Volume 37 | Number 1 | February 2016

ENGINEERS' FORUM

Lynn Nystrom


Photo / **Courtesy of Virginia Tech**

1952 - 2015

Words by 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 two 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 two terms as the editor I made mistakes, learned 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.

ON THE COVER

Photo / **C.A.M. Gerlach**

Dr. Leigh-Ann Krometis of the Biological Systems Engineering department sits atop the underground soil bunker where her experiment involving source tracking of E. coli takes place.

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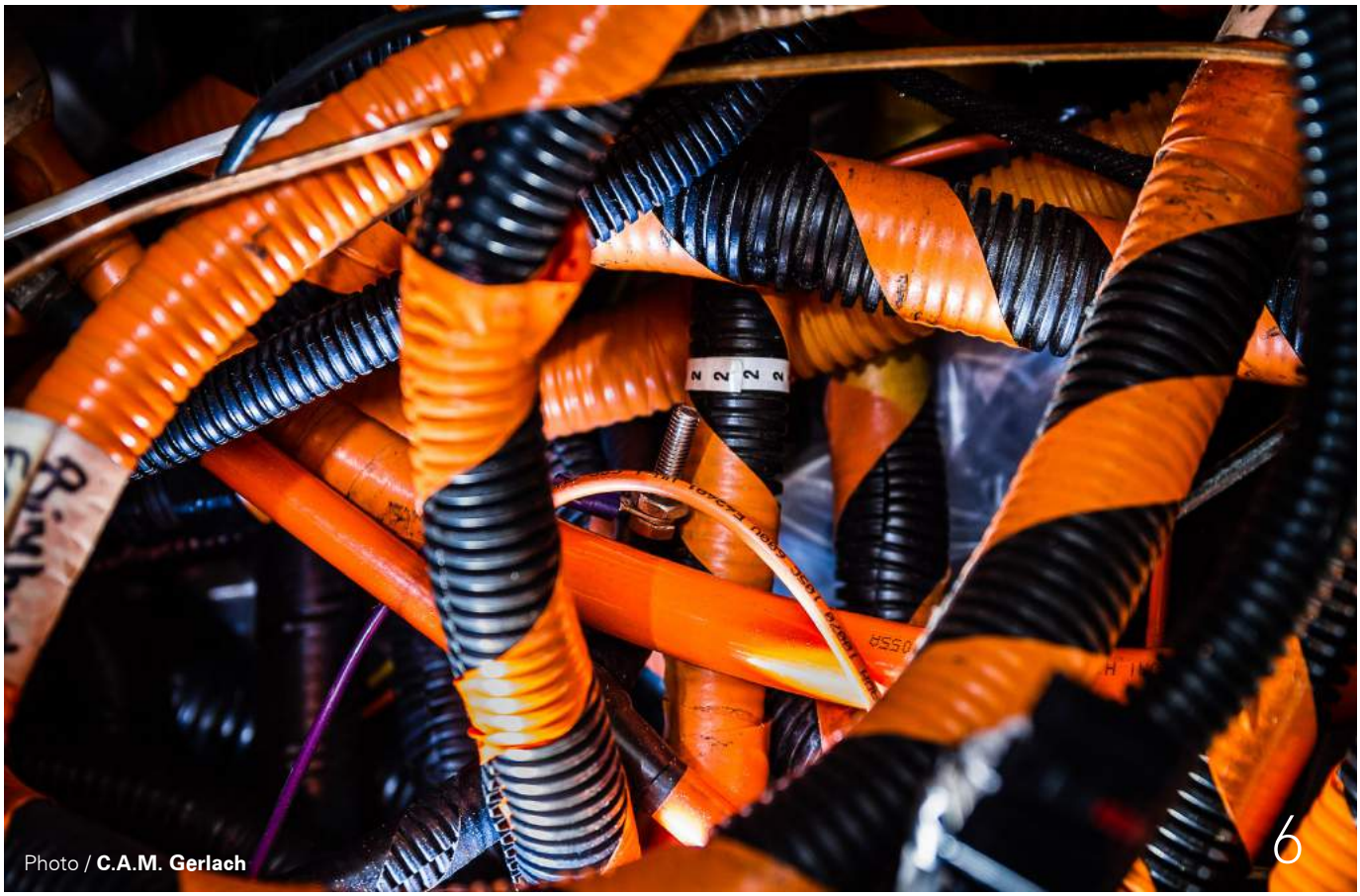

Photo / **C.A.M. Gerlach**

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Features

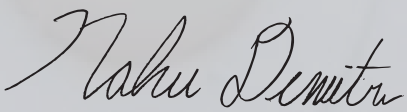
LETTER FROM THE EDITOR

Once again, we would like to thank you all for choosing the February 2016 of the Engineers' Forum. We have a lot of exciting new content that we are anxious for you all to see!

First of all, I would like to take the time to remember our dear advisor and friend, Lynn Nystrom. Lynn, a skilled and devoted Virginia Tech advisor for the Engineers' Forum since the magazine was founded in 1981, passed away December 3, 2015, after a battle with cancer. Not only was Lynn an amazing director of news and external relations for the Virginia Tech College of Engineering, she was a priceless mentor for us here at the Engineers' Forum. Without her advice and direction, the magazine would not be the successful student media resource that it is today. We miss our beloved Lynn and will forever be grateful for her devotion and guidance.

Like usual, your fellow Hokies are hard at work, researching groundbreaking studies, designing new technologies, and competing in various competitions. Want to learn more about Virginia Tech's driverless car? Check out Arianna Krinos' article about the Virginia Tech Transportation Institute (VTTI) and its incredible new design. If you're interested in engineering competitions, check out C.A.M. Gerlach's article about the Ware Lab's Hybrid Electric Vehicle Team and its performance this year in Arizona. Cody Earles has given us a detailed article about outreach at the Ware Lab, Kristine Mapili has covered the mysterious source of E. coli contamination in rural communities, and our very own Zeyad Zeitoun can give you an in-depth look at the Hyperloop, a new form of technology that is making waves in the field of transportation.

Haven't have enough? Check out our blog at http://www.ef.org.vt.edu to read up-to-date stories about engineering at Virginia Tech. Don't forget to follow us on Facebook and Twitter for continuous updates about the Engineers' Forum! We thank you for reading and are excited to give you a new issue in April 2016!



Editor-in-Chief,
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ARIANNA KRINOS JUNIOR, GENERAL ENGINEERING

The members of the VTTI Driverless Car team pose in front of their vehicle.

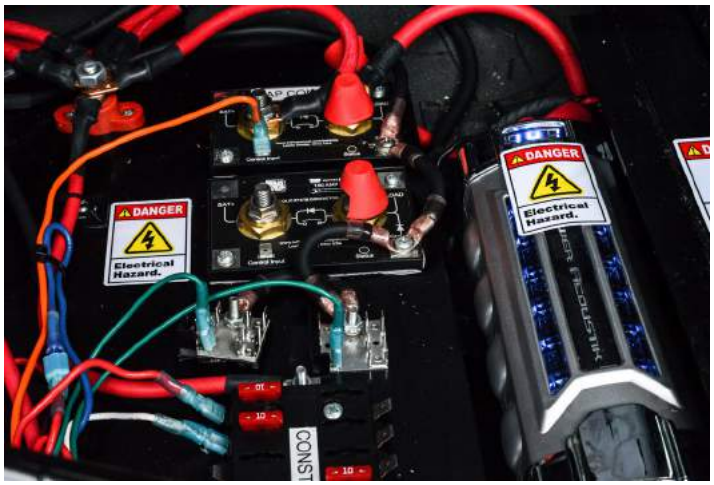
VTTI: INVENTING THE FUTURE
WITH DRIVERLESS CARS

Article Arianna Krinos **Photos** Aaron Clark

When I arrived at the Virginia Tech Transportation Institute (VTTI), the size of the establishment was what stood out the most. What had started as a small operation focused on transportation research has become a staggering set of buildings off of the busy intersection of Main Street and I-81. Andy Petersen, Director of the Center for Technology Development, handled the correspondence and arranged a meeting of the members of the driverless car team for Engineers' Forum. He took us to a conference room amidst a slew of cubicles filled with VTTI's expanding coalition of employees. Greg Brown, Carl Cospel, and Jared Bryson, three of the senior members of the driverless car team, were waiting for us in the room.

Carl Cospel, a 2003 graduate of Virginia Tech's computer engineering program and a 2011 recipient of a Virginia Tech M.B.A., described that his role is to control the electrical and computational aspects of the design. He must negotiate the challenge of implementing a high-level computer on a small circuit board, as the driverless car that they have designed is extremely compact, as well as to determine methods of retrieving and coordinating computer output. Cospel described an example of his work as learning "how to take input from one of the sensors and produce output," a process which Bryson, also a graduate of Virginia Tech's Mechanical Engineering program, labeled "sensor fusion." Bryson, conversely, is the Mechanical Systems Group Leader, through which he handles the more visible aspects of the car's controls, such as the actuator in the car's steering mechanism. Bryson and Cospel confided that their two areas of expertise can clash at times, and so it is the job of Greg Brown, Program Administrator, to ensure that each side of the project work well together in order to create a meaningful product. Brown also presides over the logistics arena of the production, such as acquiring hardware, scheduling work flow, and promoting the team's image.

The team members stressed that before the car was unveiled VTTI's role is very different from that of commercial manufacturers. While the designers of Google car and Tesla desire to build a consumer-oriented car, VTTI's aim is instead to serve as a research entity for the existing companies to improve their understanding of their products. Cospel



Left / A different example of VTTI-driven technology: equipped helmets to advance the practice of driving a motorcycle. **Above** / A close-up shot of the electrical wiring that powers the driverless vehicle.

remarked that their current "foc[i] [are] the human factors…[the members of] this generation…how they are going to be affected by the driverless car and the stigma [around it]." At the time of the interview, a recent news article had recounted the tale of a Californian Google car being pulled over for driving too slowly, and Cospel remarked that once he had heard a state trooper ask, "Who do I give the ticket to?" when another driverless car found itself in a similar situation. VTTI collaborators are making an effort to understand the social and economic impacts of automating cars, and one of the ways to mitigate this shock is through gradual transition. Conversion to a true driverless car is broken into levels: level 2 (L2) should be on the market fairly quickly, according to the VTTI team, and this is the "hands-off" level of driverless technology. L3 and L4 refer to "attention-off" modules—partial and full driverless driving, respectively. By 2020, all cars are predicted to be manufactured with L2 technology, and with the median age of a car on the road being eight years, changes will be fairly immediate, although it was pointed out that there are "always going to be outliers—[i.e]…that guy who is going to hold onto…[his] late 70s Fiat." The newest rounds of Smart Road testing—trial runs on the remotely-controlled driving range—focus on "vehicle-to-X" technology, which refers to the ability of the car to retrieve information from and communicate with not only other vehicles, but with inanimate objects such as road signs, and perhaps even with people. According to Cospel, "Times are changing…[it's a] dramatic technology…[and] we've got to know how it will affect the public." Currently, "vehicle-to-X" capabilities are limited by the Virginia Transportation Commission to "vehicle safety applications," which excludes enabling of Wi-Fi, cellular, and the like. Such safety applications include the ability of surrounding vehicles to sense deceleration of a neighboring car, at which point the car can recalibrate itself to best avoid an accident, as well as logging of vehicle data so that the Virginia Department of Transportation can detect potholes and other potential traffic hazards.

By the time we were able to view the actual vehicle, we were introduced to a crew of additional VTTI employees. Some, like Matthew Moeller, "touched about everything on the car," while others, such as William Johnson and David Taylor, were more specifically assigned to a task like routing and installation. The team prided themselves on the demure, streamlined design of the car: on the road, it would be difficult to tell that the car was abnormal, despite its trunkful of electrical components and

completely overhauled steering mechanism. A warning light illuminates when the SUV switches into automated mode, and the license plate - a copy - has a forward-facing radar. There are two cameras on the windshield for testing, and one cord is visible on the brake—otherwise, the team reported that the car appears like a stock vehicle. To develop the design, Cospel described that his recommendation was to, "build an RC car first and work [their] way up from there," and when Cospel took his first ride in the vehicle, he reported that driving without driving was easy to get used to and trust, but "for [him], that's kind of scary because, you know, I designed that."

Team members are held responsible for a typical 40-hour work week, but sometimes contributions far exceed this: most referenced dedication as deep as spending the night in the car. According to Bryson, among the most rewarding aspects of the project is the development of "technology that the rest of the world doesn't understand [and] translat[ing] it to the public, [as well as ensuring] companies like Google don't characterize the technology." VTTI aims to ease us into the future, rather than barreling right in.

The compact design of VTTI's driverless car allows for a range of complex components to be secured in a minimally intrusive manner.

C.A.M. GERLACH JUNIOR, METEOROLOGY & GEOGRAPHY

BEST OF BOTH WORLDS

HEVT AIMS TO MERGE POWER AND EFFICIENCY

Article / **Photos** C.A.M. Gerlach

The Ware Lab's Hybrid Electric Vehicle Team, or HEVT, has an impressive history to live up to, having consistently taking top spots in a long series of intensive competitions since its formation over twenty years ago. Last year, the team took second place overall in the first phase of EcoCAR 3, a four-year challenge sponsored by GM and the US Department of Energy, and the Virginia Tech squad hopes to build on this success to deliver a top-notch entry for this year's event. The overall goal of the project is to re-engineer a stock 2016 Chevy Camaro into a hybrid, emphasizing the reduction of petroleum use and emissions while maintaining or enhancing performance, safety, and consumer acceptance.

Above / HEVT team members Quinn Roels (L, mechanical subteam), William Dvorkin (HEVT project manager), and Matt Moniot (mechanical subteam) stand by one of their cars from past years' competition. The team is looking forard to surpassing their previous benchmarks as they build and test their new vehicle.

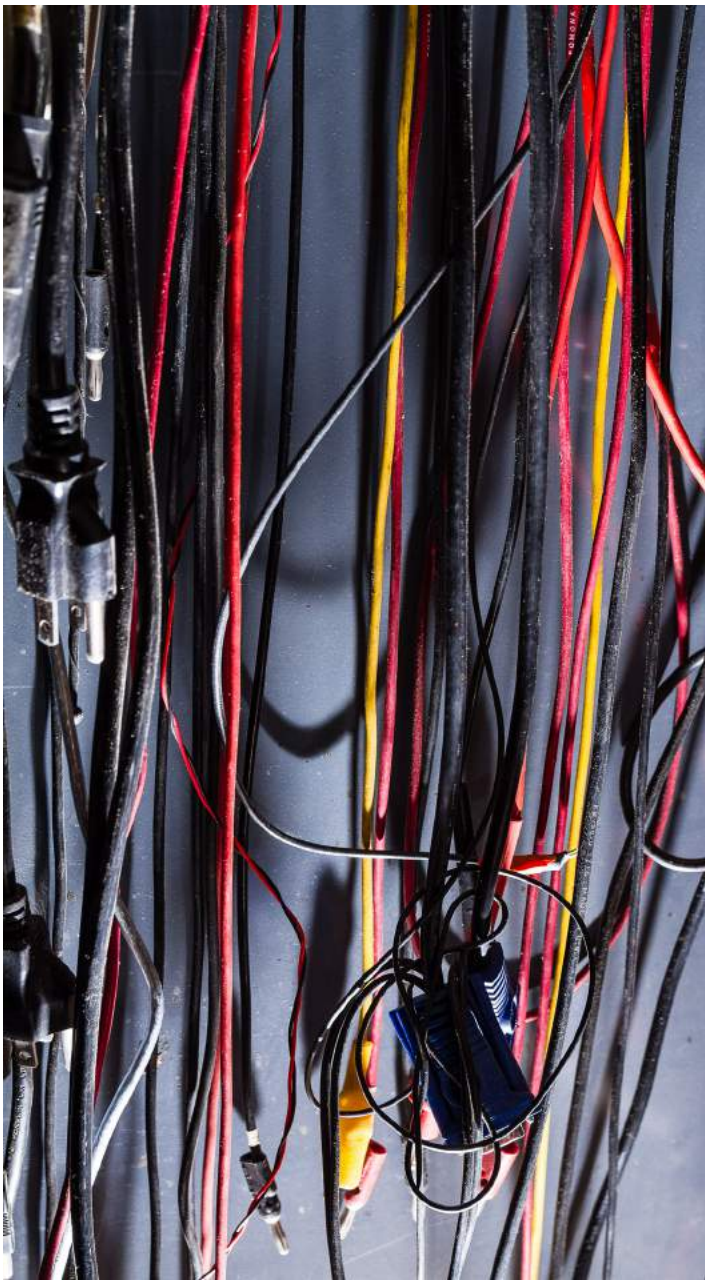
Above / Chris Flake (controls subteam) and Connor Dolan (fuel system) work on a fuel pump for their vehicle. As a hybrid, HEVT's end product needs to run well on both electricity and gasoline. **Right /** The engine block of a totalled GM pickup, ready for the HEVT team to extract it for use in their own vehicle. The increased power and efficiency of this new powerplant will help their car achieve much higher performance than previous years efforts.

At this year's competition in Arizona, entrants will be expected to produce a working vehicle that can run in at least some of the required hybrid modes of operation. As Controls Team Leader Eduardo Marquez explained, "we're not going to be testing who has the fastest car just yet," adding that, "the focus for this year is having all the components integrated in the car, with at least one or two hybrid modes operational." While they are taking the process step by step, the team looks to several key innovations to help make their vehicle a success.

Key among them is a post-transmission motor, meaning an electric propulsion system connected between the car's gearbox and its wheels, which offers a number of advantages over a more convention layout. First, this allows the hybrid vehicle to be operated in electric mode only with the engine completely off, which Marquez expects will offer a respectable 34 miles of range without using a drop of fuel. It can also be used to help the engine operate more efficiently by increasing its torque load, or augment the engine's power while using active fuel management.

Other key innovations being pursued by this year's crew include a large, high voltage battery pack that fits neatly within the vehicle's trunk, and the replacement of the original 6-cylender engine with a more powerful V8. While more gas-hungry when operating at full power, the planned engine will be able to operate in active fuel management mode, which allows it to shut down half of its cylinders when not needed. This allows it to maintain the fuel efficiency of a smaller when operating at less than maximum load, while offering better power and performance under more demanding conditions. According to Marquez, this decision was made particularly to satisfy the target market in the New River Valley area, satisfying the needs of auto performance enthusiasts while burning much less fuel.

In all, the team hopes to match its previous success in competition, along with exploring the intricacies of car design and engineering, and developing new and innovative technologies for cleaner and less expensive automobiles. Regardless of the outcome, the HEVT team was enthusiastic about the process. When asked if they were looking forward to it, Marquez's response was immediate: "Absolutly!"



Top Left / A wide variety of wrenches and tools are arranged for easy access in HEVT's bay. The team must be prepared to assemble numerous diverse components to put together a working hybrid car. **Above** / HEVT engineers Andres Coello (left, controls subteam) and Peter Bedrosian (mechanical subteam) collaborate on designing a part for their vehicle. HEVT is in the second year of four in the competition, where they must transform their virtual components into a working vehicle. **Bottom Left /** Test leads and assorted wiring hang on the walls of the HEVT team's bay. A working hybrid car requires a huge arry of componets, as well as extensive testing to ensure it functions well on the road.

CODY EARLES JUNIOR, METEOROLOGY & GEOGRAPHY

Photo **C.A.M Gerlach**


Photo **Dewey Spangler**

Left / Virginia Tech's Joseph F. Ware Jr. Advanced Engineering Lab, on the corner of Old Turner and Stanger streets. The facility not only serves as the primary venue for undergraduates to gain hands-on engineering experience on real world projects, but also helps inspire the next generation through its outreach efforts. **Above /** Students from Fort Lewis Elementary School visit the VT-Baja team at the Ware Lab during a recent tour of the facility. The enthusiasm the kids carried back with them translated into increased interest in their STEM-related classes, according to Dewey Spangler.

OUTREACH AT THE WARELAB

Article Cody Earles

Many people in the Virginia Tech community are aware of the Joseph F. Ware Engineering Laboratory, or Ware Lab. At the Ware Lab, there are a multitude of captivating projects such as an electric motorcycle and a human-powered submarine. But many probably do not know about the extensive ongoing outreach done by the Ware Lab. Everyone, from Virginia Tech students to local grade-school kids to the general New River Valley public, is invited to come learn about the Ware Lab's projects and engineering in general! When asked about the outreach program, Ware Lab manager Dewey Spangler says that he "always likes to start with the history of the Ware Lab."

The small building on Stranger Street, now known as the home of the Ware Lab, had humble beginnings. It was originally a laundromat for the Corps of Cadets, which was partially closed in the mid 1990's. The closed space then sat unused until it was acquired by the department of Mechanical Engineering and was transformed into a continuation of the Car Factory (a laboratory based where the FRITH Lab is now located in the basement of Randolph Hall). From there it was converted into the Ware Lab - with generous funding and vision of a man, and his wife, after whom the Ware Lab is now named. The sole mission of this new space was to accommodate undergraduate projects. As Spangler says, "one of the things that has grown out of the Ware Lab, beyond its original intent, was the outreach program."

The Ware Lab is currently having these outreach tours, and there were over 1300 visitors for these tours alone in 2014. Even more outreach was done through events like info sessions, career days, and workshops. Total overall participants in 2014 was a very impressive 5500 plus people interacting with the Ware Lab. The total number of outreach participants for 2015 has not been finalized as of time of this article, but is approximated to be 3000 total. September of 2015 was a notable month for the outreach program, having a total of 1400 visitors.

The photo shown above is a young boy from Fort Lewis Elementary School who is very happy to try on the Baja Teams' helmet during a recent tour of the facility. His excitement was shared by all his classmates. That is the case for virtually all K-12 visitors. Dewey was happy to mention, "I get comments from teachers, and they'll come back and say my math class was much more energetic that week because of that trip to the Ware Lab." It is a fact that the outreach program

Above / Joe Wheeler, a professor at Virginia Tech's School of Architecture, speaks with a group of second graders during a recent tour of the Ware Lab facility. The students visited as part of the Lab's outreach program, which is aimed at helping inspire the next generation of scientists and engineers.

dramatically increases the interest in STEM education - at least for K-12 students. This outreach to increase awareness for the Ware Lab was originally a side project, but has significantly grown as the Ware Lab has progressed. As more and more people learn about the Ware Lab, more and more people want to be involved.

The Ware Lab has developed to such a degree that the 10,000 square foot building is now a hindrance. One project - VT Rally - has already had to leave the Ware Lab due to the limited space, along with other factors. Other current projects are unable to acquire things such as much needed equipment, also because of the space issues. In response to the increasing need for expansion, Dewey Spangler has created an approximately one million dollar proposal to renovate the upper level of the Ware Lab building, which is currently housing offices and a tailor shop. "This plan would effectively double our floor space, from 10,000 square feet to 20,000 square feet," as Spangler says.

What was originally a laundromat has transformed quite a bit; beginning with the busy feet of Cadets trying to wash their uniforms to being the home of the creative minds of innovators. The Ware Lab is now a place where engineering projects are born and built, and a place where interests are sparked for the STEM fields used to make those projects. And it all happens together under one roof.

Above / Joe Wheeler, a professor at Virginia Tech's School of Architecture, speaks with a group of second graders during a recent tour of the Ware Lab facility. The students visited as part of the Lab's outreach program, which is aimed at helping inspire the next generation of scientists and engineers.

KRISTINE MAPILI SENIOR, CIVIL ENGINEERING

The underground soil bunker where the experiment is being conducted is located in Kentland Farm, approximately nine miles away from Virginia Tech's main campus.

FINDING THE SOURCE

E. COLI CONTAMINATION IN RURAL COMMUNITIES

Article Kristine Mapili **Photos** C.A.M. Gerlach

When a toilet is flushed, the waste water is treated and then discharged into a receiving body of water. In urban communities, the wastewater goes through a sewer system that treats the wastewater of an entire community. In rural areas where houses are too far apart for sewer systems to be an economical option, each household has its own septic system that treats the water before it is discharged into a receiving body of water. A septic tank is a large tank that collects wastewater from the household from one end and discharges cleaner water out the other end. Within the tank, solids are removed by settling via gravity. As more waste water comes in, more clean water is discharged through the other end into a drain field for biological treatment by the soil. The owner of the home is responsible for maintaining their septic tank in order to maximize effectiveness of cleaning the water. A common issue is that some people are not always the best stewards of their septic tanks, and may forget they are even there. As a result, septic tanks can become less effective in cleaning wastewater, leaving contaminants that may impact a community. If contaminants are present after going through a septic tank, it can be from a result of several factors including poor soil, the plugging up of the tank, or an inflow rate that is too high.

Dr. Leigh-Ann Krometis of the Biological Systems Engineering Department at Virginia Tech has a current experiment running in an underground soil bunker in Kentland Farm. She, along with some graduate students, aim to determine whether new "source tracking" markers can be used to confirm the source and spread of E. coli contamination in rural groundwater. In the underground soil bunker, there are model drain fields set up in

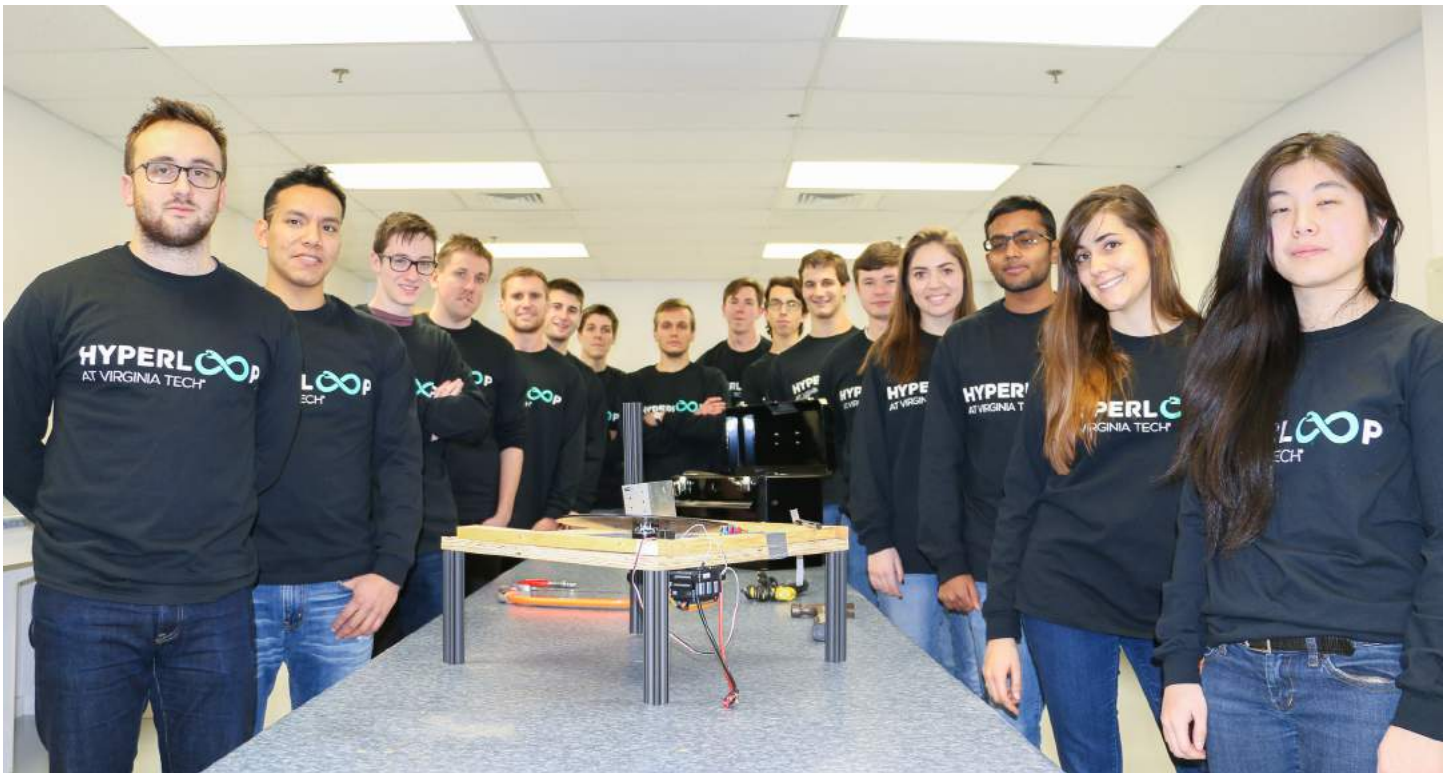
"Mini septic fields" are set up inside the soil bunker in which water enters through the top and discharges out the bottom. It takes the water two to three days to completely flow through, depending on the characteristics of the soil inside. The discharged water is tested for E. coli using source tracking.

Dr. Leigh-Ann Krometis of the Biological Systems Engineering department sits atop the underground soil bunker where her experiment involving source tracking of E. coli takes place.

which waste water, sourced from the Toms Creek wastewater station, trickles through the tank over a period of 2-3 days, depending on the hydraulic conductivity (i.e. the ease at which water can flow through pore spaces and cracks of a material) of the soils inside the tanks. The water that is discharged after going through the septic tanks will be tested for E. coli and source tracking molecular and chemical markers. While E. coli can be found in the gut and in the feces of everything that is warm-blooded, source tracking is used to figure out where the E. coli is coming from. HF183, a molecular marker, is a gene sequence in Bacteriodes that live, specifically, in the human gut. If this is found in the water, this is an indication that the E. coli is coming from human feces, and that septic tanks, rather than other sources of contamination like animal agriculture, may be a contamination issue. The team is also looking for optical brighteners, which are chemicals that fluoresce under blue light. Laundry detergents and toilet paper contain optical brighteners, and if these are found in the water, it indicates that a human waste stream may be contributing to the contamination of water.

While septic tanks are effective and affordable for rural communities as a method for waste water treatment, they only work if they are properly installed and maintained. And although there are cases where septic tanks are not effective in water treatment due to lack of maintenance, it is very helpful to know where the contaminants come from in the first place, since this can help alleviate the problem at the source.

ZEYAD ZEITOUN JUNIOR, CHEMICAL ENGINEERING



The Hyperloop at Virginia Tech design team stands proudly over a model of their magnetic levitation system prior to Design Weekend. The uniqueness of their system helped guide the team to victory at the competition.

GETTING HYPER
FOR SUPERSONIC TRAVEL

VHYPER

Article Zeyad Zeitoun **Photos** Sara Ko

Society has a perpetual desire for technological advancement, and here at Virginia Tech that desire is well fed. Revered for its diverse research and design programs, our institution delves into countless areas of research and invention in order to give students a chance to strengthen their teamwork skills while also shining light on contemporary ranges of knowledge. The university witnessed the creation of one of its newest design teams in August 2015, when a group of over a dozen undergraduate and graduate students gathered to tackle a very unique task. The team is taking part in a competition to design the travel pod for a new train-like form of commercial transportation called the Hyperloop.

Railways are quite common in the United States as a long-distance travel option. Though not the fastest choice when compared to plane travel, it still accommodates those with aviophobia, the fear of flying. National railways connect the country from coast to coast, granting citizens freedom to travel commercially on the ground. Despite our nation's constant necessity to build the most efficient and leading hardware, Japan still currently holds the crown for the fastest passenger train in service. Named the Maglev, it is able to hit a top speed of around 370mph. This is incredibly fast considering the fact that most commercial airliners cruise at just around 550mph. Nonetheless, the modern day culture of technological improvement demands higher speeds from our engineers. Elon Musk, the engineer and entrepreneur responsible for PayPal, Tesla Motors, and SpaceX, has an idea to quench this thirst for speed and bring the belt back to America. In 2013, Musk released a white paper design proposition claiming that the world would witness the creation of a "fifth form of transportation," which he coined Hyperloop. Contrary to modern methods, the Hyperloop does not use rails. Instead, it will employ a magnetic levitation system to lift the pod, which will travel inside of a vacuum-sealed tube. This conjunction will enable the vehicle to travel at a top speed of about 760mph, just under the speed of sound (767mph). Such a feat would slash travel times and fundamentally shift our view of commercial transportation. If successful, the Hyperloop would allow users to travel between Los Angeles and San Francisco, a 380-mile journey, in only 35 minutes. In local terms, this corresponds to a 25 minute journey from Washington D.C. to Blacksburg! Although this system would not be compatible for the regional Appalachian terrain, this shocking capability wields great importance.

Photo / **Courtesy of Virginia Tech Hyper Loop**

Top Left / A few team members prepare a poster-board for their presentation booth during Design Weekend at Texas A&M University, College Station. Their professionalism led them to winning the Pod Technical Excellence Award. **Top Right /** Allison Quinn, right, and another member of the team tweak the device used to test the Vhyper's propulsion system. This system is essential to launching the pod down the track with low energy requirements. **Bottom Right /** Featured here is a computerized rendering of the "Vhyper (Viper)" developed for the group's final presentation. The curvature was perfected in order to maximize the aerodynamics of the pod.

The development team at SpaceX - who will be a major part of the formulation of this project - has decided to engage the novelty of aspiring university students with the task of devising a model for the Hyperloop travel pod, and that's where the Hyperloop at Virginia Tech design team comes into play. They are lead by Daniel Kimminau, a qualified, aspiring engineer seasoned with experience. Diversity comes to mind when looking at the roster for this group with students representing many departments under the Engineering umbrella. Because designing a model such as this is no easy task, a variety in know-how is crucial to the progression of their project.

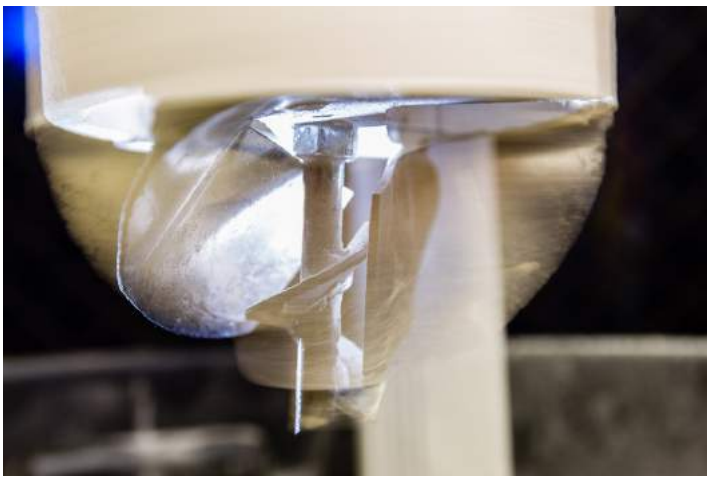
Primarily, they require competence in magnetics in order to propose an optimum positioning and setup of the magnetic array that will levitate and guide the travel of the pod. Expertise in aerodynamics is also necessary in order to design the ideal shape for the least air resistance and thus the maximum speeds possible. The success of the design also depends on Mechanical Engineers to analyze the different factors involved in accelerating the car, such as how the results will change based on the different propulsion systems and the conditions of the tube track. A mastery of electrical engineering is demanded to link the sensors on the pod with the Hyperloop central control system. This is perhaps the most rigorous undertaking because the travel of the Hyperloop pod depends on a continuous communication with several live-data sensors. Infrared sensors on the pod combined with markings on track are used to navigate the capsule. Gap sensors measure the stability of the vehicle and the distance from the tunnel walls. These sensors, combined with a wireless communication system, are used to coordinate the travel of the Hyperloop pod. More importantly, the electronics are fundamental in preserving the safety of this marvelous design. If anything were to go wrong and the car needed to stop, this electronics apparatus would transmit emergency signals to the central system in order to engage the magnetic braking system.

The team debuted their "Vhyper" (pronounced Viper) pod design at the design weekend on January 29-30, 2016. Texas A&M College Station provided the facility for this phase of the competition where participants from over 100 universities presented their findings to engineering professionals. Even Elon Musk had a surprise appearance at the event, much to the liking of the participants. Vhyper's design's potential capability impressed the judges, and Hyperloop at Virginia Tech was awarded the Pod Technical Excellence Award for the superiority of their proposition. Their design ranked them in the top 5 design teams in the entire competition. A special part of this achievement is that the Virginia Tech Hyperloop team had only 20 members – compared to other teams with more than 80 members – and received significantly less sponsoring than other teams in the rankings. However, once they emerged victorious their potential for visible success skyrocketed, and they have already began to receive more funding for their project. Our team has now been granted access along with 29 other teams to the final stage of the competition taking place in Hawthorne, California. Located at the headquarters of SpaceX, a mile-long test track is being constructed to give the teams a chance to demonstrate the efficacy of their models in full-scale. Stay tuned with Engineer's Forum for news about the future of Hyperloop at Virginia Tech.

WARELAB TOUR

Words & Photos C.A.M. Gerlach

The student design teams staffing Virginia Tech's Ware Lab have been hard at work conquering the latest challenges their competitions throw at them, and EF was there to capture some of the many exciting and innovative happenings going on around the facility. From augers to engines and autonomous sailboats to all-terrain buggies, we provide an exclusive look at how the next generation of engineers hard at work developing the next generation of technology.



Top / 1. VT Baja team members enjoy a lighter moment as Thomas Sconzo (L), and Jake Everett work on the team's vehicle, and Tyler Thompson looks on. While the engineers may enjoy their work, they must make sure to have their vehicle ready for high stakes races in the spring. **Left / 2.** The VT Astrobotics team's automated drill spins up, preparing to bore its way to recovering simulated Martian minerals. The Ware Lab-based outfit hopes its innovative "mining" techniques will give it an advantage at the competition this spring. **Bottom / 3.** Last year's SailBOT craft is exhibited at an engineering open house at Virginia Tech. The Ware Lab teams participate in numerous events each year to help inform and inspire both fellow Hokies and local children.

Top / 1. VT Baja team member Thomas Sconzo, responsible for uprights and spindles on Virginia Tech's buggy, carefully examines his work. While the team still has plenty of testing and tweaking to do before their competition in the spring, they look forward to making their vehicle as reliable as possible without sacrificing too much speed. **Bottom / 2.** Ware Lab Manager Dewey Spangler cracks a grin as he listens to his budding engineers describe the progress made on their projects. During the seven years he's run the lab so far, the facility is undergoing significant expansion and its teams have won numerous awards.

WANNA WRITE ABOUT ENGINERING AND GET PAID FOR IT?

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