engineering news

VirginiaTech College of Engineering

inside

VIRGINIA TECH COLLEGE OF ENGINEERING SPRING 2013

Robotic jellyfish could roam the seas, oceans

College of Engineering researchers are continuing to work on a multi-university, nationwide project for the U.S. Navy that one day will put life-like autonomous robot jellyfish in waters around the world. Several sizes of the RoboJelly are under various phases of development, some the size of a man's hand, while another – publicly debuted in spring 2013 – is more than five-foot wide.

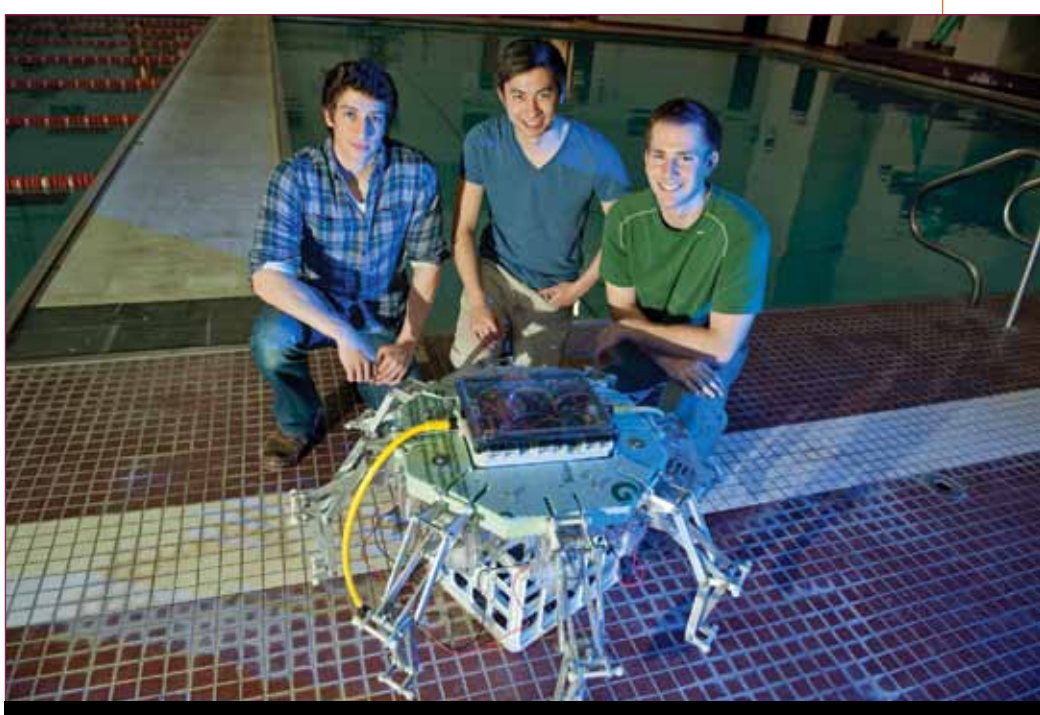
The main focus of the program is to understand the fundamentals of propulsion mechanisms utilized by nature, said **Shashank Priya**, professor of mechanical engineering and lead researcher on the project. The robot jellyfish would have several uses once put into the waters: Conducting surveillance, cleaning oil spills, and monitoring the environment.

The idea for a robotic jellyfish did not originate at Virginia Tech, but rather the U.S. Naval Undersea Warfare Center and the Office of Naval Research. Virginia Tech, is teaming with four U.S. universities on the multi-year, $5 million project. The project: build the jellyfish body models, integrating fluid mechanics and developing control systems.

The smaller jellyfish are tested inside a 600-gallon tank for movement and energy self-creation and usage, as they are being tested for self-powering autonomous operation, using hydrogen, naturally abundant in water, as a "fuel." The larger model, named "Cyro," requires a swimming pool for full tests, and is operated by electric batteries built into the robotic creature. A thick silicone layer mimics the sleek jellyfish skin and is placed over the robotic body. When moving, the robots look weirdly alive.

In both cases, the jellyfish must be able to operate on their own for months or longer at a time as engineers likely won't be able to capture and repair the robots, or replace power sources, Priya said. That is one of the many challenges facing development of the jellyfish as they progress. Priya added that, in addition to a range of sizes, jellyfish display a wide variety of shapes and colors, and are able to move on their own vertically, but depend upon ocean currents for horizontal movement.

Several more years of work remain before any models are released for reconnaissance, be it with cameras, sensors, or other devices. Other uses abound. "The robots could be used to study aquatic life, map ocean floors, monitor ocean currents, monitor water quality, [or to] monitor sharks," said **Alex Villanueva** of St-Jacques, New-Brunswick, Canada, a doctoral student working under Priya.



Left to right, robotic jellyfish research team members Alex Villanueva of St-Jacques, New-Brunswick, Canada, and a doctoral student; Kenneth Marut of Washington, D.C, and Tyler Michael of Lexington, N.C., of Lexington, N.C., both master's students. All three students are in the mechanical engineering program under Shashank Priya.

Students use 3D printers to make research models, tools, and totems

If you dream it, we can build it." That's **Christopher Williams**, assistant professor with both the Department of Mechanical Engineering and Department of Engineering Education, tipping his hat, with tongue in cheek, to the sports drama "Field of Dreams."

He's talking about his DREAMS – that's Design, Research, and Education for Additive Manufacturing Systems – Laboratory, dedicated to exploring the field of additive manufacturing, or 3D printing. More specifically, the DreamVendor, a high-tech vending machine located near the main lobby of Randolph Hall. Its inventory is infinite. You create the product, from scratch, or rather plastics. In 3D. In minutes.

DreamVendor is a set of four 3D printers that can create any physical shape that a user designs using software, with the content prep-provided on an SD card inserted into the machine. A few buttons pushed, and – voila! – instant manufacturing at one's fingertips. The only rule: The object has to be smaller than a baseball. The device uses a form of melted plastic, the same material used to make Legos, in a process similar to using a hot glue gun.

Williams said any innovative idea a student has for an invention, object, or tool can be made ready as a prototype within minutes.

The public-access machine is one of a kind, with no other known university having such a set up.

The printers are kit-built from a company called MakerBot, with new software added by Williams' students to make usage easier, and stacked inside a glass-and-metal case.

Funding for part of the set-up came from the Virginia Tech Student Engineers' Council. (See story on page five.)

"We were very surprised at how quickly the community grasped some of the more complex concepts of additive manufacturing," said **Amy Elliott** of Fayetteville, Tenn., a doctoral student in mechanical engineering who works in the lab.

The DreamVendor represents only a sliver of the work undertaken by the group of about 10 graduate and undergraduate students. In a lab one floor below, several high-end machines can print 3D objects far larger and from such materials as polymers, metals, ceramics, and even bio-materials and nano-composites.

(Left to right) Assistant Professor Christopher Williams and master's student Amy Elliott at the DreamVendor in Randolph Hall.

Luttrell elected to National Academy of Engineering

The National Academy of Engineering in February 2013 selected **Gerald "Jerry" H. Luttrell**, the E. Morgan Massey Professor of Mining and Minerals Engineering, as one of its 69 new members.

Luttrell's nomination was based on his advancement of separation technologies for the mineral and coal industries, pioneering new fields of technology in the environmentally clean processing of mined materials. These technologies allow mining firms to now recover much of the valuable materials previously gone to waste because they lacked appropriate separation technologies.

Luttrell

Election to the academy is among the highest professional distinctions accorded to an engineer. Only 14 other Virginia Tech College of Engineering faculty members previously have received the honor. (Luttrell himself is a dedicated Hokie, earning his bachelor's, master's, and doctoral degrees in mining and minerals engineering, all from Virginia Tech.)

Luttrell has 18 patents, many of which are in commercial use. His patents address three important industrial problems in mining: fine particle flotation, coarse particle flotation, and fine particle dewatering. Luttrell recently developed a new computer program for optimizing mineral and coal processing plants.

Luttrell co-invented the Microcel column flotation technology with **Roe Hoan Yoon**, a fellow NAE member and Virginia Tech University Distinguished Professor in mining. This technology is rapidly becoming an industry standard, and is one of the current best-selling flotation columns. Australian coal company BHPB-Mitsui Alliance is using the technology for all of its new plants.

Luttrell's HydroFloat coarse particle flotation system is used commercially in the phosphate and potash industries, while his StackCell fine particle flotation system is now being applied within the coal and industrial minerals industries. He also commercialized the hyperbaric centrifuge technology that is being marketed successfully by U.S. centrifuge company Decanter.

Luttrell also has developed a computer program that can be used to optimize the design of minerals and coal processing plants. In 2012 alone, he conducted more than 25 workshops, training 750-plus coal preparation plant employees.

COLLEGE NOTES

Dean's Message

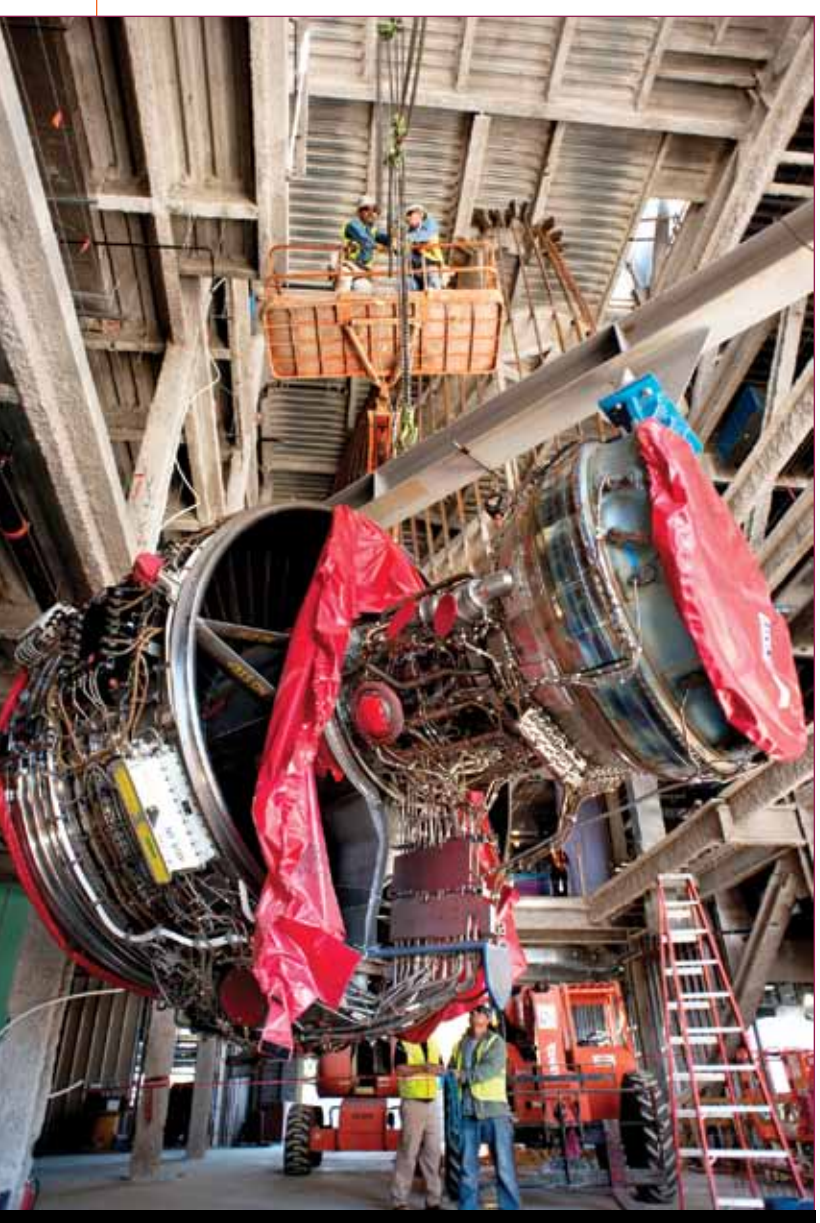
Signature Engineering Building progresses; college continues to grow programs, national stature

As the economy continues to thaw in most sectors from the near-frozen state it sat in for several years, our College of Engineering continues to expand like never before. And our horizon only grows brighter.

Near the intersection of Prices Fork Road and Stanger Street, on the north side of the Virginia Tech campus, our $100 million Signature Engineering Building is halfway through its construction and roughly a year away from opening. For in-progress photographs of the building, see page 8. As well, we have a 24/7 live webcam capturing the construction process. It can be viewed at www.eng.vt.edu/signaturebuilding/livecam.)


Benson

Out toward the Virginia Tech Corporate Research Campus, our Center for Space Science and Engineering Research, the new home of Space@VT, opened in July. Toward the shore, in Hampton, Va., the National Institute of Aerospace Research and Innovation Laboratories opened in the spring. Overseen by the institute, Virginia Tech owns the facility, which now houses the Bruel & Kaejer Laboratory for Aerospace Vibration and Acoustics, run by **Christopher Fuller**, the Samuel Langley Distinguished Professor of Engineering, and the Vessel Dynamics Lab run by **Leigh McCue-Weil**, associate professor of Aerospace and Ocean Engineering.


Engineers carefully raised the Rolls-Royce engine into place.

We're not through growing. A building dedicated to propulsion research is under construction at the Corporate Research Center, with the Virginia Tech Board of Visitors giving its blessing on the $3.5 million structure this past fall. It also would be placed in Phase II of the Corporate Research Center. In the future, the college hopes to expand its offices and classroom space by renovating and expanding other buildings on campus.

We are not just expanding the college's reach in brick and mortar. The State Council for Higher Education for Virginia is considering approval of a master's and doctoral degree in nuclear engineering, with a start target date of fall 2013. As well, the Virginia Tech-Wake Forest University School of Biomedical Engineering and Sciences added a minor starting this past January, building on the master's and doctoral programs we already have. Our class sizes also continue to grow, with the entering class of 2010 being particularly large. Our fall 2012 undergraduate enrollment was just more than 6,800, nearly a quarter larger than the 5,500 numbers we saw in the 2005 and 2006 academic years.

Monetarily, we also are growing stronger than ever. In the 2012 academic year, we reached $141 million in new research awards, a record for the college, and a substantial jump from 2010 when federal stimulus-funded research projects jumped our base to $137 million. In 2102, we received no such stimulus funding.

None of this would be possible without the help of our outstanding alumni and corporate support, especially in the face of shrinking state financial support. The efforts of several present and past members of the College of Engineering Advisory Board during the past six or so years helped spur the Signature Engineering Building into the reality it is today, as we spoke time and time again to the Virginia General Assembly and Governor's Office. We emphasized engineering as a core driver in the well-being and future enhancement of the state's economy, and our college as the engine behind that drive.

This past January, our alumni again joined us in Richmond for Hokie Day at the General Assembly, and I am confident we demonstrated the great contribution our College of Engineering makes to the state's future.

Speaking of engines and to return to the Signature Engineering Building, I would be remised if I did not single out alumnus **Phil Burkholder**, Rolls-Royce's executive vice president for engineering and technology, for helping us secure a Rolls-Royce Trent 1000 jet engine for the atrium of the new structure. The massive 15,000-pound engine hangs 15 feet above the floor in the building, installed this past summer by a team of engineers that included **David Childress** of construction company Gilbane Inc.

Childress, by the way, also is an alumnus of our civil engineering program and is another example of how our alumni remain a backbone of support, a perfect example of the past helping us herald, literally, into the future.

On page 3, you can read how the college honored Burkholder with a Distinguished Service Award. And on this page and page 8, you can see photos of the engine as it is being installed, and read about our plans to make the engine a learning tool for our students for years to come.

Let me assure you, these photos – great and thrilling as they are – do not do the site of the engine hanging in our new lobby justice. It must be seen in person, and I encourage all of you to visit Blacksburg once the building opens in spring 2014, and experience the lobby for yourself. Then tour the rest of the facility, and see how we at the College of Engineering are continuing to Invent the Future.

Richard C. Benson
Dean, College of Engineering

U.S. News *ranks college's graduate, undergraduate, online courses as best*

The College of Engineering the third consecutive year ranked 24th among the nation's best engineering schools for graduate studies, according to *U.S. News and World Report*'s America's Best Graduate Schools 2014 survey released in March.

Among public universities, it ranked in the top 15. For programs and departments: industrial and systems engineering as well as civil engineering each ranked seventh, with biological/agricultural engineering – also part of the College of Agriculture and Life Sciences – ranking ninth. Environmental ranked 13th; aerospace 15th; mechanical, 17th; and computer and electrical engineering (listed separately) at 19th.

In the September 2012 "America's Best Colleges 2013," looking at the undergraduate level, *U.S. News* ranked the College 16th overall in the nation, and sixth among public institutions. Among programs: Engineering science and mechanics ranked 5th; civil ranked ninth and environmental 12th; industrial and systems was at 10th; aerospace at 13th; mechanical at 15th; and electrical and computer each at 17th.

For only the second time, the magazine also ranked online-only programs, with the college at 13th in the nation for Best Online Graduate Engineering Programs. The listing made it the only such engineering program ranked from Virginia. The university's Master of Information Technology degree program – offered by the College of Engineering and the Pamplin College of Business – ranked third in the nation. The online IT program entails both the Departments of Computer Science and Electrical and Computer Engineering.

Tax-wise support for the College of Engineering

If your taxes are now higher, choosing the right asset for your gift to the College of Engineering may offer you even more tax savings than in the past. Donations of appreciated assets, such as securities and real estate you have owned for a year or more, typically bypass capital gains and ordinary income taxes. This reduces the effective cost of your gift when compared to a gift of cash.

Learn more about supporting the College of Engineering with a tax-wise gift. Phone **Erin Edwards** at (540) 231-4066 or e-mail eedwards@vt.edu or visit www.givingto.vt.edu.

engineering news

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ALUMNI NOTES

College honors new academy members, outstanding young alumnus for 2012

Virginia Tech's College of Engineering inducted seven new members into its Academy of Engineering Excellence, an elite group that now consists of only 112 people out of its more than 58,000 living alumni.

This year marked the 13th anniversary of the academy.

The 2012 academy inductees were:

Raymond Curry Jr., civil engineering, 1954. Founder of SMC Concrete Construction Inc. and Curry Development Inc., he has built office and apartment sectors, townhouses, single-family houses, retail centers, and industrial parks.

Thomas Digges Jr., metallurgical engineering, 1960. Worked at Newport News Shipbuilding, the Naval Research Laboratory, and at Texas Instruments before starting family-owned Virginia Semiconductor.

Marvin Johnson, electrical engineering, 1964. Began his career with General Motors, but joined small business, Lawless Detroit Diesel in 1973, and later Associated Diesel. In 1995 he was named president of the latter, now Associated Power.

Larry Marshall, aerospace engineering, 1966, and engineering science and mechanics, 1974. Spent 30 years with DuPont and retired as one of its Fellows, one of a dozen out of the 60,000 employees worldwide. He later launched Verdex Technologies.

Norris Mitchell, aerospace engineering, 1958. Hired by Douglas Aircraft (now McDonnell Douglas), he started working on aircraft development and then moved to its space division. Later he moved to think tank Research Analysis Corp. and then Science Applications International Corp., now called SAIC.

Left to right: Richard C. Benson, dean of the College of Engineering, Hobart Weaver, Maurizio Porfiri, Larry Marshall, Norris Mitchell, Marvin Johnson, Thomas Digges Jr., Raymond Curry Jr., and Samuel Shrader.

Samuel Shrader, mining engineering, 1963. Sustained 30-year career with Consol Energy starting in 1963, and by 1970 was promoted to regional industrial engineer. He was promoted to lead several Consol subsidiaries, retiring as senior vice president of its Eastern Region.

Hobart Weaver, mechanical engineering, 1950. After a long career with AT&T, working on projects as diverse as developing an anti-aircraft missile system, he was hired as vice president of marketing and sales for Methode Electronics. There he grew annual sales ten-fold.

The 2012 Outstanding Young Alumnus is **Maurizio Porfiri**, engineering mechanics, master's, 2000, doctorate, 2006. An associate professor at Polytechnic Institute of New York, *Popular Science* named him as one of its Brilliant 10 in 2012. The honor came in the wake of his research in designing robots that could engage and regulate the collective behavior of fish shoals.

College honors alumni for efforts in industry, philanthropy

The College of Engineering in 2012 honored **Phil Burkholder**, a 1986 honors graduate of the Department of Mechanical Engineering, with its Distinguished Service Award; and **Joseph R. Loring**, a 1947 graduate of the Department of Electrical Engineering, with its Distinguished Alumnus Award. As well, the Virginia Tech honored Loring with its University Alumni Distinguished Achievement Award.

Burkholder

Burkholder joined Rolls-Royce in 1986 after his graduation, and has since contributed to the propulsion system solutions for its aircraft, such as the Cessna Citation, the Global Hawk, and the F-35 Lightning II. He has four patented inventions and is a Fellow of the Royal Aeronautical Society, and has served on the College of Engineering Advisory Board from 2008 to 2012.

Burkholder was instrumental in the donation of a 14,000-pound Rolls-Royce Trent 1000 jet engine delivered from England and now hanging in the under-construction Signature Engineering Building. When the building opens in the spring of 2014, the engine – more than nine feet in width – will serve as a modern engineering marvel inspiring generations of talented students to pursue careers in science and in engineering, and as a centerpiece of art for the atrium. It now hangs the structure's main entrance.

With Burkholder's help, Rolls-Royce also is making a significant investment in the Commonwealth of Virginia, based on the state's substantial success in higher education. Rolls-Royce, Virginia Tech and the University of Virginia have established two research partnerships: the Commonwealth Center for Advanced Manufacturing in Petersburg, Va., and the Commonwealth Center for Aerospace Propulsion Systems, with centers in Charlottesville and Blacksburg.

Loring launched in 1956 the engineering firm Joseph R. Loring & Associates Inc., with the company now boasting offices in Washington, D.C., New York, and Princeton, N.J.

His firm designed the electrical systems for the twin 110-story towers comprising the World Trade Center in New York, then the world's tallest building. Other landmarks his company has helped in construction or renovation efforts: The Federal Parliament House atop Capitol Hill in the city of Canberra, Australia, the U.S. Supreme Court Building in Washington, D.C., and the King Fahd Airport in Dhahran, Saudi Arabia.

Loring

During work on the U.S. Supreme Court Building, the renovation project required that work be completed while the building was occupied. Loring described this project as one of the most challenging of his career.

Loring and his wife, Sheila Johnston, are members of the Virginia Tech's *Ut Prosim* Society. He has served on the advisory boards of the Bradley Department of Electrical and Computer Engineering and the College of Engineering. He is a member of the College's Committee of 100, and the College's Academy of Engineering Excellence.

Among many scholarships and other philanthropy efforts he has spearheaded at Virginia Tech, he has funded the Loring Professorship, currently held by **Saifur Rahman**, professor of electrical and computer engineering.

"Joseph Loring's exemplary career is a testament to his personal drive and skill as an engineer and as a businessman, and to the solid start his education at Virginia Tech gave him on the road to success," said **Richard C. Benson**, dean of the College of Engineering. "We can be proud to count him among our outstanding alumni."

Smith was devoted to work, home

C.W. "Bill" Smith, Alumni Distinguished Professor Emeritus of Engineering Science and Mechanics and a member of the Academy of Engineering Excellence at Virginia Tech, died July 30, 2012.

Born in Christiansburg, Smith lived in the same home his grandfather built in 1905 and where he was raised. The 1929 stock market crash and subsequent Great Depression forced the sale of the home, but Smith was able to purchase back the landmark building in 1948. He continued to live there until his health failed.

While attending Virginia Tech as an engineering student, he gained experience during his senior year teaching mathematics, and upon graduation accepted a job teaching in the engineering mechanics department Smith pursued his master's degree and became a full time instructor in 1948. When Smith earned his graduate degree in 1950, he was promoted to assistant professor, teaching five classes. His salary: $200 per month.

Smith

He attended short courses at MIT and at the University of Denver (Colorado) Research Institute.

He was later part of the then-groundbreaking U.S. Department of Defense 1969 Themis grant on composites and advanced materials, a project that catapulted Virginia Tech into the major research sector.

Smith's research of fracture mechanics is known "worldwide," as are his contributions to the discipline of photoelasticity.

In 1977, Virginia Tech presented Smith with its Alumni Award for Excellence in Research, and he also was named a Fellow by the Society for Experimental Mechanics. In 1986, he received NASA's Langley Research Center Scientific Achievement Award. More Fellowships followed: The American Academy of Mechanics in 1991 and American Society of Mechanical Engineers in 1996. The Society for Experimental Mechanics made him an honorary member in 2002.

His classroom efforts also received acclaim: In 1991, he received the statewide Dan Pletta Engineering Educator of the Year Award from the Virginia Schools of Engineering. He served as unofficial advisor to nearly 20 Department of Engineering Science and Mechanics seniors each year, directed some 50 graduate-level students, and helped establish a foreign-exchange program with Lomonosov Moscow State University.

In 1992, Smith retired but retained his status as an Alumni Distinguished Professor Emeritus. He continued to come to the office, and retained his research laboratory for another decade.

STUDENT NOTES

RoMeLa dominates robot soccer competition, will design robot for disaster relief missions

Virginia Tech's Robotics and Mechanisms Laboratory (RoMeLa) had another banner 2012, dominating RoboCup's international humanoid robot soccer competition for a second time. The group also signed on for the U.S. Department of Defense-sponsored DARPA Robotics Challenge, where the team will design and build a humanoid robot for intense disaster relief missions.

At the June 2012 Mexico City-hosted RoboCup, RoMeLa took first place finishes in the Adult Size class with the five-foot humanoid robot CHARLI-2 and the Kid Size class with the miniature-humanoid-robots DARwIn-OP. The second team was a joint effort of Virginia Tech undergraduate and graduate students and their counterparts from the University of Pennsylvania's College of Engineering in Philadelphia.

"This is two in a row," said an excited RoMeLa founder/director **Dennis Hong** as he and his students cheered and posed for photos after the finale match inside Mexico's World Trade Center. Added **Jack Newton**, a senior in mechanical engineering, and member of Team CHARLI: "It's amazing. Actually, I'm kind of speechless."

The combined winning Team CHARLI and Team DARwIn at RoboCup 2012 in Mexico City, both headed by mechanical engineering's Dennis Hong (far left, standing). Team DARwIn includes University of Pennsylvania engineering students, as well as those from Virginia Tech's College of Engineering.

An earlier incarnation of CHARLI-2 won the Louis Vuitton Cup at RoboCup 2011 in Istanbul, Turkey, bringing it to Blacksburg, Va., and to the United States for the first time. The tournament also marked the second year that RoMeLa used and won with the DARwIn-OP humanoid robots.

In fall 2012, RoMeLa took on the lead of an international team in developing a humanoid robot for intense disaster relief as part of the Robotics Challenge pitched by the Defense Advanced Research Projects Agency (DARPA). Hong calls the effort the "greatest challenge of my career."

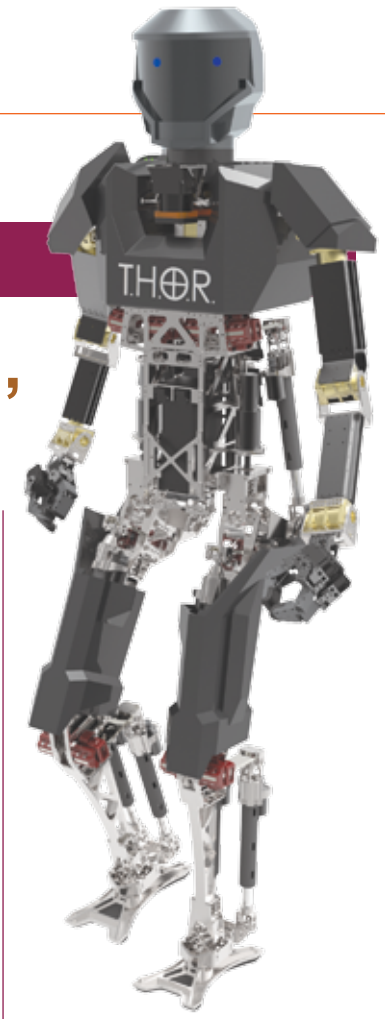
The task is massive: the adult-sized robot must be designed to enter a vehicle, drive it, and then exit the vehicle, walk over rubble, clear objects blocking a door, open the door, and enter a building. The robot then must visually and audibly locate and shut off a leaking valve, connect a hose or connector, climb an industrial ladder and traverse an industrial walkway. The final and possibly most difficult task: use a power tool and break through a concrete wall. All these tasks must be completed under a set time limit.

Virginia Tech will receive $4 million for the project.

The robot currently is in the build stage, with tests on arms and hands already underway. Its name: T.H.O.R. – short for Tactical Hazardous Operations Robot. Hong describes it as being "light, agile, and resilient with perception, planning, and human interface technology that infers a human operator's intent."

Joining Hong from Virginia Tech is **Craig Woolsey**, associate professor of aerospace and ocean engineering, and director of the Virginia Center for Autonomous Systems. **J.K. Han**, a former doctoral student of Hong's who developed the first incarnation of CHARLI, also will work on the project.

THOR team collaborators include: The University of Pennsylvania's robotics lab; ROBOTIS, a Korean-based robotics company that co-developed an open-platform version of the DARwIn-OP 'bots; and Harris Corp., an international communications and information company headquartered in Melbourne, Fla.



A rendering of Virginia Tech's DARPA Robotics Challenge robot THOR, short for Tactical Hazardous Operations Robot.

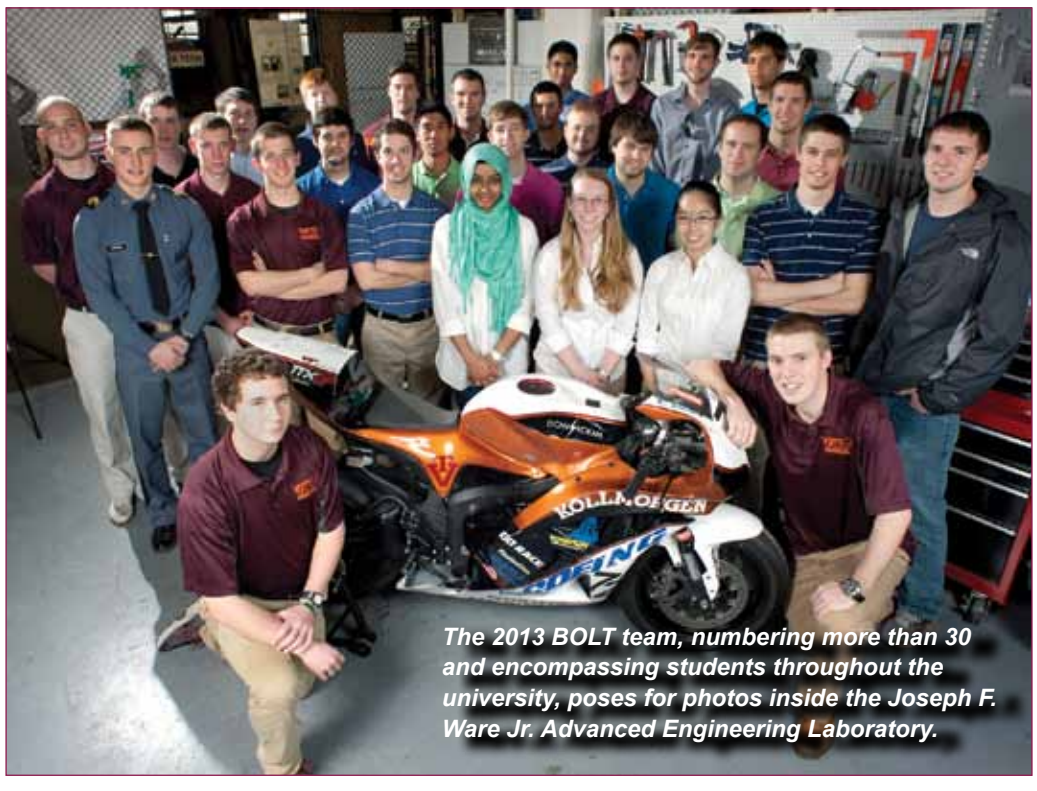
THOR will be partially based on efforts on another robot being developed at RoMeLa called SAFFiR, or Shipboard Autonomous Fire-Fighting Robot. Designed for the U.S. Navy, the humanoid robot will eventually fight fires aboard naval ships. On SAFFiR, Hong is teaming with fellow mechanical engineering professor **Brian Lattimer** and his EXTREME Lab, the latter which is developing the heat/ fire-sensing and suppression tasks of the robot. That project, like THOR, also is a multi-year mission.

Hokie electric motorcycle team holds own against professionals

A team of College of Engineering undergraduate students roared into the world of self-built electric-powered motorcycle racing, winning or placing near the top in several races throughout the United States in 2012 as part of the North American TTXGP eGrandPrIx's competition.

Virginia Tech's BOLT – that's short for Battery Operated Land Transportation – showing in the field, the world's first "zero toxic emissions" motorcycle race series, was indeed thrilling and full of prizes. It also was historic: BOLT was and remains the only university student-led team in the entire competition, going up against professional bike-building teams such as MotoCzysz and others from across North America.

"It is definitely a thrill, but most importantly we are just happy to be able to participate in the TTXGP and help forward electric vehicle technology," said **John Marshall**, a senior majoring in mechanical engineering. He was the team's leader during the 2012 year, and remains so in 2012. "If we come home at the end of the day with some trophies it is just icing on the cake. That being said this is a race team and we are out there to win, every stop will be pulled out in order to achieve this."



The 2013 BOLT team, numbering more than 30 and encompassing students throughout the university, poses for photos inside the Joseph F. Ware Jr. Advanced Engineering Laboratory.

The team had the chance to compete in a world finale at Daytona International Speedway in fall 2012, but deferred participating as the bike could not reach expected race-track speeds of international competitors. (One important note: The bike is not piloted during races by a student for insurance reasons, but by Matt Kent, an engineer at Goodyear Tire & Rubber Co. and professional racer, and others. Students on the team, however, either own personal street or race bikes. As well, they have piloted the BOLT bike in various test runs on the track.)

The 385-pound bike – a 2009 Honda CBR600RR – is completely electric powered, and was designed, built, and painted by students inside the Joseph F. Ware Jr. Advanced Engineering Laboratory. Mechanical Engineering Associate Professor **Saied Taheri** is the faculty adviser. This is the second electric motorcycle team effort overseen by Taheri, himself once a motorcycle sports participant and enthusiast.

Student members of the 2011-2012 BOLT team take the bike for a test run at the Virginia Tech Transportation Institute's Smart Road.

A new bike -- also using the body of a Honda CBR600RR – for the 2013 year already is in the construction stages at the Ware Lab.

Among the many sponsors of the team who donated equipment or financial support are: Areva Group North America, Boeing, Dow-Kokam, Dunlop, General Motors, Kollmorgen, Lockheed Martin, Penske, Solutia and a dozen others. Virginia Tech's Student Engineers' Council (see story, page five) also has donated several thousand dollars to the project during the past few years, as has the Ware Lab.

STUDENT NOTES

Virginia Tech Student Engineers' Council wins best in nation

The National Association of Engineering Student Councils honored the engineering students of Virginia Tech as having the nation's best and most philanthropic Student Engineers' Council in the nation for 2012.

Among many accolades, Virginia Tech Student Engineers' Council (SEC) was cited for its allocation of more than $100,000 to the university's College of Engineering in 2011, as well as more than $1 million in the past 10 years. This money was used for various engineering projects including: partially funding more than 30 engineering organizations such as the internationally award winning hybrid electric vehicle team; the outdoor-terrain motorsport team; and the Baja and Formula Society of Automotive Engineers' teams.

To fund these and other programs, the SEC sponsors and organizes one of the largest career fairs in the nation, attracting some 250 companies each year to the campus to recruit its engineering students. Each company pays a fee to attend the job fair, based on sponsorship level and overall participation.

With the revenue generated by the career fair, the SEC's executive group makes requests for proposals from engineering faculty and students on how to best spend the proceeds, while still making sure a portion is placed within one of the endowments held by the Virginia Tech Foundation.

"The students who make up our council dedicate most of their free time to the Student Engineers' Council because we all believe that what we are doing is making an incredible impact on so many people. Our devotion to the council is outstanding and never takes a break," said **Jeremy Codiroli** of Chesterfield, Va., the 2011-12 chairman of the council, and an industrial and systems engineering major.

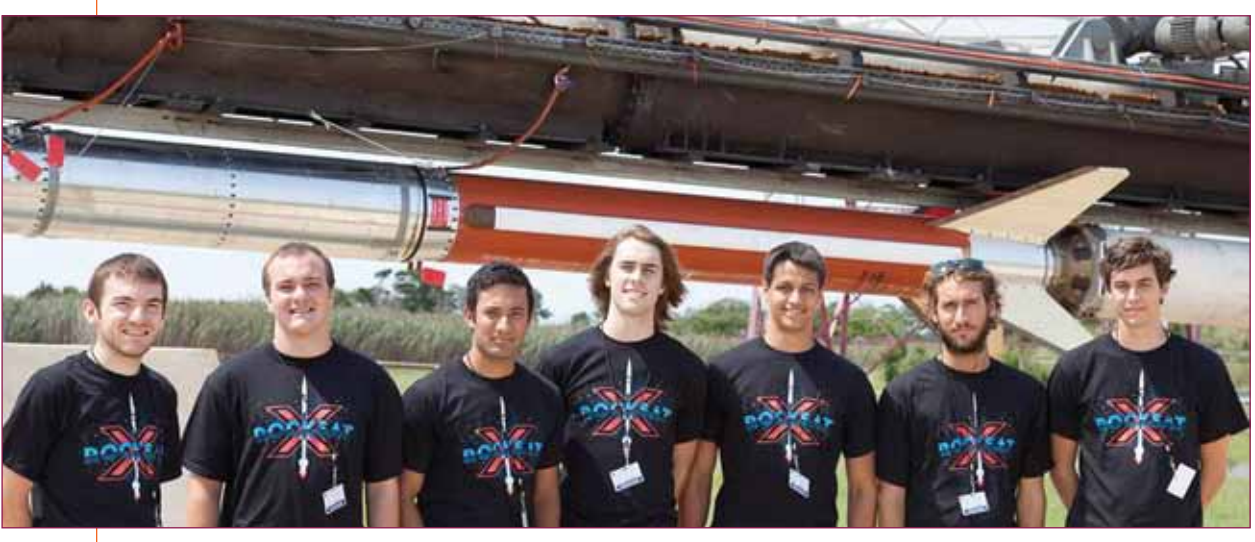
Among the activities the members of the council have also conducted are: the underwriting of community service projects; planning of an outreach program to collect school supplies for low-income kindergarten through 12th grade students; organization of a campus-wide Engineers' Week celebration; development of an annual Leadership in Engineering conference; distribution of schedule planners to freshmen to help with their campus orientation; and the awarding of three annual scholarships, also from endowed accounts.

More than 5,000 engineering students attend the Virginia Tech Student Engineers' annual Council Engineering Expo, a two-day job fair attracting more than 200 companies seeking interns and future employees.

In addition to Codiroli, the other executive members of the 2011-2012 council included: **Paul Asbury, Ben Clark, Ben Codiroli, Ross Cooper, Matthew Donaldson, Ben Drew, Alexander Dunlevy, Brian Keller, Allan Kirchoff, Alek Leckszas, John Lohr, Wes Matson, Dustin Moore, Dan Morton, Kevin Peterson**, and **Ashley Taylor**. **Lynn Nystrom** of the College of Engineering has served as the SEC faculty adviser for 33 years.

Students' experiments hitch ride on NASA rocket into space

A team of engineering students watched their experiments blast into space in September 2012, when NASA launched a 40-foot-long rocket from its Wallops Flight Facility, off the coast of Virginia, for an estimated 15-minute flight.



RockSat-X team includes (left to right) engineering students Stephen Noel of Christiansburg, Va., and a first-year master's student; Robbie Robertson of Fairfax, Va., and a doctoral student, and underclassmen Diwas Thapa of Kathmandu, Nepal; Brian McCarthy of Vienna, Va.; Ryan Hatton of Blairstown, N.J.; Jason Duane of Gainesville, Va.; and Mark Godine of Lynchburg College, Va. Not pictured is team member Rob Boone.

The launch was part of NASA's RockSat program, an educational project designed to provide students with hands-on experience in designing, fabricating, testing, and conducting experiments for space flight. The student team was tasked with designing a payload and power system to support several experimental projects, including an optical nitric oxide sensor and an aperture vacuum seal release mechanism for the Space Barometer CubeSat -- or a miniature box-like satellite -- instrument, both built by Hokie students. The payload also tested two inertial measurement units as tech demos and environmental validation for future navigation technologies.

"Launches at NASA Wallops are a sight to see," said team leader **Stephen Noel** of Christiansburg, Va., and a master's student in aerospace engineering who at Wallops. "A launch is even more significant and exciting when you have a piece of hardware or an experiment flying onboard."

Months after the launch, Noel said, "The majority of our instruments successfully collected data during the flight, and some of these technologies will be used on future CubeSat missions [and] the team of undergraduate students gained some very valuable experience." More similar projects are planned for Wallops with Virginia Tech students, including a launch expected in summer or fall 2013.

STUDENT HIGHLIGHTS

Aji

Ashwin Aji, of Blacksburg, a doctoral candidate in computer science, received one of 12 fellowships awarded worldwide for 2012-13 by global tech company NVIDIA. The $25,000 fellowship will be used in Aji's research, aimed at researching and developing next-generation supercomputing techniques.

Reza Arghandeh of Blacksburg, a doctoral candidate in electrical and computer engineering, was awarded the Association of Energy Engineers Scholarship Award in fall 2012. He also won best student paper at the American Society of Mechanical Engineering Power 2012 Conference's 20th International Conference on Nuclear Engineering.

For the third consecutive year, a team of computer science doctoral students won first place in the Institute of Electrical and Electronics Engineers Symposium's 3D User Interfaces contest. The team, also won the "People's Choice" award as voted by conference attendees. Members were: **Felipe Bacim** of Porto Alegre, Brazil; **Eric Ragan** of Pittsburgh; **Siroberto Scerbo** of Elizabeth City, N.C.; and **Cheryl Stinson** of Ottawa, Ontario, Canada.

Donté Elam of Midlothian, Va., a junior majoring in chemical engineering, won the 30-Day Sprint competition sponsored by the office of Virginia Gov. Bob McDonnell. The winning entry was selected from among 1,300 ideas submitted by state employees to help increase the state government efficiency.

A Department of Aerospace and Ocean Engineering student team won first place in the American Institute of Aeronautics and Astronautics Foundation's 2011–2012 Undergraduate Team Space Transportation Design Competition. Members were: **Nicole Heersema** of Mountainside, N.J.; **Tommy Hertz** of Fairfax, Va.; **Tom Kasmer** of Belmont, N.C.; **Maria Rye** of Oakton, Va.; **Matt Shepherd** of Annandale, Va.; **Matt Smith** of Virginia Beach, Va.; **Bryan Undercoffer** of Lexington, Va.; and **Greg Wheeler** of Chesapeake, Va.

AOE team

Min Li, a computer science doctoral candidate, received an IBM Fellowship, a worldwide program that honors doctoral students interested in solving problems of innovation. Li, of Blacksburg, researches cloud computing systems.

Devita McCullough of Colonial Heights, Va., and **Andrew Wickersham** of Blacksburg, are the College of Engineering's first Rolls Royce Doctoral Fellows. McCullough is a doctoral student in industrial and systems engineering, and previously earned a master's degree in biological systems engineering at Virginia Tech. Wickersham is a doctoral student in mechanical engineering.

Satyavrata Samavedi, of Madras, India, a chemical engineering doctoral student, was awarded a David W. and Lillian Francis Research Fellowship from the Virginia Tech Graduate School.

Virginia Tech took the top two slots at the second Student Competition on Cold-Formed Steel Design. The 2102 challenge: design an open section shape for a 48-inch-long cold-formed steel truss member. **Matthew Wilde** of civil engineering took first place, while **Armen Adekristi** of civil engineering, took second place. Both are from Blacksburg.

Ismail Zohdy of Cairo, Egypt, a doctoral student in civil engineering won the Best Scientific Paper Award for North America at the Intelligent Transportation Society World Congress in Vienna, Austria. The paper focused on autonomous vehicles and intersection controls.

The Hybrid Electric Vehicle Team of Virginia Tech received a GM car in summer 2012 as part of the EcoCAR 2: Plugging in to the Future campaign. The goal: re-engineer a stock vehicle into a more efficient vehicle while maintaining consumer acceptability. Now on its second year of the competition, the team is tasked with integrating year-one designs into a functional vehicle. Virginia Tech's previous HEVT group won the first EcoCAR Challenge in June 2011.

FACULTY ACHIEVEMENTS

Midkiff named vice president for information technology and chief information officer

Bradley Department of Electrical and Computer Engineering head **Scott F. Midkiff** was named as the university's vice president for information technology and chief information officer in October 2012. Paul Plassman, professor in the ECE, was named interim head of the department until a full-time replacement is found. The search is expected to conclude at the end of the spring 2013 semester.

"Professor Midkiff is a recognized authority on wireless networks, mobile systems, and pervasive computing," said university President **Charles Steger.** "He is eminently qualified and has the vision to serve as the university's next vice president for information technology and CIO. With his extensive academic background, he can address university computing, telecommunications, and network needs from multiple standpoints."

Midkiff added: "Information technology has never been more important to an organization than now, especially a research university. High performance computing is fundamental and essential to the research endeavor. In addition, we have already demonstrated the important linkage between information technology and the learning-teaching environment."


Midkiff

Midkiff arrived at Virginia Tech in 1986 and has developed and taught undergraduate and graduate courses in networking, wireless networks and mobile systems, network applications, and telecommunications. He was appointed head of the Bradley department in 2009.

Early in his career, Midkiff worked at the legendary Bell Laboratories from 1979 to 1982 and was a visiting research associate at Carnegie Mellon University from 1985 to 1986. From September 2006 until September 2009, he was on special assignment as a program director at the National Science Foundation before returning to Virginia Tech as department head.

While at the NSF he helped lead efforts to expand research into cyber-physical systems to improve the design of engineered systems with embedded computing and networking.

College names two department heads, three searches underway

Two departments within the College of Engineering recently named new leaders, while three others – Engineering Science and Mechanics, Electrical and Computer Engineering, and Chemical Engineering – are now searching for new heads.


Paterson

Eric Paterson, an expert in computational fluid dynamics, was named head of the Department of Aerospace and Ocean Engineering in summer 2012, taking over a position held by **Chris Hall**, who left the college in summer 2011 for a position at the University of New Mexico.

Patterson previously was at Pennsylvania State University's Applied Research Lab, the chief scientist of the computational mechanics division of the Applied Research Lab, and a professor of mechanical engineering. His research has focused on ship and submarine hydrodynamics, cardiovascular fluid dynamics and heart-assist devices, and explosives trace detection.


Parker

Robert G. Parker, a past recipient of the Presidential Early Career Award for Scientists and Engineers (PECASE), was named head of the Department of Mechanical Engineering during summer 2012 as well. He takes over the position from **Ken Ball**, who left for George Mason University.

Parker was executive dean at the University of Michigan-Shanghai Jiao Tong University Joint Institute. Before that, he was at Ohio State University, where he directed its Dynamics and Vibration Laboratory and received many awards for the excellence of his teaching and research on the dynamics and vibration of high-speed mechanical systems.

In other changes: Engineering Science and Mechanics' **Ishwar Puri** is leaving for a position at McMaster University in Ontario, Canada. An interim head has not yet been named. In chemical engineering, department head **John Walz** left for the University of Kentucky, with professor **David Cox** now serving as interim head. A replacement for electrical and computer engineering head **Scott Midkiff** also is underway. (See story above.)

Engineering faculty win NSF CAREER awards for research

Two College of Engineering assistant professors received the National Science Foundation's Faculty Early Career Development Program (CAREER) award during the past year.

Joseph Baker, assistant professor and Steven O. Lane Junior Faculty Fellow of Electrical and Computer Engineering, will use his five-year $480,000 award to study inter-hemispheric space weather connections, specifically possible similar perturbations in the northern and southern ionospheres.

Space weather refers to dynamics in the near-Earth space environment that can have serious impacts on technological systems such as satellites, electrical power grids, and communication networks, said Baker. Many of these influences are manifested in the "ionosphere," the electrically charged component of the Earth's upper atmosphere.

Baker will use simultaneous measurements from the Super Dual Auroral Radar Network, or SuperDARN for short, radars in both the hemispheres to investigate the inter-hemispheric magnetic conjugacy of ionospheric irregularities and plasma convection.


Baker

The College of Engineering has a longtime relationship with the international SuperDARN collaboration, operating five SuperDARN radars in Canada and the United States, and is involved in ongoing efforts to build several more such installations.

Christopher Williams, also an assistant professor in the departments of mechanical engineering and engineering education, will use his award – also for five years and for $480,000 – to further research into the burgeoning field of 3D additive manufacturing. (See story, page 1.) Here, Williams will be working with copper materials.


Williams

Additive Manufacturing, or 3D printing, entails creating objects by depositing or forming material one cross-sectional layer at a time. Due to the layer-by-layer fabrication approach, this technology allows complex shapes and designs that cannot be fabricated by traditional manufacturing techniques. However, no current process has effectively used copper as a material.

The new approach would involve 3D printing of a nanoparticle-filled binder into a bed of copper oxide powder, followed by a headed chemical process to convert the printed part to metallic copper. The proposed research could result in the future fabrication of copper cellular materials, and find uses in a number of goods.

Researchers break puzzle on why flu more prevalent in winter, rain


Marr

Linsey Marr, associate professor of civil and environmental engineering, and her doctoral student, **Wan Yang**, working with Elankumaran Subbiah, virologist with the Virginia-Maryland Regional College of Veterinary Medicine, have measured the influenza A virus survival rate at various levels of humidity.

Their study presents for the first time a relationship between the influenza A virus viability in human mucus and varying humidities, from 17 percent to 100 percent. The study is based on the fact that influenza has distinct transmission patterns around the world. In temperate regions, its occurrence peaks during winter, while in some tropical regions, trends lean toward rainy seasons.

Marr and Yang found the viability of the flu A virus was highest when the relative humidity was either close to 100 percent or below 50 percent. The results in human mucus may help explain influenza's seasonality in different regions. "We added flu viruses to droplets of simulated respiratory fluid and to actual human mucus and then measured what fraction survived after exposure to low, medium, and high relative humidities," said Marr.

At low humidity, respiratory droplets completely evaporate and the virus survives well under dry conditions. But at moderate humidity, the droplets only partially evaporate, leaving the virus exposed to higher levels of chemicals in the fluid and compromising the virus' ability to infect cells.

In a past study also led by the trio, researchers collected samples from a health care center waiting room, two toddlers' rooms, and one babies' area of a day care center, as well as three cross-country flights. Findings showed the average concentration was 16,000 viruses per cubic meter of air, and the majority of the viruses were associated with fine particles, less than 2.5 micrometers, which can remain suspended for hours.

Possible explanations for the seasonality of the flu have been investigated, such as the return of children to school, people spending more time indoors in the winter, and lower light levels that affect the immune system, but there is no agreement on them, said Marr.

The researchers found humidity could explain the seasonality of influenza by controlling the ability of viruses to remain infectious while they are in droplets or aerosols. The viruses survived best at low humidity, such as those found indoors in the winter, and at extremely high humidity. Humidity affects the composition of the fluid, namely the concentrations of salts and proteins in respiratory droplets, and this affects the survival rates of the flu virus.

FACULTY ACHIEVEMENTS

Devenport teams with GE on wind turbine project

Department of Aerospace and Ocean Engineering's **William Devenport** is taking part in a multi-group effort to manufacture wind turbine blades comprised of fabric stretched across a frame rather than rigid fiberglass blades. The hoped payoff: much larger wind turbines with higher efficiency and lower costs.

The U.S. Department of Energy's Advanced Research Project Agency, the National Renewable Energy Laboratory, and GE are collaborating on the $3.7 million project, along with Virginia Tech's Devenport, professor of aerospace engineering, and Aurelien Borgoltz, a research scientist with the college.

These planned blades would be manufactured in sections and assembled on site, enabling construction costs far less than currently demanded. The reduced cost "represents a significant step toward making onshore wind energy production even more economical as other forms of fossil fuel based energy production without any subsidies," the research team wrote in their proposal to the energy department.

This new manufacturing method addresses challenges with the current technology that is looking to produce longer blades, often exceeding 120 meters, in order to increase power output. The majority of the current wind turbines have rotor diameters of 50 to 100 meters. The longer blades create multiple problems: transportation requirements, stiffness of material, and equipment needs. Plus weight.

The use of wind blades would need to grow by some 50 percent to achieve a national goal of having the U.S. rely on wind power for 20 percent of its energy needs. Devenport's expertise would be used to test the aerodynamics and aeroacoustics of the new blades, using the Stability Wind Tunnel, located behind Randolph Hall.

FACULTY HIGHLIGHTS

Jaime Camelio and **Kimberly Ellis**, associate professors of industrial and systems engineering, are part of a $1 million-grant National Science Foundation-funded team to optimize laboratory processes used in making custom DNA.

The Virginia Tech Faculty Entrepreneur Hall of Fame inducted **Richard Claus**, the Willis G. Worcester Emeritus Professor of electrical and computer engineering; **Fred Lee**, a University Distinguished Professor and director of the Center for Power Electronics Systems; and **Arvid Myklebust**, professor emeritus of mechanical engineering, among its first class of honorees in April 2012.


Davis

The Virginia Tech Board of Visitors honored **William Davis** of computer engineering, **John Novak** of civil and environmental engineering, and **Hanif Sherali** of industrial and systems engineering, all as professors emeritus at its March 2013 meeting.

The American Society of Civil Engineers presented its 2012 Hans Albert Einstein Award to **Panos Diplas**, professor of civil and environmental engineering. He also was part of a team to win the 2012 Karl Emil Hilgard Hydraulic Prize from ASCE.

Stefan Duma, head of the Virginia Tech–Wake Forest University School of Biomedical Engineering and Sciences, is expanding his groundbreaking research of testing football helmets to reduce the number of concussions into the sports of hockey, baseball, and lacrosse.

The Virginia Tech Student Engineers' Council selected **Preston Durrill**, adjunct professor of the chemical engineering, as its 2012 recipient of the Sporn Award for Excellence in Engineering Education.

Marc Edwards, the Charles P. Lunsford Professor of Civil and Environmental Engineering, was awarded the Institute of Electrical and Electronics Engineers' Carl Barus Award for Outstanding Service in the Public Interest.

The State Council of Higher Education for Virginia named **Stephen Edwards**, associate professor of computer science, as a 2013 Virginia Outstanding Faculty Award winner. As well, the Virginia Tech Board of Visitors appointed him the W.S. "Pete" White Chair for Innovation in Engineering Education.

The Virginia Tech Board of Visitors named **Srinath Ekkad**, professor of mechanical engineering, as the Commonwealth Professor for Aerospace Propulsion Systems at Virginia Tech.


Feng

Wu Feng, associate professor of computer engineering, was awarded $6 million by the U.S. Air Force to use supercomputers to boost speeds in the test simulations of unmanned Micro-Air Vehicles. He also is part of a $2 million National Science Foundation/National Institutes of Health-funded study to develop quicker large-scale data analytics efforts.

The National Science Foundation and the Office of Naval Research are funding research work by **Thomas Hou**, professor of electrical and computer engineering, **Wenjing Lou**, associate professor of computer science, and **Hanif Sherali**, professor of industrial and systems engineering, to boost spectrum sharing among frequency air space for cognitive radios.


Sherali

Sunghwan Jung, assistant professor of engineering science and mechanics, will lead a National Science Foundation-funded study of how water-running lizard's dart across water surfaces, and how dogs and cats drink. **Jake Socha** and **Pavlos Vlachos**, both of the college, also are working on the research.

Michael Karmis, the Stonie Barker Chair of Mining and Minerals Engineering, received the first Gunter Fettweis Award from the international Society of Mining Professors.

Brian Kleiner, director of the Myers–Lawson School of Construction, has been awarded a $1 million, five-year grant by the National Institute of Safety and Health to study how the U.S. construction can reduce work-related injuries and deaths for construction workers.

The Virginia Tech Board of Visitors named the following professorships: **John C. Little** was appointed the Charles E. Via Jr. Professor of Civil and Environmental Engineering; **Padma Rajagopalan** was awarded the Robert H. Hord Jr. Chemical Engineering Fellowship; and **Peter Rim** was reappointed the Joseph H. Collie Professor of Chemical Engineering.

Todd Lowe, assistant professor of aerospace engineering, and **Wing Ng** of mechanical engineering, are working on a multi-year, $600,000 U.S. Office of Naval Research project to reduce the deafening noise created by fighter jets while in flight.

The Virginia Tech Board of Visitors named **Y.A. Liu**, the Frank C. Vilbrandt Professor of Chemical Engineering, an Alumni Distinguished Professor.


McCue-Weil

The American Society of Naval Engineers honored **Leigh McCue-Weil**, associate professor of aerospace and ocean engineering, with its Rosenblatt Young Naval Engineer Award.

Kathleen Meehan, associate professor of electrical and computer engineering, was one of four professors nationally named by Analog Devices Inc. as a strategic advocate to its ADI University Program.

Walter O'Brien, the J. Bernard Jones Professor of Mechanical Engineering, was awarded the Industrial Gas Turbine Institute's Aircraft Engine Technology Award at the 2012 American Society of Mechanical Engineers Turbo Expo.

Shashank Priya, professor of mechanical engineering, received a five-year Turner Fellowship as voted by Virginia Tech Board of Visitors.

The Alfred P. Sloan Foundation awarded $250,000 to **Amy Pruden**, associate professor of civil and environmental engineering, to study the effects of pipe material, water flow, and chemistry on the building plumbing microbiome. Her multi-university team includes fellow CEE professor **Marc Edwards**.

The Institute of Electrical and Electronics Engineers' U.S. chapter honored **Saifur Rahman**, the Joseph Loring Professor of Electrical and Computer Engineering, with its Divisional Professional Leadership Award.

Jeffrey Reed, professor of electrical and computer engineering, was awarded the Wireless Innovation Forum's 2012 Forum International Achievement Award for his contributions to new radio technologies.

Eli Tilevich, associate professor of computer science, received one of 10 awards worldwide from the Microsoft Research Software Engineering Innovation Foundation for his research work on mobile devices and platforms.


von Spakovsky

Michael von Spakovsky, professor of mechanical engineering, and **Charles E. Smith**, a postdoctoral associate with biomedical engineering, jointly won the American Society of Mechanical Engineers' Edward F. Obert Award for a breakthrough research paper on intrinsic quantum thermodynamics.


White

Jules White of electrical and computer engineering co-developed an app that allows users to see 4D images of any building, product, street scene, or object. The tech was licensed to the investment firm Allied Minds Inc., and won a 2013 Design and Engineering Award from the Consumer Electronics Association, among other honors.


Young-Corbett

Deborah Young-Corbett, assistant professor of civil and environmental engineering, garnered national media coverage for her work on Prevention through Design, or PtD, a new research field of construction work safety measures, following her publication in the *Journal of Civil Engineering and Management*.

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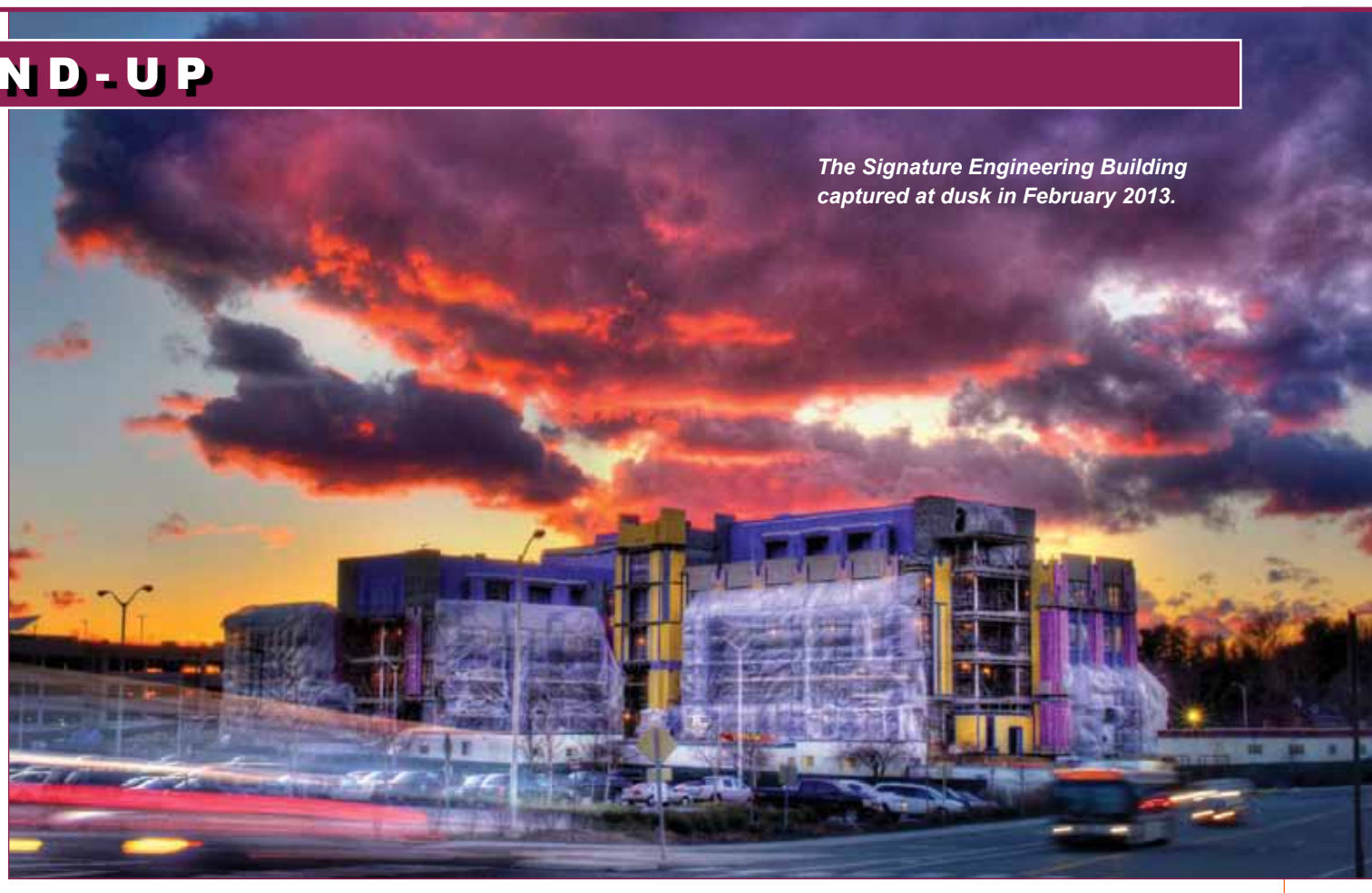
NEWS ROUND-UP

Rolls-Royce donates a jet engine to serve as centerpiece

Construction on Signature Engineering Building continues with early 2014 opening eyed



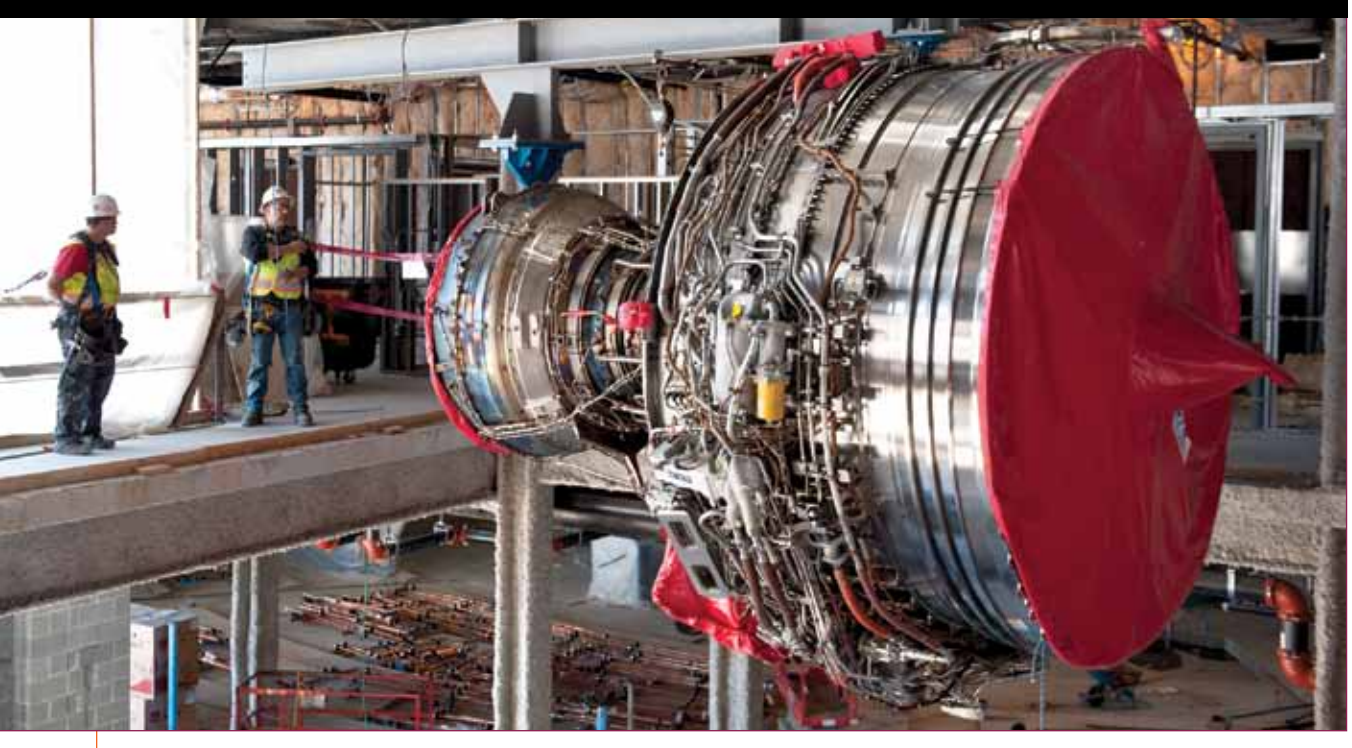
The Signature Engineering Building captured at dusk in February 2013.

When the Signature Engineering Building opens in early 2014, students, faculty, staff, and all visitors will have a unique centerpiece hanging inside the atrium of the $100 million structure – a massive Rolls-Royce Trent 1000 jet engine.

The engine arrived at the Signature Engineering Building this past August, and was installed over the entrance atrium several months later by engineers from Rolls-Royce, Gilbane Construction Co. – the contractor for the Signature Engineering Building – and others. The lifting process, and bolting the engine into its place, took more than two days. It now hangs suspended 15 feet above the floor.

The building is being constructed around the engine, which will remain in a protective cover until the structure opens in spring 2014. Rolls-Royce plans to outfit the lobby of the building with interactive kiosks containing information on engine design and advanced manufacturing to inform and excite students about careers in engineering.

Engineers carefully lifted the Trent 1000, weighing roughly 15,000 pounds, into place inside the atrium of the Signature Engineering Building.



"We hope our Trent 1000 engine, a modern engineering marvel, will serve as a symbol of excellence and inspire generations of talented students to pursue careers in science and engineering," said **Phil Burkholder**, Rolls-Royce's executive vice president for engineering and technology and an alumnus of the College of Engineering. (See story on Burkholder, page 3.)

Rolls-Royce calls the Trent 1000 "the cleanest, quietest, lightest, and most fuel-efficient jet engine in aviation service today." Additional interesting factoids: The blade tip travels at more than 900 mph --faster than the speed of sound, and each high-pressure turbine blade produces more than 800 horsepower, equal to a NASCAR engine.

"Rolls-Royce is making a significant investment in Virginia based on the Commonwealth's substantial success in higher education," said **Richard C. Benson**, dean of the College of Engineering. "Its partnership with the College of Engineering at Virginia Tech is innovative, allowing collaboration on a variety of fronts in engineering. Our long-standing activities in advanced manufacturing enable our engineering faculty and students to move quickly into research projects that Rolls-Royce will find interesting. And the display of the Rolls-Royce engine in our new state-of-the-art academic building will serve as an inspiration to tomorrow's leaders in the engineering field."

TAILGATES: ***Engineering is a Contact Sport.*** For information on 2013 pre-game tailgates for alumni, visit **www.eng.vt.edu/alumni**