

A photograph of four young men standing in a workshop. They are positioned around a metal frame, likely for a vehicle or a piece of machinery. The man on the far left is wearing a grey polo shirt and blue jeans. The man in the center is wearing a red t-shirt and a grey baseball cap. The man to his right is wearing a dark blue polo shirt and glasses. The man on the far right is wearing a maroon t-shirt and grey shorts. They are all smiling and looking towards the camera. The background shows a workshop with various tools and equipment.

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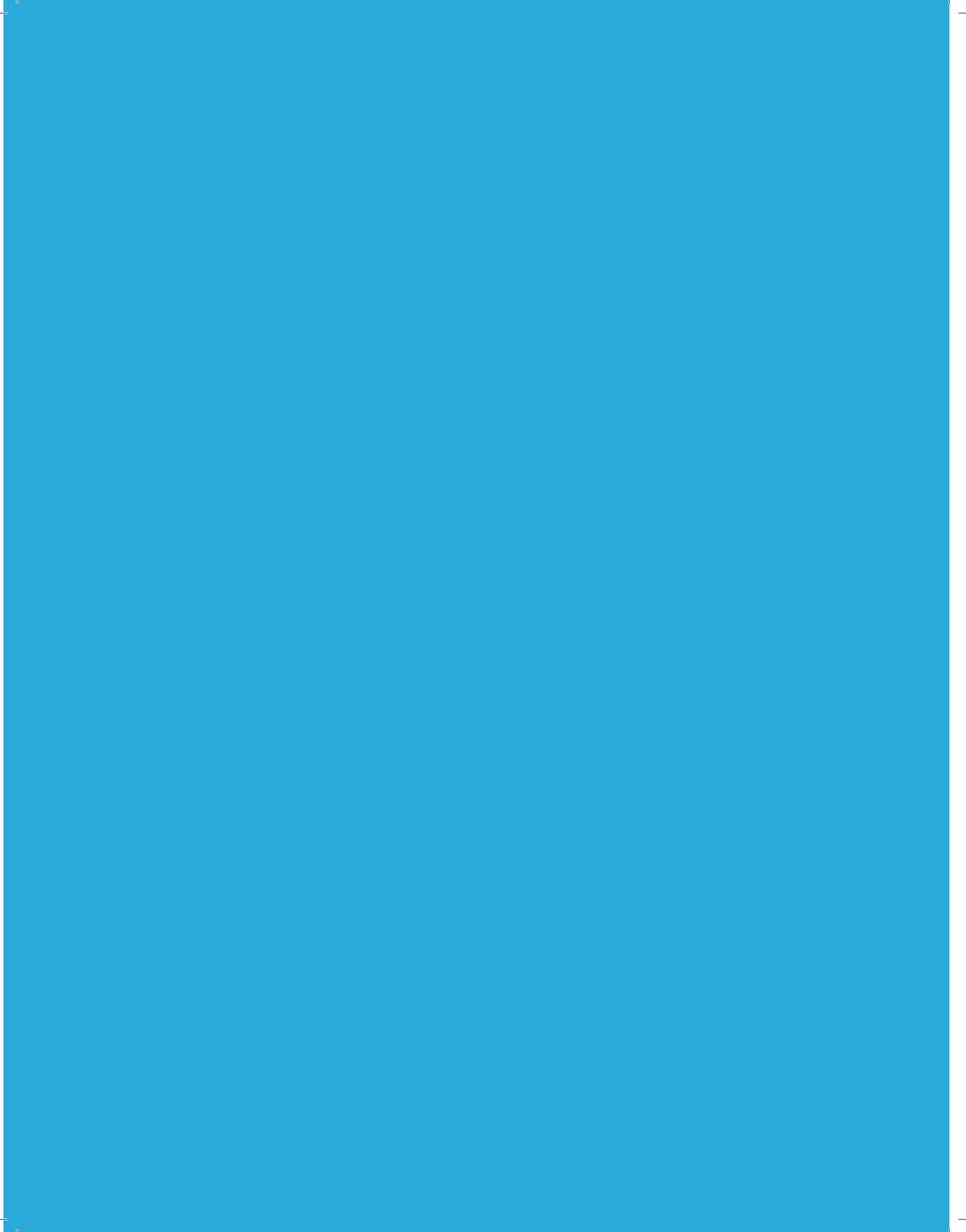
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Photo: Aaron Clark
Team leader Sangburm Lee (right) and a few of his teammates pose next to their new car for Baja SAE.

ENGINEERS' FORUM



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LETTER FROM THE EDITOR

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Welcome, readers! The *Engineers' Forum* staff is excited to fill you in on the latest and most intriguing engineering stories happening in our community. Our writers, photographers, and editors have produced another round of top quality work to wrap up the semester. Many of our key members are graduating, so we would like to wish them farewell and good luck on their individual journeys.

This edition comes at a special time for our organization; the staff at *Engineers' Forum* have successfully launched a new program to award excelling undergraduate engineering teams at Virginia Tech. In this first round of our initiative we awarded five separate teams with funds to bolster their chances for success in the future. This program also provided us with an inside scoop on the development of these teams' projects. We hope to continue this program in the future, which will enable us to both give back to the community that supports us and also provide our readers with insight on special groups of engineering students at our university.

The groups we awarded are highlighted in an extensive article at the end of this magazine, and we hope you enjoy their stories as much as we did. Three other teams have also been featured in this issue that are involved in various competitions as well as the Senior Design Expo this month. First off, Abby Slater returns with a highlight piece on a local team involved in the American Society of Civil Engineers Steel Bridge Project. They just succeeded in a recent competition last month and

will be heading to nationals this May. Following this article is a story on Virginia Tech's team for the 2017 agBOT challenge. C.A.M Gerlach returns for one last article before he graduates discussing this unique senior design team. Our new writer Hamud Hamud, a computer engineering major has written a story on 2LoudVT. This team is competing nationally to build the loudest car speakers against other teams and have successfully broken records in their category.

Our goal at *Engineers' Forum* is to demonstrate the depth and importance of engineering studies. We aim to show that outside of the tough work associated with studying engineering, there is a collection of stimulating stories about key frontiers developing in industry and how students are involved in this development. We hope you enjoy this issue and continue to read our work in the future. Past issues can be found online on our website at www.ef.org.vt.edu

Editor-in-Chief,



Zeyad Zeitoun

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The 2017 Virginia Tech Steel Bridge team poses with the finished product at their last competition. It took them just under 21 minutes to construct the entire bridge. Credit: Dr. Matthew Hebdon



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THE STEEL BRIDGE PROJECT: VIRGINIA TECH'S TEAM CRAFTS STEEL, GOES FOR GOLD

ARTICLE: ABBY SLATER

PHOTOS: JAMES SHACKLEFORD

Imagine the expertise and planning involved in constructing a bridge. Now, imagine the pressure involved in executing such a project in under 30 minutes: this is the challenge that lies ahead of the Virginia Tech chapter of the American Institute of Steel Construction/American Society of Civil Engineers (AISC/ASCE) Steel Bridge Project. The annual project is a regional competition involving 13 Mid-Atlantic schools. Teams plan and design their bridges for months in advance, meticulously building

each component in their respective labs. The individual parts of each bridge must be transported to the competition site and assembled quickly and under strict standards during the competition.

Each team must construct a steel bridge that meets the needs of a scenario created each year by the ASCE. The scenario determines the dimensional restrictions, the weight of the bridge,

Cody Furrow, Michael Kokal, Ryan Stevens, Cody Huffman, and Joseph Spaziani execute a “slide technique” to combine the bridge’s pieces. Slide-in bridge construction is a new method that can potentially improve efficiency. Credit: Dr. Matthew Hebdon



and the external obstacles, such as natural features and man-made structures around which the bridge must be built. This year’s bridge must support a 2,500-lb. weight, and measure in at 1/10th the size of a hypothetical 200 ft. bridge—so a 20-ft. model. Each year the bridge must cross some hypothetical obstacle; this year that obstacle will be a river. The bridge can’t be too high, too long, or too low as the judges will precisely measure every dimension. Even the individual pieces must strictly adhere to certain guidelines, and they cannot be larger than 3 ft. x 4 in. x 6 in.

Engineers on each team have 30 minutes to successfully assemble their bridge, with up to 15 minutes of additional time that would incur major penalties. Not only must the engineering, design, and timing be flawless, but team members may not drop a piece of the structure or pick up more than one piece at a time without penalty. The team with the fastest time, lightest bridge, fewest penalties, and lowest deflection (which is how much the bridge moves or slopes in response to the applied weight) receives the fewest points and wins the competition. I sat down with Virginia Tech’s team captains—Laura Wild, Cody Furrow, and Joseph Spaziani, all of whom are civil engineering students—and had them walk me through their process. They were hard at work preparing for their fast-approaching regional competition from March 30 through April 1, 2017. They thoroughly explained the process and goals of their team, which includes about 25 Virginia Tech students.

The first step in the development process is anticipating trouble. “Based on dimensions or the physical layout they give us, we have to identify what our challenges might be,” says co-captain

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Michael Kokal (left) and Cody Furrow (right) stack 25-pound weights during the vertical load test at the competition. Both needed to work in perfect unison to avoid any mistakes. Credit: Dr. Matthew Hebdon



Spaziani. To begin, the engineers start designing on paper what would eventually become a large and complex structure. Then, the team uses a structural analysis program—RISA 3D—to plot coordinates, plan dimensions, and “connect the dots” for several different hypothetical designs. The team specifies the exact dimensions for individual parts and plots so that when the steel is delivered they can start cutting and welding pieces right away. All welding and construction is completed in the machine shop at the Virginia Tech Ware Lab. The team was also able to practice construction in the basement of Christiansburg’s Fieldstone United Methodist Church thanks to the organizational efforts of Kara Lattimer, one of the team’s advisors out of the civil engineering department.

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In last year’s competition at George Washington University, Virginia Tech’s team came in a frustrating fourth place—only the top three teams move on to Nationals. With funding from Virginia Tech’s Ware Lab, as well as the American Institute of Steel Construction (AISC), Skanska, and STV Group Inc., this year’s team hoped to top last year’s performance.

When asked what aspects the team wanted to improve upon and execute differently this year, the captains were in resounding agreement: construction method, not design, had been their downfall. The plotting and number crunching leading up to the competition was nearly flawless, but when the time came to assemble the pieces, the team couldn’t execute the method they had practiced. This year, however, the team planned to learn from the mistakes of years past and dominate the competition. Spaziani summed up their strategy when he said, “You need to design something you can actually build.”

Come competition time, the VT engineering students did, in fact, design and build a wonderful bridge. The team came in Second Place, thus securing a place in Nationals. Before their turn on the day of the competition, the captains had the opportunity to meet with judges to ask any final questions and discuss weight placement. Their first step upon entering the strictly designated building area was to organize their tools and set out their pieces. After a simple “3, 2, 1, go!” from the judges, the team set to work. There were four dropped nuts, which added one minute to their final time, as well as four loose bolt penalties and a boundary infraction. Despite these minor violations, the team completed construction in 20 minutes, 28 seconds (25 minutes, 28 seconds

Team captains Laura Wild, Cody Furrow, and Joseph Spaziani pose with the team’s 2017 awards. They were victorious in several categories at the competition including first place in the timing category.



after penalties), which won them First Place in the timing category.

The captains are very pleased with the outcome, stating that everything they practiced came together perfectly during the competition. Of course, none of this would be possible without their faculty advisors and lab managers: Dr. Paolo Scardina, Dr. Matthew Hebdon, and Dewey Spangler to whom they expressed gratitude.

Nationals are next for this team, which will take place at Oregon State University on May 26 and 27, 2017 including 45 teams

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The team's bay in the Ware Lab displaying the bridge's frame and this year's awards. The team prepared each piece of their model in the multi-purpose Ware Lab.



from across the country. Teams have the option to completely redesign their bridges, but VT's engineers are happy with what they've built. They will only be making a few small changes to their design such as connection types and size of the spindling members.

These civil engineering students are ready to set off across the country to make their school proud. "We're going to Nationals and representing Virginia Tech against all the other schools, I think that's pretty exciting!" says co-captain Laura Wild. The team knows that Nationals will pose a greater challenge, but they hope to cross that bridge with ease.



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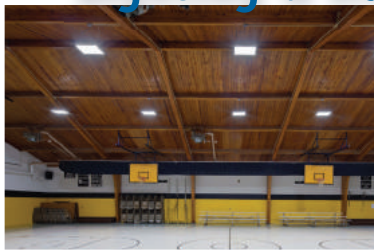
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VIRGINIA TECH'S "AGBOT" AIMS TO LEAD THE NEXT AGRICULTURAL REVOLUTION

ARTICLE: C.A.M. GERLACH

PHOTOS: AARON CLARK



The Yamaha 4x4 utility vehicle pulling the seeding trailer, modified for autonomous operation by the team. The Virginia Tech squad is counting on its power and durability to ensure their agBOT Challenge entry can successfully plant four full rows of corn.

The Yamaha 4x4 utility vehicle (L), modified to be autonomous by the Virginia Tech agBOT challenge team, stands attached to the seeding and fertilizing trailer that it pulls. Both components must work together, along with a fixed base station, to navigate and plant an agricultural field and succeed at the event.



In the engineering labs at Virginia Tech, a new agricultural revolution is brewing—one that may herald perhaps the biggest shift since the start of the ancient profession. As mechanical engineering senior Sena Hunde puts it, “The oldest job there’s been is agriculture, so it’s about time we change it up to make it more efficient and effective—and the best way to do that right now with the means we have is to use robotics.” While mechanization has greatly increased the ability of an individual farmer to feed more people, these advancements have barely kept up with the declining workforce willing and able to work in agriculture, and no widely available technology has managed to take human labor out of the equation entirely.

To achieve the necessary leap, Hunde and six fellow mechanical engineering students are building an autonomous vehicle that can “seed and feed” thousands of plants with robotic perfection at the click of a button, and without the many hours of work and intensive monitoring it would take a human to do the job. Along with serving as their senior design project, they are preparing their robot to compete in the 2017 agBOT Challenge, an industry-sponsored event featuring automatons from universities, corporations, and private groups in two different categories—Seeding and Weed & Feed.

The Virginia Tech team’s entry, competing in the former challenge, will be tested on its ability to plant crops and deliver fertilizer along four 300 m (1000 ft) rows of corn, reload itself, and stream real-time video from multiple cameras, all without any human intervention. Tech and the eight other contenders, including Purdue, Ohio State, Cal Poly, and several commercial companies, are all vying for the top three prizes to be awarded in June at the final event in Indiana.

“When we first started, none of us really knew what our strengths and weaknesses were, so we kind of worked on everything,” says Hunde. “But eventually, we divided the team in two.” Youssef Haridy, Fareez Chowdhury, and Hunde focused on the propulsion and navigation systems: modifying a stock Yamaha utility vehicle into an autonomous driving machine. Meanwhile, colleagues Alex Fuge, Alfred Fusco, Mohanned Alhakami, and Yue Shi worked on the mechanical design of the trailer, which included the robotic seeding, fertilizer, and resupply equipment. Their advisor, Dynamic Systems Modeling and Control Center director Dr. Alexander Leonessa, helped support both sides of the operation.

While last year’s effort did not end up placing in the inaugural event, the team planned a number of changes to help ensure a more successful performance. Hunde tells us, “We had a team last year who did the same project. They didn’t do too well because they didn’t consider their failures. Their system broke down because mechanically, it wasn’t very stable; it couldn’t turn.”

To avoid a repeat performance, Alhakami, in charge of finite element analysis, had the key job of “basically making sure everything we build is not going to break,” as he puts it. High-gauge steel, a heavy-duty towing vehicle, and carefully considering possible failure points nets the final product a safety factor of five—the trailer is rated for 450 kg (1000 lb), while only having to bear at most 100 kg (200 lb), leading to plenty of margin for the unexpected.

Another challenge was the variety of expertise necessary to complete the project, particularly since the entire team was made up of mechanical engineers. Hunde, whose work on the

Mechanical engineering students Mohannad Alhakami, Alfreed Fusco and Yue Shi adjust the mechanism responsible for raising and lowering the seeders on the trailer portion of their AgBot. The team hopes their improved design will enable excellent performance at the competition.



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navigation hardware and software for the vehicle required diverse electrical engineering and programming skills, relates that “it was a sharp learning curve, I would say, but that’s the beauty of being an engineer at Virginia Tech; you have a lot of support from people around you.”

Key support came from the team’s advisor; as Hundt continues, “Dr. Leonessa has been doing autonomous systems for many years now. He’s participated in almost anything you can see autonomous at Virginia Tech.” Their department also played a role in this as well—according to Hundt, “mechanical engineering is one of the majors where you have exposure to almost everything. So maybe we’re not experts in controlling motors, but we have the background...and we just have to add to that.”

While Yamaha, the Virginia Tech Student Engineers’ Council, and the university’s mechanical engineering department provided financial support for the project, money was still a major concern. However, the team aims to flip that into an advantage for the final product. “We don’t get everything we want: every motor, every computer, every controller. If that was the case, it wouldn’t even be a challenge,” says Hundt. “So we had to work with what we had, and what we can acquire based on the budget we were provided with. This is a start in the right direction to making this available to everybody.”

The team hopes to be able to do that at Virginia Tech’s Senior Design Expo on April 28th where they’ll exhibit their prototype to the public. By then, they aim to have a working final product, aside from the autonomous, GPS-based control system. However, the vehicle will still be able to be remote controlled

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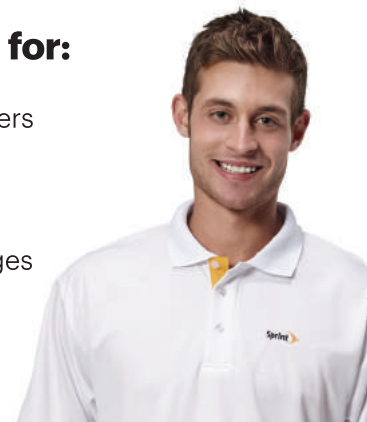
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Mechanical engineering senior Sena Hunde works on setting up the agBOT team's base station for use. This component is a crucial part of the autonomous agricultural system the team is building, providing centralized control, GPS correction, and multiple live video feeds from the vehicle in the field.



through a joystick, and from there, according to Hunde, "adding a GPS system to it is only a minor addition."

While Virginia Tech's team is still putting together the final pieces of the project, they have high hopes for their chances in the competition. According to Hunde, "Anybody can compete so it's an open competition, not just undergraduate students, so it's going to be people who have a lot more experience than us and schools that have a lot more funding available. But we're going to do really well since we've been working very hard, and our system is solid."

Even if the team doesn't take top honors, its members will still have gained much from the experience. As Alhakami relates, "We learned stuff we weren't taught in school; we had to teach ourselves a lot." And Hunde adds, "[It was] a lot of pressure, but having that pressure on you teaches you that if you go through the right steps, you'll make the right decision." Looking to the future, Hunde remarks, "I see this project going a ways, and maybe in a few years, this prototype will be an actual product that will be used by actual farmers. That's the goal."

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SHATTERING RECORDS AND WINDSHIELDS WITH 2LOUDVT: STUDENT CAR AUDIO CLUB

ARTICLE: [HAMUD HAMUD](#)

PHOTOS: [AARON CLARK](#)

Many of the student teams here at Virginia Tech maintain a long-standing legacy of evolving their hobbies through their academic work. That synergy also holds true for Virginia Tech's very own 2Loud Team led by Mark Soler, a fourth-year electrical engineering major. The three-member car audio club and design team have recently been making noise both literally and figuratively in national competitions. Champions of last year's National Sound Pressure League (NSPL) World Finals in the 24 to 48-inch no wall category, 2LoudVT succeeded in being the only collegiate team to win in any of the league's categories. The finals were hosted on September 10, 2016 here in Blacksburg. That same day, the team also took second place in the competitive Hardcore category, shattering records and windshields alike. In fact, windshields breaking due to the pitch levels are scenes you might very well come across in the competitive car audio world.

Team leader Soler's interest in cars and car speakers started as a personal hobby, which eventually materialized in his 1990 Honda Civic hatchback. Purchased for a mere \$250, it was his daily mode of transportation before he invested it full time towards his team's undergraduate design project, which also now includes a 2002 Mitsubishi Galant. The group began their endeavor by initially stripping Mark's vehicle to create room for a huge subwoofer enclosure while making it feasible to alter in the future. The other two current members of the 2LoudVT team are Ben Stern and Rory Kirkpatrick: both of which are also pursuing fields relevant to the undergraduate team's work. Ben is currently studying computer science and physics, while Rory is double majoring in electrical and computer engineering. The passion all three of these students share for car audio and loud speakers manifests itself in their outstanding achievements.

(Left) Mark Soler's 1990 Honda Civic Hatchback with its antique license plate. The interior was stripped to make room for the massive audio system in the rear of the car.

(Below) The two DC Audio subwoofers are planted right behind the front seats of the vehicle. The sound from these subwoofers can reach immense decibel levels without blowing out.



The car sound pressure community is very active, with teams and divisions all around the country competing with one another year-round to perfect their designs and produce the highest sound levels possible. During these competitions, contestants must play specific notes at set pitch levels and the peak decibel level is recorded regardless of how long that level is sustained. This allows for a uniform method of comparing decibel levels between teams. The records for peak decibel (dB) levels in these competitions are surpassed on a regular basis, and this is a tradition that Virginia Tech's 2Loud Team is no stranger to. Last September's NSPL World Finals found the group achieving a record 158 dB at peak level, winning them first place. That record would be beaten only half a year later by 2LoudVT after reaching a peak decibel of 159.6 dB in the locally hosted-event known as the "Blacksburg Beat Down." This event took place at the Chicken Hill lot on April 1st and featured teams from across the country. The event served to demonstrate not only the continual progress of the group since their creation, but also the team's unique mastery for manipulating car speakers and sound pressure.

The triumphant trio maintains an impressive cast of patrons that either fund or support the team in their project. This includes official support from Virginia Tech's Budgetary Board, as well as valuable sponsorships from a number of key hardware companies. Currently, 2LoudVT receives batteries from XS Power, a company that specializes in producing 12 to 16 Volt AGM and Lithium batteries and chargers. The students were also given amplifiers from car audio company Vital Power. Perhaps most importantly, dB Designs provided them with a unique subwoofer system that is one out of 20 sets ever made. However,

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The enclosure that 2LoudVT built can be seen here in the trunk of the Civic. Two batteries that power the system rest on each side of the box.

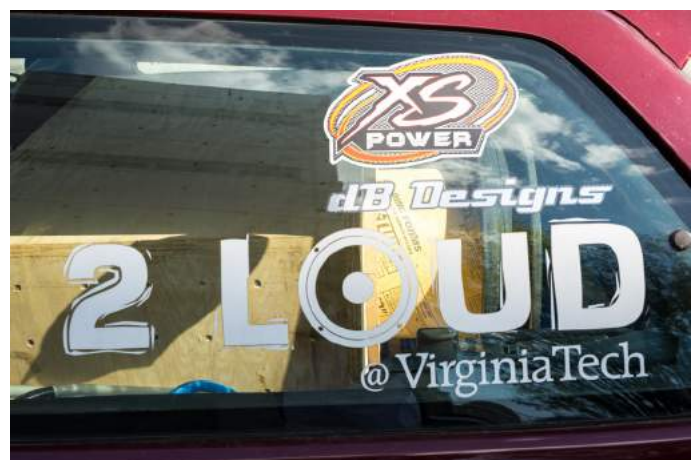


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the team's work doesn't end there: their setups usually include a complex assortment of receivers, audio enhancers or enclosures, horns, alternators, and quality speakers. When correctly assembled, these components allow the system to reach those consistently record breaking sound levels.

The team's faculty adviser, Dr. Steve Southward, is a Virginia Tech associate professor currently researching fields like signal processing, ground vehicle performance, and dynamic systems simulations. Like the students he mentors, his background, work, and expertise are all significantly relevant to the overall objectives of the team. 2LoudVT's current goal is to successfully achieve the loudest volumes capable from a dual-battery setup.

Car speakers were a hobby for Mark, Ben, and Rory, but now they serve as their undergraduate design project—which will become their senior design project. Mark sees a future in this industry and has already completed an internship making speaker enclosures. The 2Loud team runs an active Facebook page that is regularly updated. Their page includes information about ongoing projects as well as photos and videos of their events; check them out for interesting footage of blown out windshields, record-breaking events, and information on their upcoming competition in Fredricksburg at the end of this semester.



Two key sponsors of 2LoudVT are shown on the rear window. XS Power provided the batteries for the sound system, while dB Designs provided the subwoofers.

Mark Soler poses with the controller for his sound system. Mark made the crucial initial investments in altering his car to get this team started.



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VIRGINIA TECH ENGINEERING MAGAZINE LAUNCHES NEW STUDENT GRANT PROGRAM

ARTICLE: ZEYAD ZEITOUN

PHOTOS: AARON CLARK & JAMES SHACKLEFORD

The *Engineers' Forum* magazine was brought to life in 1981 by Niall Duffy, a Virginia Tech aerospace engineering graduate who received both bachelor's and master's degrees. Twenty years later, we began to realize our potential to give back to the community that gave us the foundation to succeed. We first established the Duffy scholarship in 2001, which awards the Editor-in-Chief of our magazine with a yearly scholarship. This investment continued to grow since then and in 2009 Kari Adkins, the former Editor of *Engineers' Forum* announced a \$100,000 gift to the Education Foundation that also pays back the staff of the magazine for their work. Above all, the continual partnership from our advertisers has allowed us to provide financial support to our student colleagues in engineering.

This year, we decided to branch out and extend our generosity to the types of groups that we often cover in our magazine. Our staff allocated a certain portion of our budget to give back to the student base that provided us with so many great stories along the way. As of March 2017, we have successfully launched a new initiative to award excellent engineering teams on campus with grants to help fill the financial gaps between them and their goals. *Engineers' Forum* magazine awarded five separate undergraduate engineering teams with grants this semester, and it was an honor for us to support the needs of our peers while gaining inside access to several groundbreaking stories around campus.

(Left) Frank Caserta poses with the nose piece of the redesigned Formula car. The use of carbon fiber for this and other pieces is a crucial aspect of the lightweight design.

(Below) The frame and motor for the electric car are pictured here. Extensive work goes into the setup and wiring of these components.



A SPECIAL REVISIT TO THE WARE LAB

Our magazine has covered the fantastic work that has come out of the Ware Lab on a yearly basis. Many of our past issues have highlighted several undergraduate teams out of the Ware Lab, which has been managed by Dewey Spangler since 2009. His support of expanding the capabilities of the Ware Lab enabled our students to put together cutting-edge projects to compete on a national and even international level. The November 2014 issue of *Engineers' Forum* features an in-depth review of this success story.



Pictured is the seat of one of the cars used in previous Formula SAE competitions. This and many other retired projects can be found in the lobby of the Ware Lab.

Three undergraduate teams who work out of the ware lab received awards from *Engineers' Forum* this year. The first of which that our readers may be familiar with is the **VT Motorsports** team that competes in the annual Formula SAE competition every May. Formula-style racecars are designed and built for this competition by about 120 schools from around the world. We got the chance to speak with team leader Frank Caserta who is responsible for the tuning of the engine's design. Formula serves as his mechanical engineering senior design project, which is a common trend in the teams we spoke to in this issue of *Engineers' Forum*. Caserta spends around 12 hours a day on this full-time project in between the Ware Lab and the engine dynamometer room in the basement of Randolph Hall. He only puts in a fraction of the total work that this project requires, however. This team has around 60 total members and volunteers, with 37 individuals responsible for specific parts of the final vehicle.

When all is said and done VT Motorsports hopes to improve on last year's performance; they dealt with some troubling performance issues at the competition. They hope to learn from their mistakes and return as strong competitors this May. Outside of the classic Formula SAE gas-powered car competition, VT Motorsports is also taking on the challenge of designing an electric car for Formula SAE Electric in Lincoln, Nebraska this June. Supporting this new endeavor requires substantial funds with an extensive list of donors including alumni as well as companies in the automotive industry; their design has also been bolstered by a recent donation of Carbon Fiber to make the car lighter and stronger. With our small boost as well as the continual support of other sponsors, we hope Formula SAE has got what it takes to have a strong go for first place.



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Right next to VT Motorsports' bay, another team participating in Society of Automotive Engineers (SAE) competitions can be located. **Baja at Virginia Tech** is a team we featured nearly 10 years ago in another issue of our magazine. They compete in the Baja SAE series to design an off-road vehicle following a strict set of guidelines set forth by the SAE. Sangburn Lee updated us on the status of their team; he was also joined by team lead Robert Pickens and sub-team leads Alex Williams and Austin Fleming who all posed for the cover photo of this issue. The 25 senior mechanical engineering undergraduates who make up the team are supported by 30 to 40 volunteers—all helping to make this project happen. In fact, being an official team member requires that this is their senior design project, with specific deadlines set in class including presentations and updates on the team's progress. They encourage recruitment of volunteers before senior year so they have the right experience and background for a successful transition into the main team.

Baja at VT last competed in June of last year at two separate competitions at Tennessee Tech and Rochester. They placed well in both competitions, but had some technical issues that they are working hard to adjust and hope to learn from. At these events, the days are divided into "static" and "dynamic" tests. The static tests include in-house presentations and introductions for each team to present their final products. Teams must outline the costs of their design as well as how the car was put together. The dynamic tests span over the second and third days of the competition and are the key part. Specifically chosen members of the team drive their car in these tests where teams fight to get the best lap time in multi-lap variable terrain courses. During our visit, they were gearing up for success at the Gorman, California competition starting April 27, 2017. Our funds are helping support an increase in around \$30,000 necessary for their budget to send so many key team members across the country this year.

(Left) Two vehicles used by VT Baja in past competitions can also be found in the Ware Lab lobby. The inspection certification stickers can still be seen pasted on the cars' frames.

(Below) One of the cars used in last year's competitions with the inspection sticker from the Tennessee Tech and Rochester events. These vehicles must pass a careful safety check before entering competition.



The frame, suspension, and cabin of the Baja car. The car's design includes important mechanical aspects from their previous designs, pictured in the Ware Lab lobby in the photo below.



An awardee that we hadn't heard of until the launch of our awards program also works in the Ware Lab and competes in the National Aeronautics and Space Administration's (NASA) Robotic Mining Competition. NASA has tasked universities nationwide with helping advance the capabilities of rovers digging the surface of Mars. **Virginia Tech Astrobotics**, Autonomous Regolith Extraction System (ARES) joined the program only a few years ago. Currently led by mechanical engineering senior Garrett Stair, VT Astrobotics placed ninth out of fifty teams in last year's competition. The team now consists of 32 members, 13 of which are seniors. VT Astrobotics is a particularly diverse team of undergraduate students, with representatives from seven different departments in the college of engineering.

After a recent friendly competition at Kent State University in Ohio this past February, the team uncovered further possibilities of autonomous operation in their rover. Their system uses a camera to detect a laser projected in front of the robot. The program they built enables this sensor to detect and avoid any obstacles to pick the fastest route between two points. The goal for the upcoming competition this year is to be able to autonomously mine 90kg of material in 10 minutes. NASA will host the competition at the Kennedy Space Center in Florida from May 22 to 26. Our financial support will help ARES purchase precision cut and bent materials for the final construction of their robot.

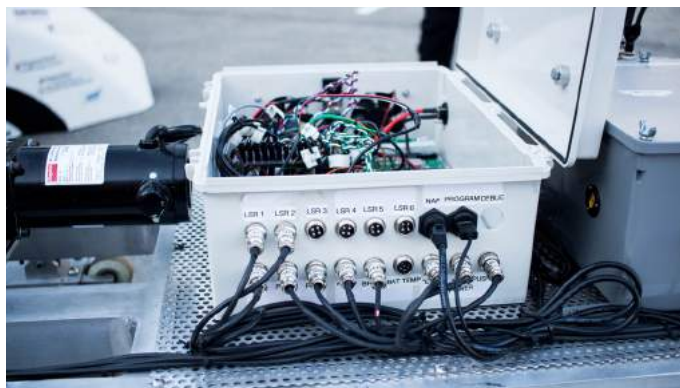


Hyperloop at Virginia Tech: A Reinvented Vhyper

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We first covered **Hyperloop at Virginia Tech** in the February 2016 issue of *Engineers' Forum* just over a year ago. I personally had an early look at a team that would grow to become one of the most important teams Virginia Tech has ever had. This group of ambitious engineers is competing to build the best pod for a newly proposed train that can travel at the speed of sound. Only 20 members were a part of the team behind Vhyper when *Engineers' Forum* first covered them. Despite their relatively small size, they still ranked in the top five out of around 100 teams that initially registered for the competition. Now, Hyperloop at Virginia Tech has quickly grown to 70 undergraduate members that are divided into seven sub-teams. They are divided by individual skill and passion into testing, aerodynamics, power, avionics, mechanics, structure, and business sub-teams.

The complex communications system can be seen in the center of the pod behind the seat. This system relays important information about the speed and position of the pod.



A close-up of Vhyper's suspension, with the removable skin resting on the floor in the background. The wheels are only used during the launching and stopping of the pod, as the pod uses a magnetic levitation system at higher speeds.

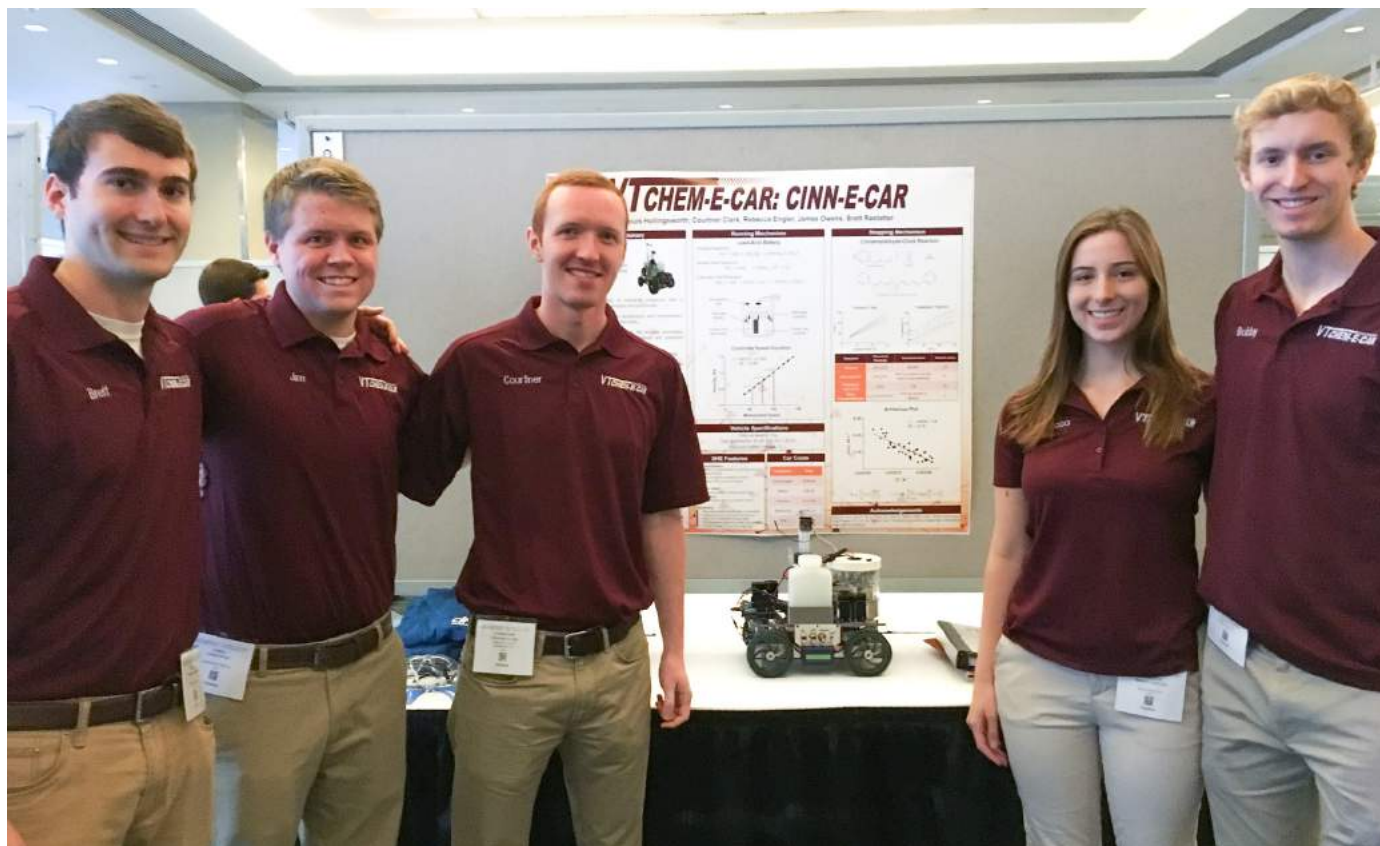


Over the past few years, many members have already found potential careers related to their work with Hyperloop. Daniel Kimminau, the former team lead who first gave us the opportunity to cover the team is currently an intern at SpaceX, the host of the competition. Nathan Robertson was also on the original team with Kimminau and is currently employed full-time as a Data Scientist at SpaceX. Clearly, the Hyperloop project has had an appreciable impact on the lives of the students involved. Once again, we found that many of the team members take on the project as their senior design obligation.

Team lead Andrey Gubanov filled us in on the success of Vhyper during initial testing, which he said has opened the door for many key sponsorships; a long list of sponsors can be seen spread across the pod's skin. Most notable is Orbital ATK, who has provided a unique propulsion tank valuing around \$250,000. Advised by mechanical engineering professors Dr. Robert Parker and Dr. David Goldsmith, the Hyperloop team has reinvented its design and set itself on a new course to success for when they revisit the one-mile test track in Hawthorne, California this August. They chose a new design for their skin because of two key features: the new skin has better aesthetics and is broken down into only two parts versus the seven components of the old skin (which was featured on the cover of our December issue). They will compete once again this summer against strong competition to try and reach the top speed with their redesigned pod.

(Left) The redesigned Vhyper displays a long list of key sponsorships. This new design comes less than a year after the initial reveal of the former sleek black pod last September.

(Below) Members of the VT Chem-E Car team pose with their final product. This photo was taken at the AIChE annual student conference in San Francisco. Credit: Virginia Tech Chem-E Car

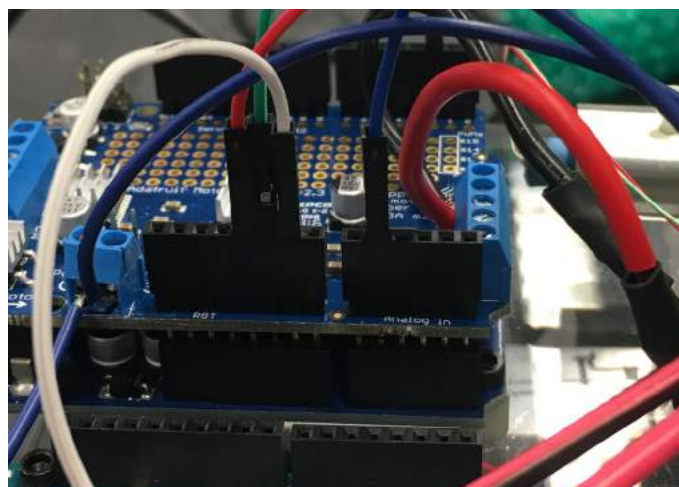


CHEM-E CAR AT VIRGINIA TECH RECEIVES BOOST

The fifth team to receive an award from *Engineers' Forum* is called **Virginia Tech Chem-E Car**. This group of seven chemical engineering undergraduates and one materials science and engineering undergraduate is aiming to expand its capabilities by building a second car using our financial support. They compete in regional and international competitions sponsored by the American Institute of Chemical Engineers (AIChE) to design and construct a car the size of a shoe box. The crux of this project is that the car must be powered by a chemical energy source. This requires that the students set up and program an injection system that can moderate how fast the chemical reaction occurs inside the car's battery. The car uses an environmentally friendly Zinc-Air battery that is controlled by the classic Iodine Clock reaction; this demonstration indicates when a reaction is complete when the initially clear liquid solution turns dark blue. They took their carefully constructed design to compete at Rowan University in New Jersey over the weekend of March 24 this semester.

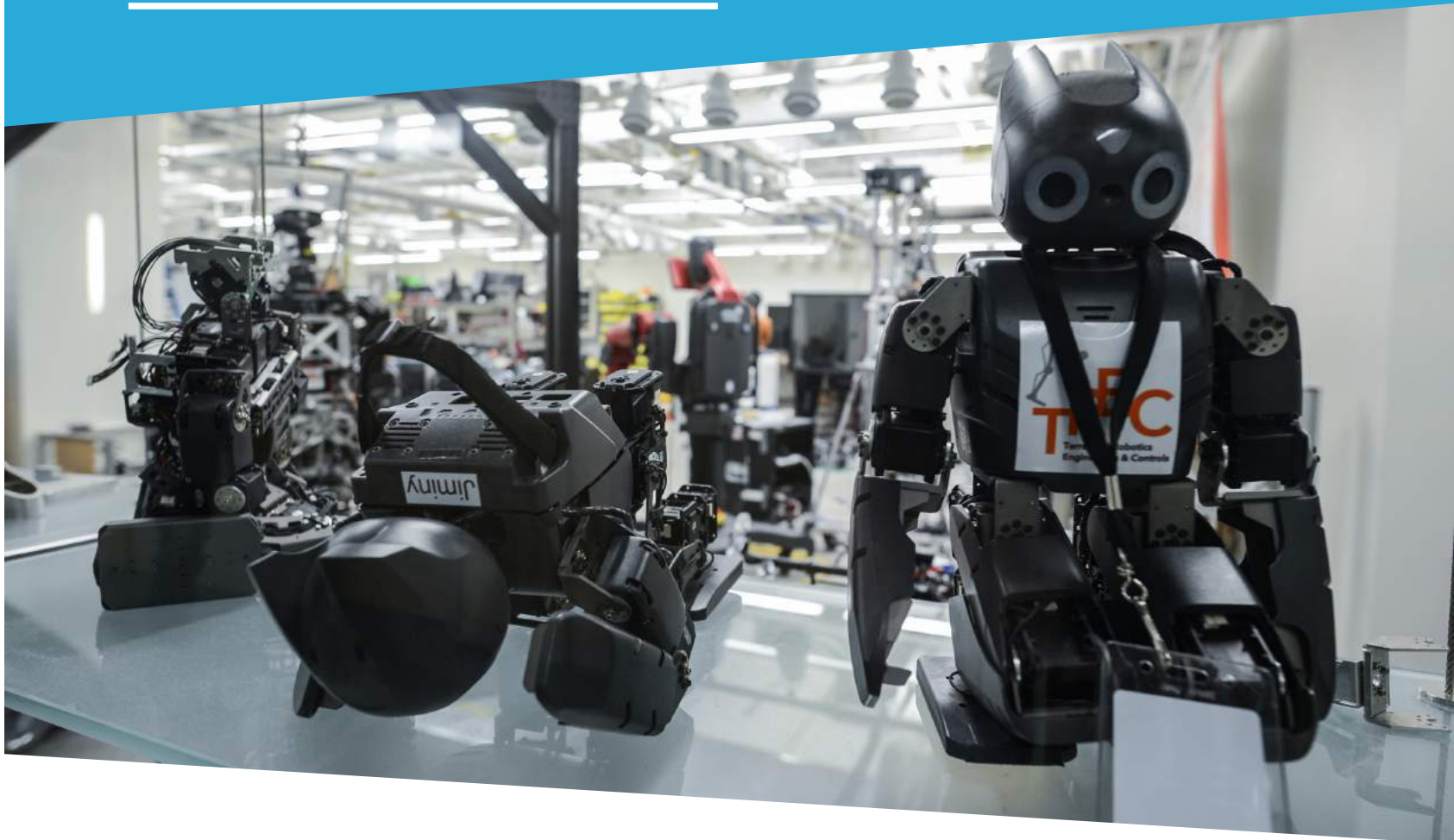
VT Chem-E Car placed 4th out of 22 teams at the Rowan competition, thus qualifying them for nationals in Minneapolis this fall. Jim Owens, a sophomore in chemical engineering and the Chemistry Lead filled us in on the details of his team, led by chemical engineering senior Bobby Hollingsworth. According to Owens, "Being a part of the car team has been a great way to apply my problem-solving skills outside the classroom... a lot of cross-disciplinary knowledge goes into each design iteration and we have to use the resources available to us to learn along

A close-up of the Arduino board and wiring used to monitor the chemical process powering the car. This provides key data on the progress of the reaction in the car's battery. Credit: Virginia Tech Chem-E Car



the way." This task closely parallels engineering problems that can be found in industry, which is providing these students with some insight as to what they can expect upon graduation. Furthermore, the Chem-E Car project has enabled this group of students to participate in professional and community outreach. They continually partake in showcases around campus held by the department of chemical engineering and are also working on publishing their own article in the *Chemical Engineering Education Journal*. We hope that our support along with assistance from the Virginia Tech Student Engineers' Council will help them obtain the materials and knowledge required to achieve grand success at the national competition this year.

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