic Racing Motorcycle Association (AHRMA) events. The team started out strong, and in 2012 BOLT I won the all-electric TTXGP North American series, which officially made the bike the fastest 75-class bike in the entire western hemisphere. The 75 classification refers to the size of the engine. BOLT II followed hot on its predecessors heels and won the AHRMA eMotoRacing Series in the New Jersey Motorsports Park in July 2014.

This year begins the next two-year development cycle for the newest installation in the BOLT family, and this generation promises to be the best yet. To pull off this tall order, VT BOLT has created different sub-teams, each responsible for a different aspect of the bike. "At the beginning of the year, the team usually reassesses its structure and decides, 'Okay, what are our priorities this year,' and we divide up appropriately," explained Kyle Harvey, VT BOLT 2015 team lead.

This year, the sub-teams include: a tail team, a systems integration team, a chassis team and a battery box team. The tail team this year is all about composites. Their goal is to use carbon fiber and other lightweight, yet strong, materials to decrease the overall weight of the bike, particularly on the tail or seat area.

The systems integrations team is all about the wiring and solid state components of the bike. Their domain is hooking up the controls of the bike accessed by the rider to the internal components of the bike including the engine, the battery box and various other integral components and sensors. The battery box team is devoted to designing a "modular battery-box system." This system is responsible for providing the electricity for which the motor, and the rest of the bike, operates on. Many factors are taken into consideration, including general shape, cell configuration and energy management systems.

The goal of the chassis team is also quite lofty. Made up of mainly juniors, the team, in essence, is responsible for completely redesigning the fundamental structure of the bike. In years past, VT BOLT has modified a 2004 Suzuki GSX-R1000 donated to the team, and converted the gas engine and fuel storage tanks into an electric engine and battery box storage. However, these modifications made the interior of the bike awkward. For example, key components of the BOLT II, such as the battery box, are almost completely inaccessible and require dismantling half the motorcycle to gain access. To fix these problems, the team is building from the ground up with an emphasis on lightweight materials. Since this process promises to be rather lengthy, a solid half of the team is juniors. This allows them to work on the chassis for two years. Their goal is to finish a prototype by the end of this year, and use the next year to optimize and refine the prototype.

Going along with the various sub-teams at work on the bike, BOLT II and the incoming BOLT III have several factors that set them apart from most other electric motorcycles out there. "Our battery capacity exceeds that of the competition that we've been able to gain data about," explained Harvey. "We have a very powerful motor with a very large capacity. That makes us a kind of a brute." Harvey stresses that because of their powerful engine and battery, weight reduction and distribution are critical foci for the BOLT III. This is why they are completely redesigning their own frame and turning to lighter composite materials wherever they can.

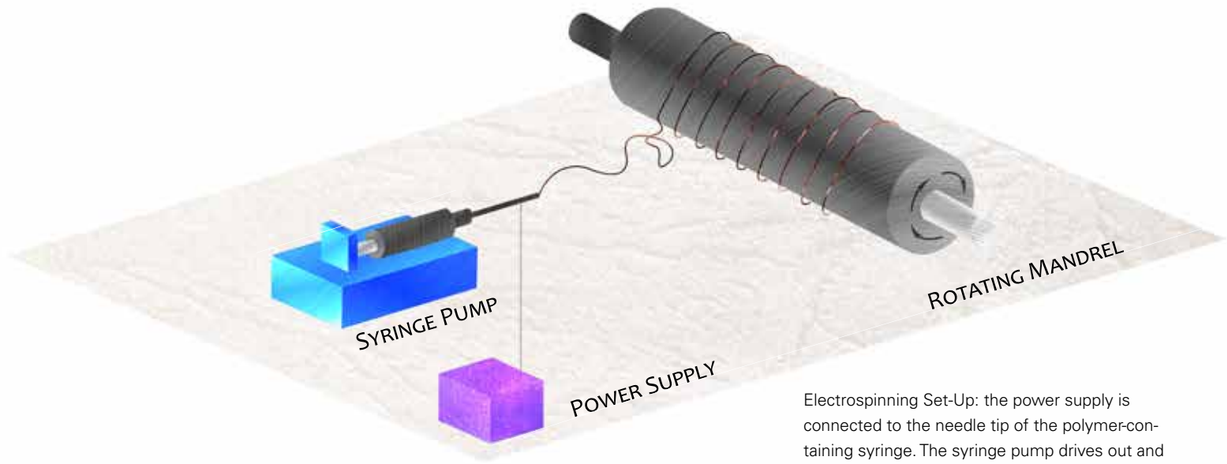
In order to maximize time spent working on the bike, most events the team competes in are in the late spring and summer. However, from October 17 to 19, the team is traveling to Daytona International Raceway to compete in the AHRMA eMotoRacing 2014 series, where they hope to claim the college motorcycle speed record. Ohio State currently holds the fastest time of 144 mph. With the advantage of the wide-open track at Daytona, VT BOLT hopes to snatch the record away. Other than this event, however, the team does not plan on competing this year. Instead, the team is devoting all of its time and energy into creating a prototype of BOLT III.

Needless to say, the whole team, especially Harvey, is extremely excited about the upcoming year. Harvey is a senior in electrical and computer engineering. Although many of his responsibilities are managerial, he finds time to help with all the sub-teams, especially the systems integration team. He is described as a "renaissance man" by fellow team member Brandon Scott. Harvey urges any underclassmen that are interested in the team to stop by and visit. He stresses that no previous knowledge of motorcycles is needed.

VT BOLT is well on its way to becoming a dominant fixture in local and international motorcycle competitions. Each passing year brings the team closer to their goal of racing at the Isle of Man.

Research Scientist Profile: Dr. Aaron S. Goldstein

By Naomi Butler-Abisrror,
a sophomore in chemical engineering



Electrospinning Set-Up: the power supply is connected to the needle tip of the polymer-containing syringe. The syringe pump drives out and maintains a constant flow of polymer. The fibers are collected by the grounded rotating mandrel.

The biomedical engineering discipline is filled with an expanse of remarkable researchers hailing from various technical backgrounds. These researchers have concentrated their knowledge and skills in the endeavor to develop biocompatible devices, processes and materials that could potentially aid the medical field in the betterment of the quality of human life.

One such researcher is Dr. Aaron S. Goldstein who, aside from being a Virginia Tech research faculty member, also serves as associate professor of chemical engineering and as assistant department head for undergraduate studies at the university. Dr. Goldstein's research focuses on skeletal tissue engineering and mechanotransduction. Over the past few years, his research team has been investigating how to guide stem cells to differentiate into bone and connective tissue, such as tendons and ligaments, by manipulating the chemistry, topography and mechanical properties of biomaterials.

As a high school youth, Dr. Goldstein displayed the defining characteristics of an engineer by exhibiting an affinity to dismantling, reassembling, constructing and tinkering around with objects such as bicycles and electronics. After entering UC Berkeley, he declared a chemical engineering major and spent his undergraduate years conducting research, securing a summer job at Lawrence Berkeley National Lab and doing a co-op term at SRI International.

As a fresh college graduate, Dr. Goldstein's first job in industry was in chemical process design at M. W. Kellogg Ltd. His work involved laying out the basic plans for new chemical units. While working for the company, he found that his passion was in fiddling around with things to see what would happen. That did not sit too well with his manager, who was more concerned with seeing results rather than ongoing investigation.

Dr. Goldstein's burgeoning curiosity and propensity for experimentation eventually led him to enroll at Carnegie Mellon University to pursue graduate studies. Once there, he had the opportunity to meet the different faculty and learn about their respective projects. He was encouraged to select a subject and adviser that he felt comfortable with. He ultimately selected a project on how mammalian cells interact with implantable biomaterials. The goal of the project was to find out how to modify vascular grafts so that endothelial cells would attach, proliferate and prevent blood contact with the graft material. To that end, he built a device that could subject adherent cells to fluid flow, and that could be mounted on a microscope so that one could observe how cells responded to flow over many minutes.

This fascination with overseeing cell behavior and interaction in response to changes in the extracellular environment and substrate of adhesion—whether chemical or mechanical—would eventually become central to Dr. Goldstein's own research in skeletal tissue engineering.

Dr. Goldstein arrived at Virginia Tech in 1999. He has since embarked on many different projects throughout his time at the university. One project, which was in collaboration with Dr. Scott Guelcher, a Virginia Tech chemical engineering alumnus of 1992 who now works at Vanderbilt University, involves creating elastic meshes comprised of micron-diameter fibers and examining the effect of their diameter and degree of alignment on ligament tissue formation. A second project, in collaboration with Dr. Linda Dahlgren at the Virginia-Maryland College of Veterinary Medicine, involves stretching these meshes to activate mechanotransductive signaling pathways and enhance tissue formation. A third project, soliciting the assistance of Dr. Tijana Grove from the Chemistry Department, involves tethering peptides to the fiber surfaces that can interact with specific adhesion proteins present on cell surfaces. Finally, a project in cooperation with Dr. Abby Whittington from chemical engineering & materials science engineering, involves creating meshes with a spatial gradient of chemical, mechanical and topographic properties.

In Dr. Goldstein's lab, electrospinning is the main meth-

True electrospinning apparatus and setup. The white sheath on the aluminum foil is the collected microfibers.

od for fabricating polymer microfibers. Electrospinning is a technique for generating polymeric fibers that involves three rudimentary components: a high voltage supplier, a capillary tube with a needle of small diameter and a metal collecting device. To carry out the process, one electrode is placed into the spinning solution and the other is attached to the collector; the voltage supplier is adjusted to a high voltage that is used to establish an electrically charged jet of polymer solution out of the needle. Prior to reaching the collector, the polymer solvent dissolves and the polymer solidifies into ultrafine fibers that can then secure to the collector.

"We can tune the fiber diameter from 0.1 to 5 microns, and alter the chemistry," Dr. Goldstein explained. "Currently, the polymers that we are using are degradable polyesters, similar to the degradable sutures used by surgeons, as well as degradable elastic polyurethanes."

The lab has also been adding additional ingredients to the fibers, such as mineral particles to aid in bone formation, and chitosan — a chemical derivative of chitin — to permit grafting of biochemicals to the fiber surface. The fabricated materials are also characterized by scanning electron microscopy (SEM) — to image the fibers — and by mechanical testing at the Institute for Critical Technology and Applied Sciences Nanoscale Characterization and Fabrication Laboratory. Mammalian cell culture is often carried out on the surface of these materials, and the seeded cells are allowed to grow in order to later be imaged and characterized for gene expression.

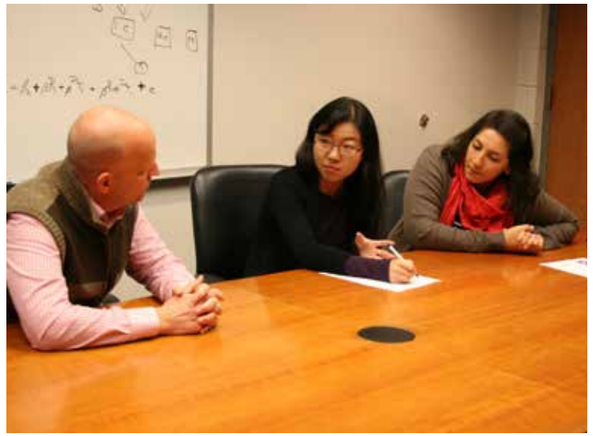
Today, different strategies and materials are being investigated unceasingly by researchers like Dr. Goldstein worldwide in order precipitate progress and improvement of current biological models. As the scientific bank of knowledge continues to expand, the techniques that will eventually be employed may one day resolve the challenge that engineering functional ligament and bone tissue poses.
"In my area of research, a good result can raise a whole new set of questions to be answered, so it's harder to describe progress than it would be for a well-defined project with clear deliverables," Dr. Goldstein shared. "One thing that's nice about our material is that it's very flexible and easy to adapt to many different types of problems. That is, it's a tool or a platform for scientific discovery."

Development of Self-Regulation Research Group in Psychology at Virginia Tech

Images by Robel Fasil, a senior in industrial and sytems engineering

Self-regulation is an essential part of healthy learning and functioning. Self-regulation varies widely between people, and develops and changes over the lifespan. The Development of Self-Regulation (DSR) research group in Psychology includes three labs and investigators: Cognitive, Affect, and Psychology Lab (Martha Ann Bell), Individual Differences in Development Lab (Kirby Deater-Deckard) and JK Lifespan Development Lab (Jungmeen Kim-Spoon). With funding from the National Institutes of Health and National Science Foundation, we investigate the development of multiple interconnected systems of self-regulation spanning cognition, emotion and behavior from early childhood through adulthood. We measure self-regulation and its predictors and outcomes using multiple methods (surveys, observations, genotyping, physiological and neural activity) that utilize statistical modeling techniques that test competing theories about how self-regulation "works."

Dr. Kirby Deater-Deckard



Indiviual Differences in Development Lab

Cognitive, Affect, and Psycology Lab

JK Lifespan Development Lab

Supercomputing at Virginia Tech

By Sarah Stewart, a senior in industrial and systems engineering

Because of movies like Transcendence and Lucy, the public is becoming more acquainted with the idea of supercomputing. Supercomputing, or high performance computing (HPC), is the use of a supercomputer to perform advanced calculations that cannot be solved on a regular computer, or would take an infeasible amount of time to solve — perhaps months or years. With this resource, researchers, students and faculty no longer have to limit their problems and simulations to only what one computer can handle. The Advanced Research Computing (ARC) group spearheads Virginia Tech's research in supercomputing, which is broken into two areas: high performance computing (HPC) and visualization.

Virginia Tech currently houses four supercomputers, three of which are directly accessible to students. Brian Marshall, one of the computational scientists on the HPC side, referred to the supercomputers as clusters. Cluster refers to connecting several computers in parallel to form one supercomputer, rather than creating one large, complex single machine. The four supercomputers are BlueRidge, HokieSpeed, HokieOne and Ithaca.

BlueRidge is the supercomputer that has received the most press. It is the fastest cluster available, but in order for students to run jobs on it, they must be sponsored by their advisor.

HokieSpeed is a graphic processing unit-accelerated (GPU) cluster that uses the same graphics processing units originally targeted to the video game and PC display market. These GPUs are especially useful for accelerating visualization packages. HokieSpeed is also the most efficient, or "green," of the four supercomputers.

HokieOne has shared memory. This means it appears to be one large supercomputer, rather than a cluster, to the program you are running on it. Underneath, it is still a cluster of smaller computers.

Lastly, Ithaca targets new users. It can run Matlab software, a programming language many engineering and math students are familiar with. All jobs submitted to the clusters are monitored, so if you attempt to do something like mine bitcoins, you will lose all of your supercomputer privileges permanently.

One of Marshall's projects involves the Virginia Department of Environmental Quality (DEQ). The DEQ had been running their simulations on Athena, a supercomputer that Virginia Tech has retired. Marshall is currently working to change the simulation code so that it can be run on BlueRidge, while striving to make the simulations run faster and better than before.

Another HPC project involves NVIDIA Jetson development boards, which are typically used for automotive applications. Marshall, James McClure (another computational scientist at ARC) and an undergraduate student are working with network traffic monitoring on campus. Currently, the IT Security Office is only capable of monitoring a small amount of network traffic since their methods are not automated. Marshall, McClure and the undergraduate

student are looking to place several of the NVIDIA Jetson boards around campus for the purpose of filtering traffic so that only important or suspect internet traffic is sent to the IT Security Office to monitor.

ARC's Visual Computing group provides high-performance visualization infrastructure and services to take the simulation results, up to terabytes of information, and turn them into interactive 3-D visuals that we can understand. Visualization at ARC includes the Visionarium Lab in Torgerson Hall, and high performance clusters at the Andrews Information Systems Building. In the Visionarium, students and faculty have access to a number of high-resolution, stereoscopic and immersive displays. For example, the VisCube is a room consisting of three 10 by 10-foot walls and floor with 1920 by 1920 pixels each.

When entering the VisCube, special glasses are worn to transform two 2-D images into immersive 3-D virtual reality. There is a virtual camera rendering a slightly different view of the scene for each eye, just like regular human vision. The user navigates the virtual world with a handheld controller that is tracked and the image adjusts appropriately to the user's perspective. This allows you to travel through and around objects, with the virtual image appearing to float in the center of the VisCube.

High performance computing and virtual reality are commonly used for applications in fluid dynamics and molecular dynamics as well as design, architecture and mechanics. Computational science and HPC simulation are providing new insights into real (and proposed) systems. For example, Professors Burns, Borggaard, Cliff, Zietsman, Gugercin and Iliescu in the Mathematics Department and the Interdisciplinary Center for Applied Mathematics (ICAM)

Students explore the airflow, temperature and humidity in a simulated heating/cooling scenario at life size in the Visionarium's VisCube.

are building improved control systems for energy-efficient buildings (see images). In these images, the thick tubes represent the air flow; the colors demonstrate temperature; and the wire-like cages represent physical boundaries.

Another area of visualization research is using commodity virtual reality hardware, like the Xbox Kinect and stereo televisions, to improve spatial visualization skills. Incoming freshmen engineering students are given a series of tests, one of which tests spatial visualization skills. Spatial visualization describes the act of manipulating an object in your mind. This includes turning a numbered die and cutting a cross-section of an object. Strength in spatial visualization skills has been linked to success in engineering. Students

The user's viewpoint and controller are each tracked with six Degrees-Of-Freedom for embodied interaction.

who need extra practice to strengthen those skills will soon have the opportunity to have a more interactive and fun experience.

The next frontier is scaling up to bigger data and systems, and connecting visual environments to live running simulations for computational steering. Recent work in ARC is enabling remote, clustered visualization on HokieSpeed and BlueRidge so that users can visualize their data without moving it. Managing large data and maintaining interactive frame rates for analysis at the speed of thought is an ongoing research challenge.

ARC is always looking to reach out to students and to publicize the free resources and classes that they offer. Although freshmen students may not be capable of jumping right into HPC or virtual reality, certainly juniors and seniors from various science and engineering majors are suitably prepared. Marshall described HPC as having a "steep learning curve," but also found the learning process to be fun.

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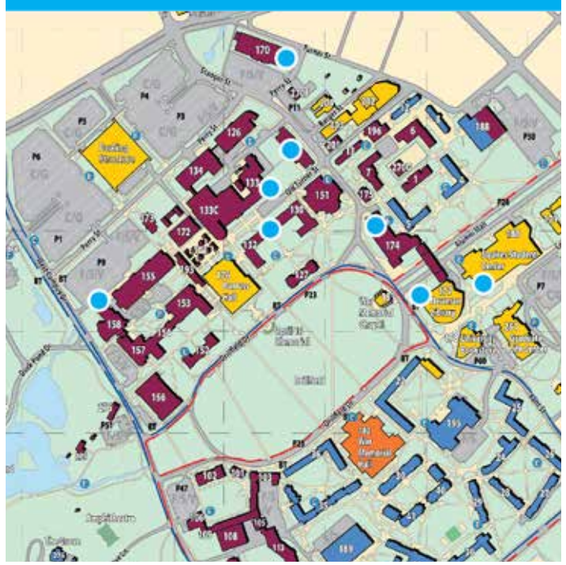

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