Engineers' Forum

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Letter From the Editor

Hello fellow Hokies!

This year the Engineers' Forum welcomes you back to another semester of fun, work, and opportunity. With all of the latest freezing weather it is a good idea to take shelter once in a while and rest for a moment with a hot drink. Hopefully during that time you can pick up an issue and read through some of the latest news from engineering! This issue we get you straight into the hands on action with an overview from Eileen about the famous ISE and ME manufacturing lab and some of the amazing projects worked on there. If you're interested in the incredible properties of the super-material grapheme, take a look at Kanika's article. Thinking about your life after college? Joseph takes a look back with one of our VT alumni in an interview about some of the hard choices that come after college in a professional setting.
Zuhra takes a look at what it means to be a woman engineer at Tech, while Alex has the newest interview from our Interim Associate Dean, Dr. Eric Westman, about his experiences and his plans for Tech. Take a glance at what happens when engineers and scientists collaborate in Nahu's Scieneering article, and check out the specs of 3 interactive robots on our campus with Robel's Beaming Technology article.
This year we are also taking special look at the projects happening this year in our famous Warelab. Ben has looked at several upcoming groups working on some diverse and interesting projects. Want to learn how to build a bridge from scratch?
We strive to bring you most informative and interesting information from all kinds of sources and people. If you have any suggestion on how to improve the magazine we welcome your input. Our racks are located in Norris, Torgerson, Surge, Squires, Newman Library, and Turner Place.
Take a look inside! And thanks for picking up an issue!

Coleman Merenda

Coleman Merenda
Editor in Chief

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Letter To the Editor

To: Editor, Engineers Forum

The November 2013 issue of Engineers Forum contains an inaccurate and troubling article on pursuing a Ph.D. in engineering. Particularly disturbing is the assertion by a misinformed current VT ME student to the effect that one can't obtain a Ph.D. with a Dissertation on aerodynamics and then get a job as a designer. This assertion is quite simply false. Three examples from many possible cases can serve to demonstrate the falsity of that student's statement. First, a recent Ph.D. graduate from the VT Aerospace & Ocean Eng. Dept. is now in charge of the Boeing 787-10 Dreamliner upgrade program. Second, a VT AE Ph.D. now heads NASA's Environmentally Responsible Aircraft (ERA) program. Third, a distinguished Ph.D. aerodynamicist with many years in aircraft design at Lockheed has joined the VT Aerospace & Ocean Eng. Dept. faculty to teach aircraft design to our seniors. One could easily cite many more similar cases. It is certainly true that a B.S. graduate from a first-class AE program like that at VT can have a successful career as an aircraft designer. But, he or she will have to compete against co-workers who have obtained advanced education in modern aerospace theories and techniques at the M.S. and Ph.D. levels. And, these considerations are not limited to aircraft or spacecraft design. They apply equally well to any kind of engineering design. Many of the highest-level positions in industry and government have a Ph.D. degree as an implicit, and increasingly as an explicit, requirement. Why not equip yourself with the highest level of education that you can absorb in order to successfully compete with the best and brightest in a global economy? You don't want to miss out on a promotion compared to someone who can put "Dr." in front of their name, even if it is only from a lower-level US or foreign university.

Joseph A. Schetz, Ph.D.
Holder of the Frederick D. Durham Chair in Aerospace & Ocean Engineering

ISEs and MEs Love Manufacturing Processes Lab

By Eileen Lacaden, a junior industrial and systems engineering major

Engineering students hardly ever look forward to labs that require three hours of precious study time every week. It's difficult to be excited for lengthy labs after going through the frustration of scheduling a large block of time into an already intensive course load. But after experiencing the first day in manufacturing processes laboratory (ISE 2214), students can't wait for the next lab day to come.

As an undergraduate course requirement for both the industrial and systems engineering (ISE) and mechanical engineering course programs here at Virginia Tech, ISE 2214 gives students "down and dirty" hands-on experience with different types of manufacturing processes. The lab takes place in the Manufacturing Processes Center (MPC). The MPC is comprised of the Modern Manufacturing Processes Labs, located in 174 Whittemore Hall, and the Computer Aided Manufacturing (CAM) Lab, located in 189 Durham Hall. It contains a variety of equipment that students learn to operate in order to understand the basics of each process. The lab and its machinery are only as good as its teachers and operators! The class instructor, Phillip Ratcliff; lab technicians Randall Monk, Kelly Snidow, Randy Waldron, and Joe Linkous; and the teaching assistants create a friendly and enjoyable atmosphere that encourages students to want to learn. They also ensure the safety of all individuals that enter the MPC.

As described in the ISE 2214 Lab Manual by Dr. John P. Shewchuk, Associate Professor for the Grado Department of Industrial and Systems Engineering:
"While these laboratories cover a wide variety of manufacturing processes including assembly, casting, machining, CNC (Computer Numerical Control) machining, manual and robotic welding, and inspection, equal emphasis is placed on understanding product flow and control. To this extent, the laboratories employ engineering drawings, route sheets, work orders, and inspection forms, just like real manufacturing facilities."

The goal is to introduce students to what a real manufacturing work environment is like. The staff stresses the importance of preparation, inspections, and clean-up. Listed below is a brief description of each of the labs covered in this course:

Switch Box Lab: Students learn how assembly lines work by performing in an assembly line themselves. Their goal is to produce working switch boxes. The line is placed under various conditions so that they can analyze how different changes affect the quality and quantity of the product, as well as the efficiency of the line.

Pulley Lab: Students begin the lab by sand casting their pulleys. They build a mold the shape of a pulley, and then the technicians pour molten aluminum alloy into the mold. . After the mold hardens, the students must machine their pulleys to bring them to specified measurements using a lathe, drill press, and hand press. Last is inspection, where the students use measurement instruments such as calipers, gages, and a Helmel Coordinate Machine to see if their pulleys are within the measurement tolerance.

Mounting Plate Lab: Students use horizontal and vertical milling machines to cut holes and grooves into a steel plate. Then, they write a program to run a numerically controlled machining operation on a steel part and use a computer-aided manufacturing software to build another steel part. After inspection, the pieces are welded together. The parts are then joined by both manual welding and robotic welding.

Sheet Metal Forming and Powder Metallurgy Lab: Students deep draw (sheet metal forming process) an aluminum blank to form a cup. Then, they compact metal powders to form parts which are sintered together by the instructor.

Wire Electrical Discharge Machining (EDM) Lab: Students operate the EDM machine to form cuts in a stainless steel piece. Wire EDM works by feeding spools of wire into the work area to generate sparks which burn material away.

Turning Lab: Students work together to complete cuts in a steel specimen using a lathe at different speeds. They measure the changes in temperature and the cutting forces when performing at these speeds.

Students seem to have learned some useful things from taking ISE 2214; being immersed in an engineering curriculum typically draws out a passion in the students to learn how things work and to try to make them better. Alex Ross, a senior in industrial and systems engineering, plainly stated, "It was an engaging hands-on experience that provided insight into the processes used to manufacture products we use every day. [It was] one of the few clases I didn't have to force myself to pay attention to." Other students have described ISE 2214 as being "very well-organized and informative" and even "one of my favorite classes I've taken."

Skills and knowledge that students gain from participating in this lab are especially valuable when they apply for a job or are on the job already. Employers like to know that their potential employees have had some type of hands-on experience. Taking this course provides our engineering students with that advantage before senior design projects or undergraduate research come into the picture. ISE undergraduate Kevin Ponceloranca commented:
"I had a co-op with Bosch-Rexroth where I interacted with operators, maintenance personnel, and machines used in the manufacturing processes [lab]. It was helpful to have some prior knowledge of machines and machining operations."

Kevin is interested in the manufacturing sector, which is one of the most prevalent career choices for ISEs. Electrical engineering undergraduate Logan Wilding had something to say about ISE 2214, as well. "Honestly, this is my favorite class of the semester, or for that matter, of my entire college career… this class is not even required, but absolutely worth it," he declared. Evidently, students have had very positive experiences in this lab. Hopefully this will continue to for years to come!

Additional information about the Manufacturing Processes Center can be found at www.ise.vt.edu under Research Facilities.

Girl Engineer

By Zuhra Malik, a senior civil engineering major

Tell us a little bit about yourself. Where did you live and study, and what previous jobs have you held?
I was born in Denver, but moved to Iowa in my childhood. I ended up returning to Colorado, where I lived in Fort Collins. Having an interest in engineering and mining from a young age, I studied geophysical engineering at the Colorado School of Mines, where I got my bachelor's degree. I then worked for the oil and gas industry for one year. Over time, I found I was more interested in geology and seismic behavior, so I went to the University of Colorado and proceeded to get my master's in Ccivil engineering, with a focus in oil and rock mechanics. There are many design challenges associated with rocks, mining, and geological surveying in general, and I was eager to get involved in research.

After one year in private civil engineering consulting, I found an opening at the Denver Research Center, which was a division of the Federal Bureau of Mines. I greatly enjoyed all the work that I did at the Bureau of Mines; we conducted tests and made major developments in mining technology. Unfortunately, the government decided to shut down the program, which left me out of a job. I now had four children and bills that had to be paid, so I went back into consulting. I then found an opportunity for a Ph.D. at Virginia Tech – I decided to give up my life in Colorado, and move to Blacksburg. I became a faculty member in 1999 and have been here ever since.

Did you ever envision yourself working in education?
Never – the thought didn't even cross my mind until I was working on my master's degree. I did a short internship with Shell in Texas, and with my previous work experience, realized I enjoyed research and education far more than industry work. Over the years, I've had the opportunity to collaborate with great professors and peers. Working with students from so many backgrounds has truly been phenomenal, and the students here at Virginia Tech are exceptionally brilliant and motivated. In addition, I've also been able to communicate with researchers at other institutions throughout the world, including ones at universities in China, Australia, and Canada.

What drew you to Blacksburg in the first place; what has kept you here?
There are so many great people here in Blacksburg. I may have been a faculty member, but I've always felt like a student, as all of my peers and pupils have taught me so much. The leadership has always been supportive, and the engineering students at Virginia Tech are very inspired and dedicated. The town is a great place to raise a family, and everyone is very friendly. My life in Colorado was always hectic and rushed. Blacksburg in comparison, is very quiet and laid back. I felt the town embodied nature when I was so used to a landscape dominated by nurture. All of these factors, along with the opportunity to get my Ph.D. and continue research, made the move a great choice.

Have there been any "career-defining" moments? What are some of your proudest feats?
One of the Ph.D. candidates I worked with, Dr. Kray Luxbacher, who is now a faculty member here at Virginia Tech, was one of the first to observe changing stress in seismic tomography. Seismic behavior is very similar to the weather; even with the best tools, the Earth behaves in very unpredictable ways. However, unlike in meteorology, there are very few methods to predict and detect future seismic behavior, regardless of reliability. She was one of the first to develop a new way to show changing conditions underground, similar to how Doppler radar works, but for earthquakes. Being able to work with her on such a revolutionary new technology was an amazing experience, and I believe one that opened entirely new areas of seismic study that will benefit millions around the world.

Have there been any major hurdles for you during your career?
I was not completely prepared for college. I still had a high school work ethic when I came into freshman year, and I actually failed my first test. It was a major wakeup call: college would actually require me to work like I never had before. For the rest of the semester, I studied tremendously and I actually managed to get an A in the class that I had failed the first test in. My advice to all the students here at Virginia Tech is to never give up. Expect challenges and hurdles, but work through them, and you will be rewarded. Later on in my career, while I was working here at Virginia Tech, I was trying to apply for a federal grant for research I was conducting. It was a very prestigious honor to receive this grant, and as such, it was very difficult to secure. The first time I applied for this award, I was denied. I asked the program manager what I did wrong, and how I could improve to raise my odds of getting the grant in the next year. He gave me some valuable feedback, which I incorporated into my work over the course of the next year. The next year, I was actually awarded the grant, which enabled us to do some incredible research. The research, in fact, was the seismic prediction I discussed earlier. I would like to reiterate that sometimes, things will not go the way you want them to the first time around; you will have to persevere, accept your failures, and learn from your mistakes. There will be hurdles, but if you stay motivated and work hard, you will succeed.

Is there anything you would like to tell the students here at Virginia Tech?
I would, again, just like to say how incredible everyone here is. It is such a great honor to work with such brilliant minds. I am always impressed by the people here in the engineering program. It's always a pleasure to be able to help you all achieve your academic goals. As I mentioned previously, things may be difficult at times with your studies, or with problems that occur outside of school, but I urge you all to keep up the great work ethic and enthusiasm for learning.

Graphene: Magic of Flat Carbon

By Kanika Saini, a graduate student in electrical engineering

Introduction: Graphene can be described as a two-dimensional material consisting of a single layer of carbon atoms arranged in a honeycomb or chicken wire structure. . It is high quality, strong, light, and transparent; it is also an excellent conductor of heat and electricity. It was discovered in 2004 by Andre Geim and his colleague Konstantin Novoselov. Geim and Novoselov won the 2010 Nobel Prize in Physics for their research. It is astonishingly strong, and yet, it is the thinnest material in the universe. It forms a high quality crystal lattice with no vacancies and dislocations in the structure. Graphene is an awesome material which never ceasesto amaze us. This article explores the various areas where applications for graphene are being found.

Solar Energy: Recently, graphene was found to be a more efficient material (cheaper and better absorbent) compared to indium tin oxide (ITO), which is presently used in electronic displays and other solar cells. It can be used as a transparent electrode in photovoltaic cells, replacing a layer of ITO that is brittle and becoming increasingly expensive. Graphene has one key advantage over ITO: it allows more than 97% of light to pass through to the solar cell beneath, regardless of its wavelength. In contrast, ITO tends to block certain wavelengths more than others. If graphene was to replace the solar cells in the future, electricity would become very cheap since the solar cells would produce energy continuously, and not just when sun is shining. As a result, our dependency on nonrenewable sources (such as thermal and nuclear energy) for power generation would decrease considerably, and the potential for a cleaner environment would increase

Photo detectors: Modern communication systems make use of fiber optic cable for transmission of data to long distances; however, when the data reaches its destination it requires photodetectors to translate the optical signal to electrical signal. Researchers from Vienna University of Technology (VUT) have created a silicon chip with an integrated photodetector made of graphene. The graphene photodetector is very small and works with a very high transmission speed and latency. This photodetector can be integrated with a computer to provide optical data transfer that enables faster communication among the cores and lesser electricity consumption
.

Touchscreens: Graphene can be used to make flexible and transparent electrodes. It is increasingly replacing ITO since indium is so rare and expensive. Touchscreens in mobile phones, iPads, and computers that use graphene as their conductor can be shaped using plastic rather than glass. This would make the screens thin and unbreakable, and you wouldn't have to worry about shattering your phone ever again. Also, you would be able to fold your mobile phone or tablet in your pocket
.

Transistor & Integrated Circuit: the future of computing! Graphene can be used to make transistors that are very fast. Transistors made from graphene can work at frequencies up to the terahertz range (10e12 Hz). In the coming times, graphene will eventually replace silicon in integrated circuits as the technology reaches its fundamental limits (since the transistors being used in CPUs and GPUs can't be miniaturized any further). This can be achieved due to special properties of graphene which makes it more metallic and stronger than diamond. It is also a better electric conductor than any material discovered to date; however, transistors are not easy to make with graphene since it has no band gap (meaning there is no energy range in graphene in which electron states cannot exist). In other words, it's impossible to switch off transistors made from graphene. Those working in or studying electrical engineering know that switching constitutes an important part of any integrated circuit, and problems occur if the transistor cannot be turned off and turned on. Scientists are working to rectify this problem. The good news is that once this problem is overcome, circuitry used in portable devices such as cell phones, laptops, and other electronic devices will become exponentially faster and operate at high frequencies of 10 GHz (10e9 Hz). Additionally, upload speed will also increase. A team at the University of California, Santa Barbara (UCSB) has proposed the first all-graphene chip, where the transistors and interconnects are monolithically patterned on a single sheet of graphene. It was found to surpass the performance of current latest technology (22nm CMOS process); however, it will take some time for the laboratory prototype to become available to the masses.

Batteries: Graphene can be used to make high-power super capacitors that would make batteries obsolete. A super capacitor differs from a regular capacitor because it has a very high capacitance. It stores energy by means of static charge as opposed to electrochemical reaction. Batteries used in mobile phones or portable devices would recharge in seconds and work for weeks in between charges. With the advent of this technology, you won't be able to use a dead phone as an excuse anymore.
Water Filter: Water purification and desalination are two of the great challenges of mankind. In particular, portable water purifiers and filters are always in demand. Graphene sheets perforated by small holes have first been explored as potential candidates for water filtration. Holes with a diameter of one nanometer (a billionth of a meter) are big enough to let water molecules sift through, yet small enough to stop any undesired chemicals from entering. Hence, graphene can solve the problems of providing clean drinking water at a lower cost and ease.
Tennis Racket: In early 2013, HEAD (manufacturer and marketer of premium sports equipment and apparel) announced their new range of graphene tennis rackets: the YouTek Graphene Speed series. These rackets range in cost from $170 to $286. HEAD explains that the rackets are constructed with graphene, which enables a redistribution of weight from the racket shaft to the grip and head. This allows players to generate more kinetic energy when they hit the ball.

Bionic Devices in Living Tissue: The term bionic means a mix of biology and electronic. It refers to devices, such as artificial hearts or cochlear implants, which assist people with hearing loss and can help improve an organ or a tissue. Bionic devices made of graphene would last longer (possibly a lifetime) since graphene is resistant to salty ionic solutions inside living tissue. This is in striking contrast to metallic parts that can corrode after a few years, and possibly release toxic metals into the body Imagine putting transistors made of graphene along a damaged spinal cord. Such transistors could detect nerve impulses in the undamaged section of the spinal cord and conduct them past the damaged area to the nerves in muscles. This could allow people to regain the use of their arms or legs after a spinal cord injury.

Summary: Who would have thought that graphene had so many applications? Graphene is useful in many different fields, and has the potential to increase the quality of our lives. This recent discovery has changed the direction of research and created a lot of interest.

Introducing the Future: Scieneering

Nahu is a sophomore majoring in biochemistry

Problems in the real world have become multi-dimensional and require the collective efforts of both scientists and engineers alike. In the wake of the BP oil spill, prizes were awarded to experts and entrepreneurs in the STEM (science, technology, engineering, and mathematics) fields that could develop a method to efficiently clean up the Gulf Coast. To keep pace with further challenges, Virginia Tech and other noteworthy universities – Stanford, UC Berkley, and Purdue – are leading a new push towards the interdisciplinary studies of engineering and science.

Scieneering program was created in 2009 to help fill the void between scientists and engineers. "We ask students the questions and together they give us the answers," said Scieneering director Keri Swaby. The program not only gives the independence needed for students to learn from one another, but also provides a laissez-faire style of teaching conducive to interdisciplinary learning.

Scieneering is a minor provided to all undergraduates who want to expand their horizon. Instead of structuring the curriculum, students have the option to choose from a pool of classes they want to pursue. Engineers take a variety of science-based courses, (vice-versa for scientists) and by doing so, Director Swaby hopes students will get a holistic understanding of what it truly means to be a Scieneer. "The opportunities in this program are endless," said Danielle Smalls, a junior majoring in industrial systems engineering.

One of Scieenering's eldest and brightest members, Smalls has seen the program grow from 30 to 120 members within three years. "The program is really starting to gain notoriety around campus," said Smalls. "We all want to be given the opportunity to create our own success as students and that's exactly what Scieneering provides."

Professors throughout campus come to weekly seminars and give abridged presentations on their research. As well as lecturing, professors give recounts of their own experiences working with others outside of their profession; many say it is quite difficult digesting all the information received working as a collaborative unit, but cite effective group communication as the most challenging aspect of collaboration. "Communication is key! Professors from other disciplines will assume you understand what they are saying even though you might be completely lost," echoed Smalls. "You have to force yourself and continue asking questions or else you will quickly fall behind."

In 2010 Virginia Tech was awarded $1.4 million by the Howard Hughes Medical Institute grant. Thanks to their generous contribution, students in the program are now given a $2500 stipend, $1000 for research supplies, and a personal mentor to help guide their work on a research topic of their choosing. Members can even showcase their research at research conferences across the country; but it does not stop there.

Scieneering is only the beginning of a new field of studies coming to Virginia Tech. By 2015 the College of Science plans to offer five new majors: Computational Modeling and Analytics, Science Technology and Law, Nanoscience, and Systems Biology.

Aristotle once said, "The whole is greater than the sum of the parts." Today's challenges are unprecedented. Problems are now multi-dimensional and have become too complex for just one expert to solve alone. Engineers, much like their scientist counterparts, have accrued many accomplishments; however, to progress, the two groups must work together. Thanks to the initiative taken by Virginia Tech and other schools, the name of the game has changed. Scieneering and other similar programs have removed the shackles off students in structured curriculums and have put the tools for a better future in their hands.

Interview with Dr. Erik Westman

By Alex Papp, a Freshman in General Engineering

I recently had the opportunity to speak with Dr. Erik Westman, the new Interim Associate dean for Academic Affairs at Virginia Tech. He spoke to me about the events that brought him to where he is today, and about what advice he would like to give to current students.

In first grade, I decided that I wanted to be an astronaut, just like Sally Ride. I would draw pictures of myself wearing space suits, surrounded by stars and gazing at Earth. The next year, I decided I wanted to be just like Kristi Yamaguchi. I wore sparkly dresses and pretended to ice skate in the kitchen. Growing up, I had tea parties with my dolls and snuck into my mom's makeup drawer, but I also had bruises from unsuccessfully climbing trees, played with my brother's Hot Wheels and created little cities out of Legos.

By high school, I knew I wanted to be an engineer because, even though I couldn't wear a pair of skates, I could use my creativity to build schools and hospitals, or maybe even work for NASA.

I was in for a surprise as an engineering major though. On the first day of the workshop class for the introductory engineering class, I counted four other girls and more than fifteen boys. In the class that proceeds the first intro class, I could no longer find my friend who was in my class the previous semester last class; she had switched her major.

In 2009, 87% of freshman engineering students continued on to the second year of engineering. Although I couldn't find any statistics of how many of those students were female, it's hard not to notice how many girls drop out of engineering after the first or second semester.

"I was initially interested in engineering because of my strong connection to the fields of science and math while in high school. I was always drawn to these subjects because they challenged me," Adina Bhatti, an international studies major who graduated in 2013, told me.

Adina entered Virginia Tech as a general engineering major, hoping to one day work for an NGO as an environmental engineer. After her first semester, Adina switched out of the engineering department.

"The engineering department was very competitive, which I could handle, but I had so many interests I wanted to pursue and I felt that engineering could not satisfy them all," she said.

In a Journal for Engineering Education study, 113 undergraduate students who switched out of engineering in the years 2004, 2007 and 2008 cited poor teaching and advising, the level of difficultly and the ability to identify with engineering as the major reasons for discontinuing the major. The last reason is especially important for keeping women and minorities enrolled in engineering.

But the real problem is not retention. It's the fact that most women don't enroll in engineering to begin with. According to the College of Engineering, in Fall 2013, 82% of eng neering undergraduate majors were male and just 18% were female. While the university has programs geared towards women in engineering, including Hypatia—a first year living and learning community—our upbringing shapes what we want to do later in life. As young girls grow up, they know what a doctor, veterinarian and actor does, but do they know what an engineer does?

"Girls are inundated with princesses, pop stars, and decorating kits. Meanwhile, boys are surrounded with math and science games, construction toys, puzzles, and brain teasers," said Debbie Sterling in a Forbes article. Sterling, a mechanical engineering graduate from Stanford, founded GoldieBlox, a toy company whose goal is to inspire more girls to become engineers when they grow up. With construction toy sets, young girls follow along the storybook adventures of Goldie, a curious engineer who loves to tinker and build. GoldieBlox, however, raises a question: do all construction toy sets need girl versions embellished in pink and purple?

From walking down the toy aisles at Walmart, I realized that the majority of toys that develop spatial skills are geared towards boys rather than both boys and girls. A couple weeks ago, I walked into the Lego store and bought my six year-old sister two boxes of Legos from the girls section: Snow White's Cottage and Olivia's Newborn Foal. She rarely touched the original Legos in a box under her bed, but when I handed her the boxes from the girls section, she wouldn't stop playing. Why?

"Because you can make a house with a princess and it has a bunny," she told me. But this same little girl is also obsessed with the game Minecraft, which has no princesses or bunnies, but rather zombies instead. She likes the game because she can build houses, have a library, and collect gems. Minecraft isn't considered a "girly" game, but because it combines elements that attracts both boys and girls, it's helping my little sister and many other girls her age with geometry, math, and spatial skills.

Computers and technology are changing the world, but it's mostly the men who are taking part in this. Engineering enables us to find solutions to the global problems we face. While there isn't just one answer to why more women don't choose to enroll in engineering, many future female engineers are lost at a young age because of misconceptions about engineering, discouragement, and a lack of female engineering role models.

Efforts are being made by the Center for Enhancement of Engineering Diversity (CEED) and other Virginia Tech programs, to change the conditions that discourage women from pursuing engineering. Each year, the Society of Women Engineers hosts Brownie Day to promote STEM fields to young Girl Scouts through crafts and activities. Programs like this enable young girls to meet female engineering students and erase the image they may have of an engineer: a man fixing a car or a train conductor. Additionally, C-Tech 2 (Computers and Technology at Virginia Tech), a two week summer program, encourages high school girls to pursue engineering in college.

Through real world applications and fun hands-on activities, girls can explore the different opportunities that await them in engineering and get a head start on college life. It shouldn't just be a boy's world out there. Whether they want to be the next Sally Ride or Kristi Yamaguchi, young girls should be told they can succeed in anything.

Ware Lab Correspondence

Hello all,

I am proud to introduce the all new Ware Lab Correspondence section of the Engineers' Forum magazine! Look to this section now, and in future issues, for up-to-date info, project details, photos, and more from the teams of one of the most exciting places to be on campus: the Ware Lab! Keep in mind that this issue just scratches the surface in terms of the existing teams and depth of content. It is meant to keep you informed and perhaps inspire you to get involved.

Featured in this issue are four exciting teams I had the pleasure of getting the inside scoop on. Read on to find out what the Autonomous Surface Vehicle Team (ASVT), AISC Steel Bridge Team, Formula SAE, and SAE Aero Design East have all been up to.

Hope you enjoy!

Ben Gingras

AISC Steel Bridge Team: Speed, Design Tools, and Connections

AISC SBT at a Glance
Project Stage: Design/Build
Competition Date: 4/4/2014

During the design phase this past fall, the team used a structural engineering software called RISA 3D to make a mathematical model of the bridge. RISA 3D allows the team to calculate deflections, loads, and member stresses; tasks that AutoCAD has only a limited capacity for. However, the team is converting its RISA files to AutoCAD, which is a better software for dimensioning the bridge. Dimensioning simply means making sure everything fits together as intended. This coming spring will be the fabrication phase for STB, a time when, Andrew half-jokingly remarked, "all new problems crop up." Andrew offered the following example of a typical problem seen during the fabrication phase: "Consider a member designed to have a contact surface with a crazy angle, say 70 degrees. However, when we go to make the cut, we find out that the machine can only cut angles up to 30 degrees. We either need to find a way to finagle a 70 degree cut, or more likely, redesign the member."

Andrew Garrison (center) gathers the SBT around his screen to show a CAD example of the new connections for the 2014 competition.

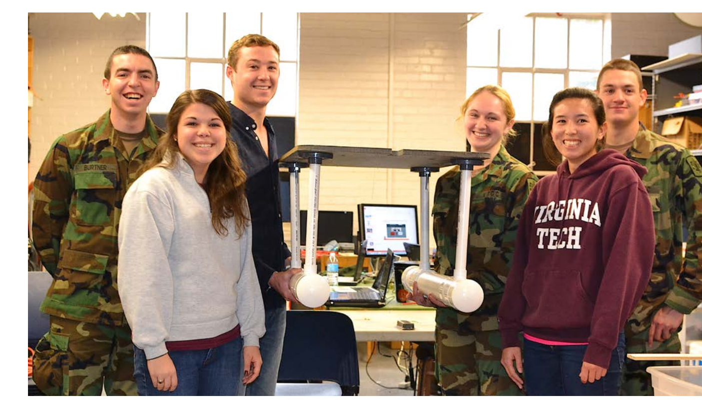
In terms of innovation for the next competition, the team has spent much time designing new connections for the bridge's members. Andrew informed me that a lot rests on how well your connections are designed at competition. The easier they are to put together and secure, the faster the team's assembly time will be. Even more importantly, it's the connections that are the likeliest to fail during competition. The team's solution is an "easy-slip" connection that it designed this past fall. As for a description of them, remember in ENGE 1024 when the instructor told you to verbally describe to your neighbor some complicated physical object with through holes, angled cuts, chamfers, etc.? Well, I am reminded of that now. Check them out for yourself in the picture above.

For more information on AISC STB, visit: http://www.asce.cee.vt.edu/?page_id=5

Autonomous Surface Vehicle Team (ASVT): Above and Beyond Competition Requirments For the Sake of Learning

ASVT at a Glance
Project Stage: Design
Competition Date: 6/8/2014

Currently, ASVT is in the design stage of its project development. In an interview with Cory Steinert, co-leader of ASVT with Emily Cosgrove, I learned some of the steps the team has taken to meet these challenges. The first step, Cory explained, was getting everybody on the same page in regards to naval architecture terminology. ASVT is a senior capstone design project, and as such, is comprised mostly of mechanical engineering seniors. Some had taken naval architecture electives, but the team rightly decided that it was important to build a common vocabulary before beginning design work. The next step was to understand the competition. The team took stock of customer requirements outlined in the competition guidelines and also made a list of metrics that would validate the final design. After generating an idea of what work needed to be done, the team then organized itself into three sub teams: hull design, power, and propulsion. Cory then explained the "hierarchy of inputs" that the team had used to generate its overall design. Think of it as an iterative feedback loop. First a hull design was produced. From this, the drag of the hull could be calculated for a target speed specified by the team. Given the drag at that speed, the required thrust to



ASVT holding up its newly made swath prototype in the ASVT project bay.

balance the forces and retain a constant speed is known; it is the same magnitude as the drag force. This information is then passed along to the propulsion sub-team, which determines the best means to achieve the required thrust. The propulsion team then determines the power to deliver this thrust. This required power is then given to the power sub-team, who determine the best means of powering the propulsion system. The primary constraint for the power sub-team's selection is the weight of the means it selects as this decision affects the hull design, the very first item in this feedback loop. It is by repeating through this feedback loop that ASVT will arrive at its final design.

ASVT meets to finalize presentation before Winter Break.

Cory explained that since ASVT is a senior design project for most of the team members, the team's goals do not end with excelling at the competition. They also collectively desire to learn more about technologies salient to the efforts of the Office of Naval Research, a prominent sponsor of the competition. To this end, the hull design sub-team elected to research swath designs for the hull of the boat. Most teams, Cory informed, build pontoon boats where a deck is fixed atop two hollow or foam filled cylinders, called pontoons, which rest atop the water. In a swath, the two buoyant structures that the deck rests upon, analogous to the cylinders in a pontoon, are below the water. Cory explained that the main advantage this difference entails has to do with wave mechanics. In open water, there is more particle motion at the surface of the water. Intuitively, this makes sense as it is the wind that creates and perpetuates waves, and wind only directly acts on those particles at the very surface of the water. By designing a surface vehicle such that its buoyant structures reside beneath the water where there is less particle motion, the overall stability of the craft is improved. Additionally, the buoyant structures of the team's swath design will be "peanut shaped" because their research found that, according to Cory, "a constricted diameter at the midsections of the structures reduced the drag for low speed swaths."

For more information about ASVT, visit: https://sites.google.com/site/vt2013asvteam/home

Formula SAE: Improving Information Sharing for a Rapidly Growing Team

Formula SAE at a Glance
Project Stage: Build
Competition Date: 5/14/2014

With all of these sub-teams however, the challenge of coordinating information sharing between them has been especially prevalent this year. For example, should the suspension team decide that the engine is best positioned an inch and a half closer to the center of the chassis, several sub-teams ought to be made aware of the decision. Moving the engine could affect minor, but important, changes in how the electrical team chooses to wire the vehicle. It could push the seat forward, creating less space for the driver and a problem for the ISE/Ergonomics team. It might cause concern for the aerodynamics sub-team by changing the stability of the vehicle. The previous examples were contrived, but nevertheless intended to demonstrate the butterfly effect of design choices made on a complicated project such as a Formula One-style car.

While Formula SAE's faculty advisor, Dr. West, guides everyone along, he is largely hands-off and allows the upperclassmen to manage the team's affairs, Vince explained. As such, it is largely up to the upperclassmen to meet this challenge of information sharing. In my interview with Vince, we discussed one solution as being the frequency and types of meetings the team holds. Each week, there is a general team meeting, one of which I had the opportunity of attending. I observed that the sub-team leaders each took a turn at the front of a classroom and presented polished, to-the-point slideshow presentations

Formula SAE's Brian Oeters grinding a tab to be welded to the 2014 car's chassis in the Ware Lab.

Formula SAE's 2013 car in the team's project bay.

bringing the packed room up to speed on the progress of that sub-team. There was little cross-conversation. In addition to a general meeting, an independent study time is allotted to underclassmen members to work on the 2015 car. Although they are independent study timeslots, they are managed by underclassmen. Finally, senior members are enrolled in ME 4015 during the fall, and 4016 in the spring. These classes count for their required engineering design and project courses, and are also where "[the sub-team leaders] get down to the nitty-gritty details," according to Vince. In contrast to general team meetings, there are open, yet focused, conversations that take place in addition to the positive critique of one another's work, design reviews, manufacturing reviews, and funding discussions that are held. It is in these meetings where the real cross sub-team communication occurs.

Apart from meetings, Vince discussed another way the team is considering rendering cross sub-team communications faster and more cohesive. Currently, if a teammate is looking for information on a part or system, they have to sift through all types of files from Word and Excel to MATLAB and CAD. Vince mentioned that the team is interested in implementing a product lifecycle management software called Siemens Teamcenter. This would allow them to compile all of the team's data files, regardless of the type, into one place. Using software like Teamcenter, a Formula SAE member looking for information about a part, for instance, could simply type its name into the interface and every technical report, excel data sheet, AutoCAD file, Matlab file, etc. would be referenced for them. In addition to improving team communication and sharing generally, such software would also be an excellent tool at competition to access information about parts or systems to repair them and/or modify them as the need arises.

To learn more about VT Formula SAE, visit: http://www.vtmotorsports.com/ and like their page on Facebook named "VT Motorsports"

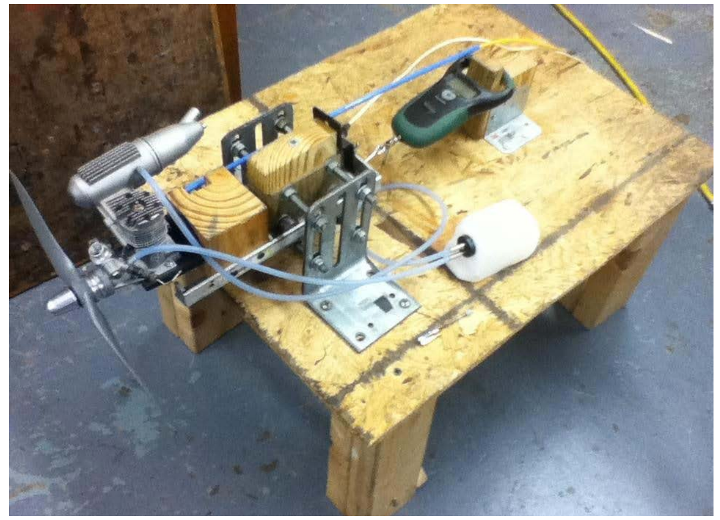
SAE Aero Design East: Meet the Mavericks

SAE Aero Design East at a Glance
Project Stage: Transitioning - Design to Build
Competition Date: 4/11/2014

Virginia Tech's SAE Aero team is participating in the SAE Aero Design East competition, which will be held in Marietta, Georgia. The central mission requiring successful completion in the Advanced Design category consists of bringing a three pound "humanitarian" aid package to an elevation of at least 100 feet, making an approach towards a target located on the competition field, and then dropping the package down onto the target, with points scored for accuracy. The team must specify which direction, either upwind or downwind, that they will attempt their approach, and they must adhere to it during the flight. The requirements for the plane state that the team must install a Data Acquisition System (DAS) that will record and report the plane's elevation in feet back to a ground station. Additionally, the plane must have a First Person View System (FPV) to be used as a sighting device. A secondary pilot will be allowed to use the FPV that will stream real time video to either a laptop or FPV goggles. The secondary pilot will verbally inform the primary pilot of the planes course and proximity towards the target. The primary pilot will remotely maneuver the plane while only using his own eyes from the ground.

SAE Aero Design test wing under construction. Will be tested in a wind tunnel on campus to determine the theoretical lift coefficients of the team's wing design.

The team worked this winter to complete its design and test its wing sections to determine their theoretical lift coefficients (test wing construction pictured to the left). By January 27th, they hope to have completed the construction of the plane. At my request, the team discussed some of the considerations that went into generating their design. Justin Agud, Chief Engineer for SAE Aero, explained that the first step was to interpret the competition requirements. From the competition requirements, they knew that, because they would be scored primarily



SAE Aero Design engine undergoing testing.

upon successful completion of the task, stability of the plane would be essential. The mission task requires precision; they needed to design a plane that could fly straight and level. A high degree of maneuverability was not vital since there is no rule against taking wide turns at competition. Also towards the end of designing a stable plane, the team recognized the need to account for the sudden loss of three-pound package during flight. If not properly considered, this could catastrophically disrupt the balance of the plane midflight. The solution, Justin explained, was to design a stable plane, calculate its center of mass, and position the three pound package and release mechanism just below that point. The result when released would simply be that the plane would rise briefly. No momentum is created around the plane's center of gravity due to a sudden imbalance because, as positioned, the package has an R value (distance) of zero relative to the center of gravity to begin with, so the loss of it has no effect on the balance of the plane.

To learn more about SAE Aero Design East competition, visit: http://students.sae.org/cds/aerodesign/east/

Special thanks to Prof. Dewey Spangler for his contiued support of this correspondence and to all the teams and team members I have had the pleasure of getting to know.

They Say Hind-Sight is 20/20: Virginia Tech Engineering from the Perspective of an Alumnus

By: Joseph Davis, a senior mechanical engineering major

I had the opportunity to meet with T.J. Elmore, a Virginia Tech alumna who graduated with a degree in mechanical engineering in 2009, to discuss Virginia Tech engineering in hindsight. Elmore now works at Celanese in Narrows, VA as a reliability engineer. Her job involves studying root causes of equipment failures and proper equipment maintenance strategies. Elmore, who described reliability engineering as a "combo of short and long term equipment strategy," explained to me that she investigates why equipment breaks down and predicts when it will break down next. These types of analyses could benefit any company as they allow for continuous improvement to systems and machines in the plant.

Elmore got involved with Celanese by spending time working as an engineering co-op student for them after deciding she needed to take a break from school. She spent two terms with the company and enjoyed it. Before her senior year, she accepted an offer to work for them full-time after her graduation.

"Eight," Elmore said when asked how prepared she was, on a scale of one to ten, to practice reliability engineering after graduating from Virginia Tech. She continued, "Looking back, [the Virginia Tech engineering program] really helped a lot," but, immediately after graduation, she felt unprepared. The Virginia Tech work load improves students' work ethics along with providing exceptional computer skills to engineers, she said.

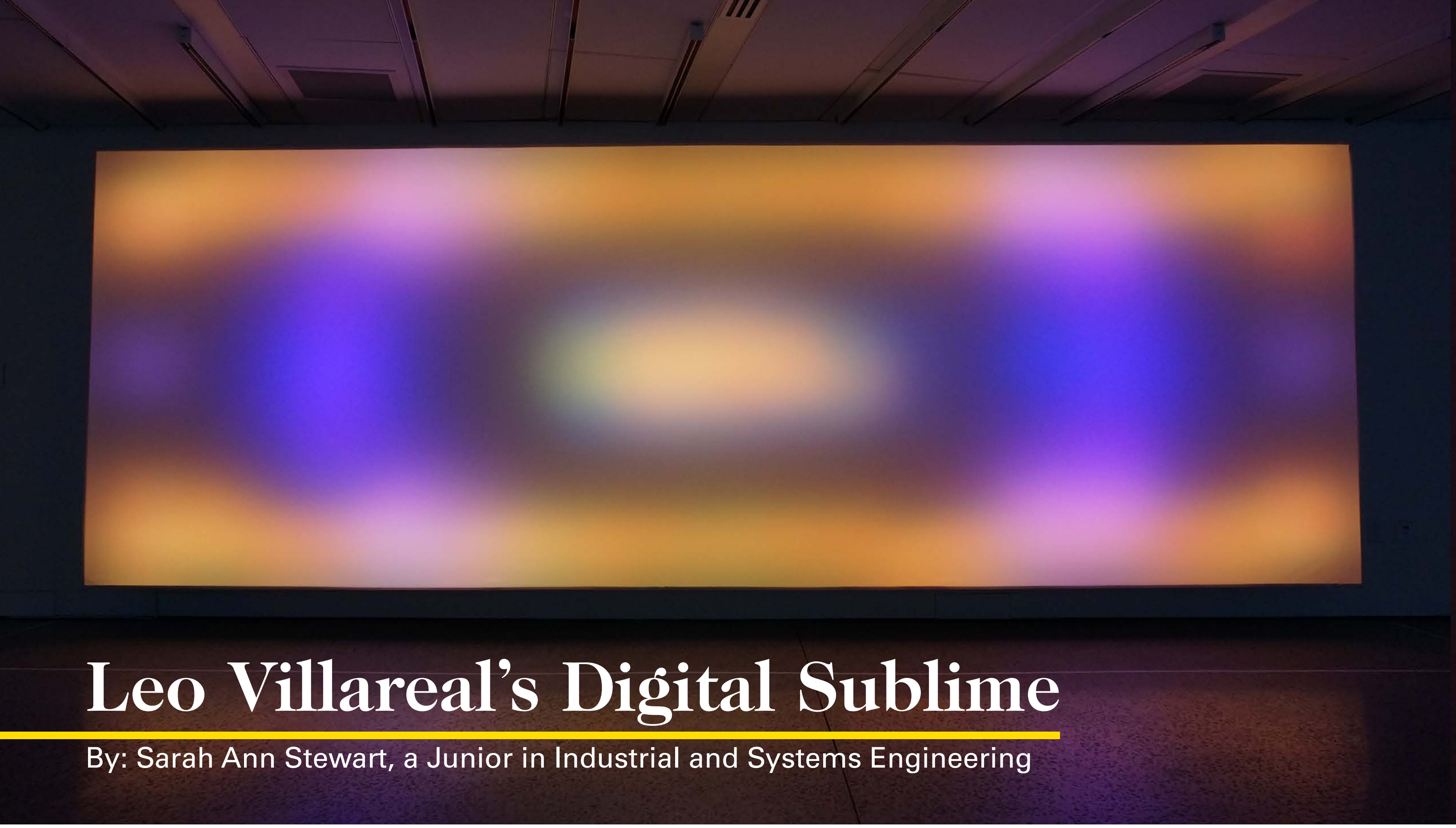
Business, project management, psychology, and communication were skills Elmore found to be much more important to have than she originally expected upon entering the work place. Recalling her experiences working with people from all walks of life, Elmore commented, "You need others to help you out with your job. You have to be able to communicate." She also found that she was unprepared for the amount of individual work she would have to do. At Celanese, she has a lot of individual reliability projects, which is a change from the countless group projects she worked on while studying at Virginia Tech. As a result, she spends much of her time in meetings updating supervisors on the progress of her work, as opposed to working directly with them on her projects. "Engineers won't just be doing technical work. Reading and understanding people is necessary to success and progress," she said.

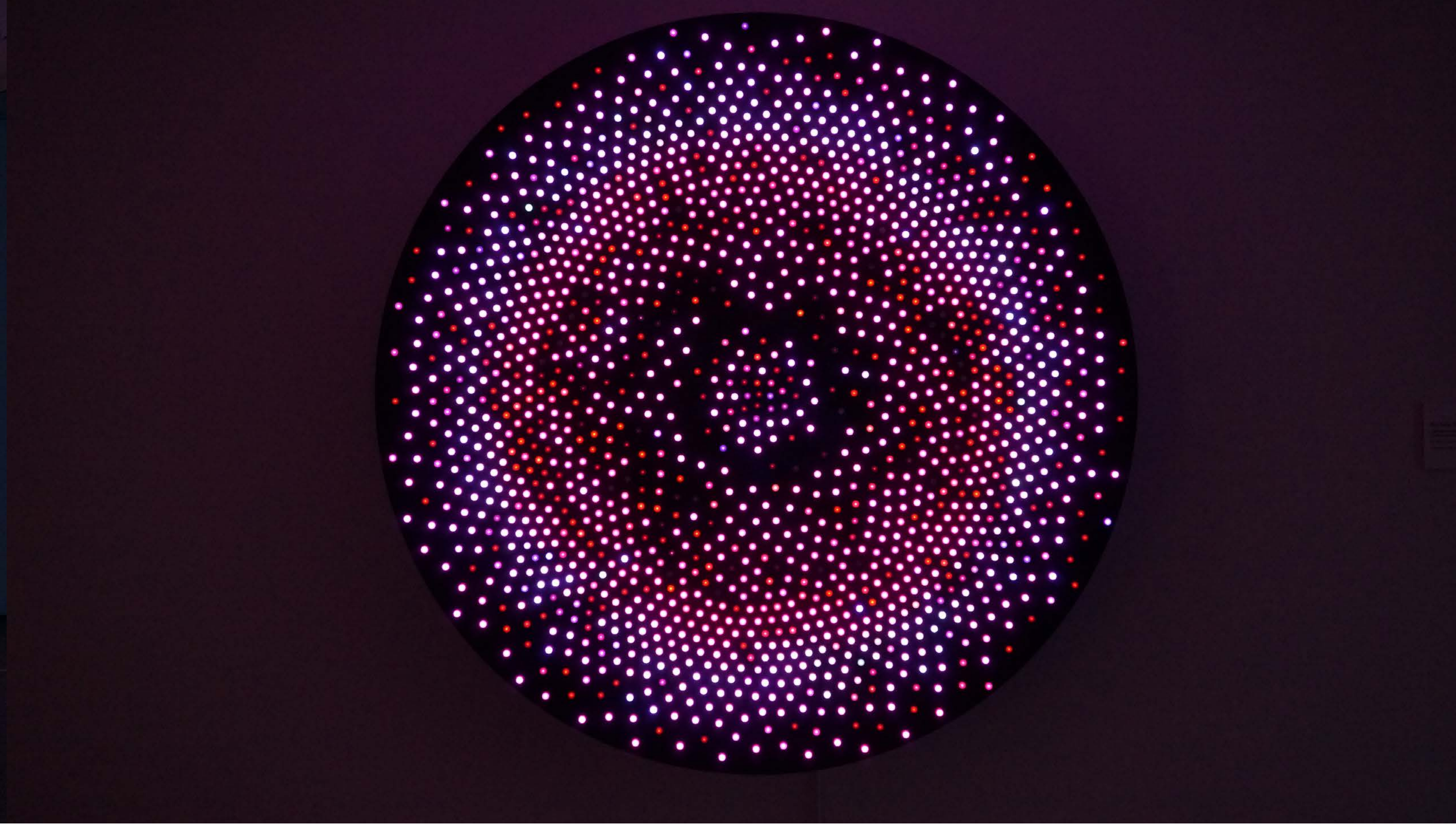
Elmore feels that she uses what she learned in mechanical design (ME 3614) more than any other class. "If it's a mechanical part and it exists, it's discussed in that book," she said, referencing Shigley's Mechanical Engineering Design, the textbook used in that class. Elmore said she wished she had done a better job of "grasping big picture concepts of courseload" while she was in school. She also cites "hands-on mechanical work" as a great way to better understand classroom concepts.

Elmore would like to offer this advice to all undergraduate engineering students: "Get as much hands-on experience as you possibly can. Theory is great. Hands-on experience is great. Doing both allows for an understanding of the full picture. Listen and learn from your classes; you will actually use them." "Make a bad decision every now and then," she added, advising students to have fun and relax a little to get away from studying.

Virginia Tech engineering is among the elite engineering programs in the world. However, don't assume that real-world work experience is unnecessary or useless. If anything, it completes the premiere education Virginia Tech offers. As Elmore said, "there are things school can't prepare you for." Work experience is invaluable and classroom work is necessary.

Remember this the next time you're studying for a boring conceptual math test: since you will have something to offer a company in the future, primarily your education, make the most of it so that you can leave a company, and this world, in better condition than when you walked into it.





Leo Villareal's Digital Sublime

By: Sarah Ann Stewart, a Junior in Industrial and Systems Engineering

To the engineer's eye, Leo Villareal's exhibit, Digital Sublime, is where engineering meets art. The exhibit's artworks contain microcontrollers, custom software, circuitry, and thousands of light-emitting diodes (LEDs). It appears as though an electrical or computer engineer abandoned their ordinary career in order to tap into their artistic side; but, Villareal, the mastermind behind these pieces, doesn't hold an engineering degree. According to his website, he has two art degrees:a bachelor of arts in sculpture from Yale University, as well as a graduate degree in Interactive telecommunications from New York University (NYU).
So where did Villareal learn how to use such complex technologies to create art? According to NYU's webpage, the school's interactive telecommunications program consists of courses such as microcontroller workshop, which teaches students concepts like A/D conversion, interrupts, serial communications (I2C, SPI, etc.), I/O latching, and timers. If you're an electrical or computer engineering student or professor here at Virginia Tech, this may sound oddly similar to a course called microcontroller interfacing that teaches most of the same concepts. Other interactive telecommunications courses include basic analog circuits, circuit design and prototyping, and electronic design and prototyping, courses that seem to cover all the basics of electrical engineering. Villareal's incorporation of this technical knowledge into his exhibits, such as Digital Sublime and The Bay Lights, dazzles audiences as small as Virginia Tech's campus, and as large as major cities, such as San Francisco.

Digital Sublime was one of the art exhibits located in Virginia Tech's Center for the Arts from October 28th to December 15th. It contained four magnificent pieces: Big Bang, Scramble, Amanecer, and Diamond Matrix. Villareal harnessed and exploited the medium of light. The movement of colors and light inspired both appreciation and fascination in those who entered the exhibit.

Upon entering the exhibit, you were greeted with a colorful, quick-paced light show in the shape of a large circle with a diameter of 59 inches. This piece was Big Bang (pictured above), and it contained 1,600 LEDs, a microcontroller, circuitry, and anodized aluminum. The LEDs are covered with circular, perhaps plastic, screens that very slightly expand the illumination of each individual light. At first, Big Bang appear to be just a splendid light show, but the centric expanding and contracting of the LEDs' apparent movement hints at how a computer animation of the Big Bang would move, only with a larger array of colors. The colors and movement were constantly evolving; there was green, pink, red, and multiple blues that filled the black, space-like sculpture. The piece's vibrant colors allow it to feel more like art than science, yet it maintains the balance between art and science.

Next, as you made your way to the larger exhibit room, you were greeted by a 24 in. by 24 in. square piece mounted on the wall. This piece, called Scramble (picture above), contained similar items to Big Bang, but also incorporated wood and plexiglass. This piece was far more subtle than Big Bang, and evolved at a much slower pace. It contained oranges, blues, pinks, yellows, purples, and white. It was much more abstract than the other artwork in the collection, and a little harder to appreciate, but still intriguing. There were layers of differently colored square lights at the center of the piece which diffused outward and morphed into the next sequence in the colorful design.

Deeper into the exhibit, there was a gigantic, 7 ft. by 20 ft. rectangular design spanning the left wall. Amanecer, was the only one that didn't need a microcontroller to produce its movement. The piece had harshly diffused LEDs that produced fuzzy, two foot, circular lights in changing colors that slowly expanded and migrated across the rectangular expanse. The LEDs weren't merely illuminating and darkening, or expanding and contracting; the display moved with gentle, slow fluidity. There was yellow, orange, pink, blue, and several other colors, that formed sunrise and sunset-like images that cast reflections on the glossed floor below. According to the Spanish Dictionary, Amanecer is the Spanish term for "dawn" or "daybreak," which matches perfectly with the imagery the piece created.

Finally, you reached the back wall with Diamond Matrix (pictured above), the most intriguing and stimulating piece of the Digital Sublime collection. It was a black, 62.5 in. by 62.5 in. square with 3,600 uncovered, undiffused, white LEDs. The design was simply black, white, and gray, but dazzled the eye more than any of the other flamboyantly colorful pieces. The progressing LED design had impeccable fluidity—it sparkled, exploded, contracted, drifted, circled, danced, and pixelated. Its movement was more fluid than fallen leaves naturally tossing in the wind. Every single inch of the "canvas" was fully utilized, creating a design so fluid and complex. And after staring at Diamond Matrix for almost 15 minutes straight, my mind suddenly came back to the looming question — the one all the curious minds of the engineering and technically inclined pondered — but how does it work?

According to his website, Villareal creates his own custom software that aids in controlling the images that are produced. But even though he devises clearly-defined algorithms, even he cannot fully predict every image his designs produce. Villareal says, "Central to the work is the element of chance." He strives to produce behavior without "a preconceived outcome." But sadly, my understanding stops there. I do not know how exactly Villareal creates his work, though I'm sure there are a few engineers at Virginia Tech who probably do. But Villareal's work is nonetheless awe-inspiring and incredibly captivating. Digital Sublime and other works and collections by Villareal are the flawless exhibitions of how lofty, complex technologies, like those learned in the electrical and computer engineering and computer science departments at this university, can be utilized to create work that provides aesthetic pleasure. Digital Sublime is an art collection that the nerdy engineers and the art enthusiasts can equally enjoy. For the audience this campus would inevitably attract, engineers and non-engineers alike, it was indeed a brilliant choice for this exhibition to help kick off the recent opening of Virginia Tech's new Center for the Arts.

Beam-ing Technology at Virginia Tech

By Robel Fasil, a junior industrial and systems engineering major

Have you ever been so sick or tired (or lazy) that you just couldn't gather the energy to get out of bed for class? Well Virginia Tech may be able to help you out! A company called Suitable Technologies has lent Virginia Tech three personal telepresence robots, called Beams. Beams can be used to represent a person at an event if they cannot physically be there. This technology is taking telecommunication to a whole new level! Beams were designed for companies to save business trip costs, but Virginia Tech will also be using the Beams for students to attend classes remotely, and for instructors to teach classes remotely by controlling the Beams from their computers. The Beams are located at the InnovationSpace in Torgersen Hall, where I was lucky enough to speak with Jennifer Sparrow, Director of Emerging Technologies & New Ventures of InnovationSpace, about the Beam devices. She also gave me a demonstration of the Beam in action.

Each Beam is made up of a screen at the top (representing the "head"), a base, and a long body that connects these two together. With the screen at the top representing the head and a height of around five feet, the Beam is designed to feel somewhat like a human. The Beam moves around using wheels located at the base. There are two cameras on the beam: one above the screen and one on the base. The Beam also features multiple speakers and microphones for communication.

The Beam is operated with a computer application that pairs with it, and requires a strong network connection using 4G or Wi-Fi. Because of the high bandwidth needed to control the Beams, Virginia Tech will only be using Wi-Fi to connect to the Beams. This means that the Beams can only be used in buildings with Wi-Fi coverage, so you will not be seeing them roll past you on the Drillfield. Once this connection is established, the operator can use the keyboard, or even an Xbox controller, to move the Beam backwards and forwards at different speeds, as well and rotate the Beam.

The operator uses their webcam to show their face on the screen and to speak through the Beam's speakers, giving the Beam some personality. Sounds picked up by the Beam's microphones are streamed to the operator through the application to hear conversation, emulating human ears. In addition, the operator also has the option change the view of the Beam's screen to show whatever is on their computer screen (files, videos, etc.)

To get a sense of the Beam's location, displays of the cameras' views are included in the application. The above-screen camera is at a level set to emulate human eyes by offering a view of what the operator would see if they were at the event physically. The base camera gives a view of the Beam's path in order to navigate through obstacles on the ground. For darker environments, the base also features a light by the camera to brighten the path.

Ms. Sparrow allowed me to try out the Beam (as pictured). As is the case with most new technologies, it was confusing at first and I couldn't get it to move smoothly, but I got more comfortable with it as I continued to test it. Ms. Sparrow and the others at the InnovationSpace were able to maneuver it effortlessly. Conversation was easy both to and from the robot; it really felt as if I was right next to the person using the Beam. With some more practice moving the robot, I feel as though I could use it without any problems.

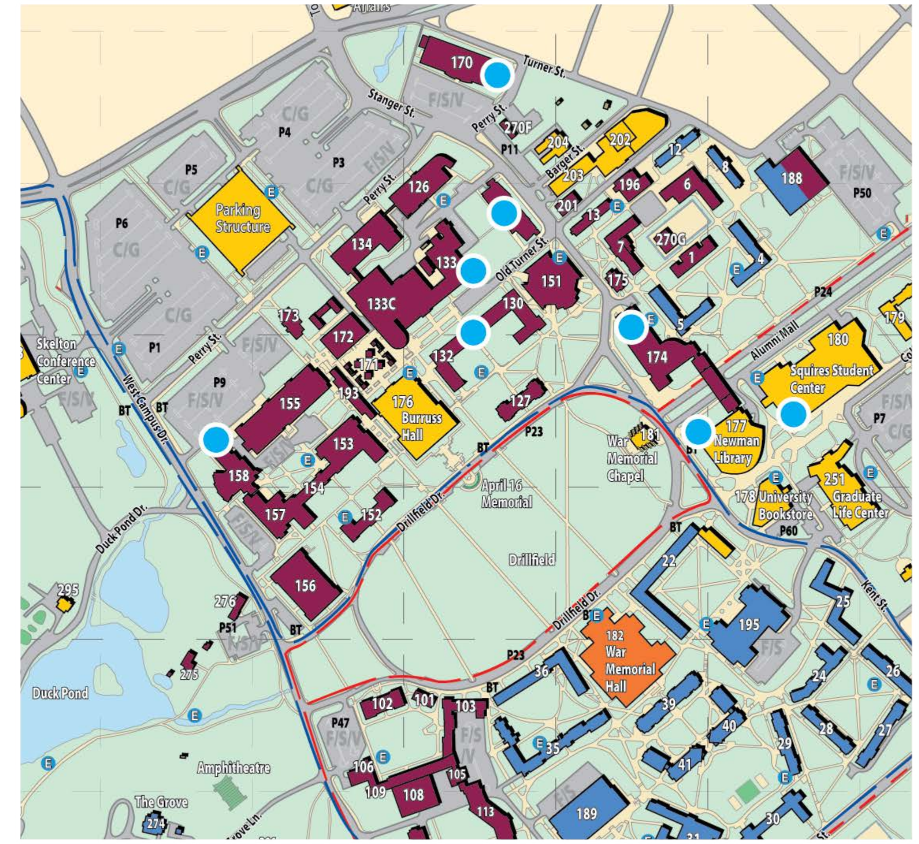
The three Beams at the InnovationSpace were given puns as names as a way to individualize them from one another. The names include Amelia Beamhart, Beam Aldrin, and my personal favorite, George Beamington Carver. They would like to name one Frank Beamer but felt that that would be "pushing the envelope."

The Beam has already been successfully used for distance learning. During the first week of fall semester classes, electrical and computer engineering professor Dr. Joseph Tront was able to teach one of his classes from his hotel room while on a trip to Asia. An assistant at the InnovationSpace pretended to be a sick student that would use a Beam to remotely attend class in order to test the Beam out. At first students were staring at her, but as time passed, they eventually got used to the Beam. Even with a class size of 65 students, she could easily raise her hand to answer questions and move around to work on group assignments. She was even able to hear one student say "bless you" when she sneezed. The only problem came when she received an email alert that distracted the teacher and students. Overall it was a positive experience.

Suitable Technologies may even use these devices to interview potential recruits at Virginia Tech career fairs. Suitable Technologies is willing to discuss what enhancements the Beams may need with users at Virginia Tech. Some potential additions include a basket or tray to hold things, or a stick to open doors. "We want to get students to contribute ideas that could help their experience at Virginia Tech," Sparrow mentioned. Similar to this, Ms. Sparrow recently started an organization at Virginia Tech called Tech Teams. The idea of Tech Teams is rapid prototyping of new technologies. They want to bring new gadgets to campus that are emerging in the technology field and get them in use quickly, possibly within a few weeks. After using the gadget, participants would give their input to Tech Teams in regards to whether the gadget should continue to be considered for use or not. They would love volunteers, and if you are interested in participating, please contact Ms. Sparrow at sparrowj@vt.edu.

While all of this sounds great, please don't get your hopes up. Virginia Tech probably won't let just anyone use these for class. Unless you have $16,000 to spare (the starting price of a Beam robot), you will probably have to get out of bed to get to class.

More information about the Beam robots can be found at suitabletech.com.



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