Students Invent Sound-Wave Fire Extinguisher

A thumping bass may do more than light up a party—it could flat out extinguish it, thanks to a new sound-blasting fire extinguisher created by George Mason University undergrads.

The fire extinguisher uses low-frequency sound waves to douse a blaze. Engineering seniors Viet Tran and Seth Robertson now hold a preliminary patent application for their potentially revolutionizing device.

The idea to fight fire with sound waves came when they were choosing a class project for ECE 492 and 493, Advanced Senior Design, where students produce and present a project for a final grade.

Tran and Robertson’s 20-pound, Flash Gordon-style prototype was born through $600 of their own money and about as many trials. Their sound-wave device is free of toxic chemicals and eliminates collateral damage from sprinkler systems. If mounted on drones, it could improve safety for firefighters confronting large forest fires or urban blazes.

Initially, both students thought big speakers and high frequencies would douse a fire.

“But it’s low-frequency sounds—like the thump-thump bass in hip-hop that works,” says Tran, who joked that rappers like 50 Cent could probably douse a fire, and that hip-hop celebrity endorsements might be just the ticket to hawk their fire extinguisher.

“Some students take the safe path, but Viet and Seth took the higher-risk option.”
Dear Alumni and Friends,

Welcome to the inaugural newsletter for the Department of Electrical and Computer Engineering at George Mason University. Since coming to Mason just a little over a year ago, I have been amazed by the talent, professionalism, collegiality, and enthusiasm of the faculty and staff. Working with a faculty that has a shared vision for excellence in teaching, research, service, and outreach along with a culture of collaboration and support both within and outside the department makes the job of being a department chair exciting and rewarding. In this and future newsletters, I hope to share stories about the excitement and innovation within the department and throughout the university.

George Mason University has grown from one small building, established as a branch of the University of Virginia in 1957, to the largest public research university in the Commonwealth of Virginia. Today Mason educates 34,000 students on five campuses. In 1985, the university established the Volgenau School of Engineering with an initial focus on information technology-based engineering. Since then the school has experienced explosive growth. It currently offers 34 different degree programs spread across eight departments. After experiencing an 18 percent increase in enrollment this past year, the Volgenau School of Engineering has become the fastest growing school at Mason.

The Department of Electrical and Computer Engineering is actively engaged in a wide variety of amazing and challenging research projects in fields ranging from electronics to communications, from signal processing to big data, and from controls and robotics to computer engineering and cyber physical systems. With nine IEEE Fellows, seven National Science Foundation CAREER Awards, and one Office of Naval Research Young Investigator Award, and a total of 28 faculty members holding more than 35 patents, the department is also engaged and committed to excellence and innovation in education.

In this newsletter, you will find articles related to our engineering degree programs, including a remarkable story about an invention developed by two undergraduates for their senior design project that received worldwide media attention and even an appearance on the Tonight Show Starring Jimmy Fallon. You will also meet some of our new faculty and hear about well-deserved awards.

I invite you to follow us on Facebook, and I look forward to sharing more news and stories of our department in the future.

Monson H. Hayes
Chair, Department of Electrical and Computer Engineering
Listening to the Ocean

Kathleen Wage’s love of the ocean led her to study its sounds. An associate professor in the Department of Electrical and Computer Engineering, Wage studies sounds in the ocean and enjoys spending time on research ships. Not surprisingly, the U.S. Navy is interested in this type of work, and her Ocean Acoustic Signal Processing group has received nearly $1 million in funding from the Office of Naval Research for two separate grants.

From the time she was an undergraduate at the University of Tennessee–Knoxville to when she interned at Oak Ridge National Laboratory, through her graduate work at Woods Hole Oceanographic Institution and her recent project in the Philippine Sea, Wage has been interested in signal processing and how sound travels under water.

"Under water there is no such thing as GPS, and sound is the only effective way to determine the position of submerged objects," says Wage. "Sound travels differently in the ocean than it does in the air. It travels much farther and at a very low frequency. It doesn’t travel in a straight line, and it is affected much more by ambient or background noise."

Wage has been at Mason since 1999 teaching and researching problems that blend array processing, acoustics, and oceanography. Her current research combines her knowledge of signal processing and her love of the ocean. Wage’s research group is collaborating with University of Hawaii oceanographer Lora Van Uffelen. In this study, they aim to characterize ambient noise in the deep ocean, understand how sounds scatter due to internal waves, and develop new processing techniques that make acoustic tomography easier to use by employing stationary and mobile platforms.

From 2009 to 2011, Wage spent 55 days onboard research ships, deploying arrays of hydrophones (underwater microphones) and other equipment. Now her group is focusing on analyzing data from a 5-km long vertical line array from this voyage. The research is relevant for a number of applications, including tracking seasonal variability of the ocean environment, detecting submarines, and conducting seismic surveys.

Earlier, the team was awarded a grant for work on co-prime sensor array processing. The ONR Basic Research Challenge program funds this project, which will investigate techniques for designing sonar arrays that require fewer sensors, making them more cost-effective and energy efficient.

Wage hasn’t been at sea since the Philippine Sea, or PhilSea, experiments in 2011, and says she misses the ocean environment.

“My time now is spent with my team here at Mason, running programs and analyzing the data,” says Wage. “The emphasis on real data, as opposed to simulated data, is a theme that runs throughout our research. As important as simulations are, things often look different on paper than they do in the physical world.”

Her next ocean voyage to gather more data may take her to the Arctic to measure the noise of the polar icecaps.

“We know more about the surface of the moon than we do about the earth’s oceans,” she says.
Janos Gertler Retires

When the Volgenau School of Engineering opened 30 years ago, Dr. Janos Gertler was one of its first faculty members. This May he will retire. Gertler has been an integral part of both research and teaching in control theory, and we will miss him. We asked him a few questions to learn more about his experiences at Mason and hear about his plans for the future.

What has been the focus of your research while at Mason, and how did it change over time?

My general field of interest was digital control and systems identification; within this I did my research in fault detection and diagnosis in engineering systems, at the intersection of control and signal processing. I was doing general methodology in model-based methods. I was then fortunate to develop a long-lasting collaboration with General Motors (GM) that allowed me to work on some very practical applications. The financial support we received from GM also made it possible for us (with several graduate students) to extend our methodological work. Later we developed methods facilitating automated fault diagnosis using Principal Component Analysis. This work was done in collaboration with the University of Maryland and supported by a couple of National Science Foundation grants.

More recently I spent several years working on the macroeconomic modeling of the effect offshoring and rehiring had on the U.S. economy.

What do you view as your most significant accomplishments during your time at Mason?

The two decades from 1985 to 2005 were professionally the most productive period of my life. This is somewhat surprising since I was not very young then. I published many papers and wrote a book on fault detection and diagnosis. I was invited to deliver plenary or keynote papers on the subject at seven international conferences. My work has been cited about 6,000 times in the international literature, including about 2,000 citations of the book (Publish or Perish—Google Scholar).

The GM work was particularly rewarding. The algorithm we developed at Mason, in collaboration with colleagues at GM, has since been implemented on millions of GM cars. So if you drive a Chevy or a Cadillac and the “check engine” light comes on, think of us.

I was also very active in the International Federation of Automatic Control (IFAC), where I served in a number of leadership positions. Among other things, I was the chair for six years (and a member for 35) of the Managing Board of IFAC Publications, a joint venture with Elsevier Science responsible for the publication of six journals and the proceedings of about 30 conferences annually. I was also the editor-in-chief of one of IFAC’s journals, Annual Reviews in Control, for 19 years.

What have you found to be the most rewarding part of being a faculty member in ECE?

I really appreciated the collegial atmosphere of the department. Several members of the department I am proud to consider my personal friends and I never had any conflict with anybody. I enjoyed very much working with bright graduate students. In almost all of our major papers (that is, the diagnosis methods we developed) there was an important idea that came from a student.

What are your plans for retirement?

My dream is a house at the waterside, with a rowboat, at a place where it is summer all year long—but this will not happen (and I would get bored soon anyway). More realistically, I may continue teaching at Mason as an emeritus. Also, my friends at the Technical University of Catalonia (in Terrassa, Barcelona) have invited me to do some teaching there. I would also like to work with multicultural groups of students, sharing my own multicultural experiences and thoughts with them. And I want definitely to spend more time with my granddaughter.
Cybersecurity protects digital data and systems, no matter where or how that data is stored and transmitted, regardless of the nature of the systems processing and storing that data. The scope of cybersecurity can be intimidating—a well-written and secure application that transmits data over encrypted channels may still expose that data at rest on a mobile device. It may leak the cryptographic keys through side channel attacks or through vulnerabilities in supporting software. If an attacker discovers a single vulnerable point, that may compromise all of the data or an entire system. Securing data and systems means keeping them safe against every possible attack.

The general public may not understand such low-level operations or how to secure them, but the cyber attacker community does. ECE faculty and students combine engineering with technical and creative skills to discover system vulnerabilities and devise fixes before the systems are put into production, and they address these issues at low levels.

For example, one ECE research group tests hardware implementations of cryptographic algorithms, looking for inadvertent and subtle leakage in the circuits that would expose the system to an attack. Another group is exploring the security of Unmanned Aerial Vehicles, especially the security (or lack of it) in control communications. ECE faculty is exploring the security of physical control systems, finding vulnerabilities in systems such as traffic light controllers. And related research has implemented traffic modification attacks in video messaging and IP network communications. Yet another collaborative ECE research group is extracting and reasoning over digital fragments recovered from traditional storage devices, work which is being extended to flash memory, mobile, and Internet-of-Things devices.

In addition to their research, ECE faculty develops and teaches classes in network security, industrial control systems security, secure RF communications, cyber physical systems, embedded and real-time systems, power grid security, and cryptography. As digital data and systems continue to expand, the need to secure such data and systems at all levels will become increasingly important. ECE faculty use their research to inform students who will become tomorrow’s cybersecurity workforce.
Over the last year, several of our faculty and staff have been recognized for their excellence in and outside the classroom. A big shout-out to our superheroes:

**NATHALIA PEIXOTO**—2015 University Teaching Excellence Award

**PELIN KURTA**—Mason Teacher of Distinction

**SMRITI KANSAL**—Certificate of Excellence for Outstanding Achievement in the Field of Academic Advising

**PATRICIA SAHS**—Exceptional Support Award

**CARL SCHAEFRER**—Adjunct Faculty Service Award

There is no doubt that these are very well-deserved awards, and we owe each of these individuals our thanks for the outstanding contributions they make to ECE here at Mason.

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**Sound-Wave Fire Extinguisher, continued from page 1**

It has taken time for their idea to catch on. In researching ideas for the class project, Tran learned that the Defense Advanced Research Projects Agency was working on the concept, and that West Georgia University was working on a similar project called Prometheus. So Tran thought, “Why don’t we be the ones to make it happen?”

Robertson and Tran’s classmates were envious of the idea, saying, “You guys will make us fail.” Several professors also threw cold water on their idea before the pair convinced Electrical and Computer Engineering professor Brian Mark to mentor their project.

“My initial impression was that it wouldn’t work,” he says. “Some students take the safe path, but Viet and Seth took the higher-risk option.”

Mark knew nothing about fire extinguishers, so he took a wee step into the abyss himself.

“They’re really special,” Mark says. “Viet is the idea man, and Seth is practical. At the final presentation, he wanted to use some fancy new presentation technology, but Seth convinced Viet to stick with a simple PowerPoint. They didn’t win the competition, but their presentation before a large audience was impressive.”

The inventors make a powerful team. They met as freshmen. Tran, an admitted sub-stellar student in high school, learned study discipline from Robertson, a student athlete who mastered time management.

“I’d wake up at six after we studied until three in the morning, and he’d already be at wrestling practice,” Tran says.

Mason helped the inventors apply for a provisional patent.

“The provisional patent application they filed gives them a year to talk publicly about the invention, to test the market, and to determine whether pursuing the patent makes sense,” says Carolyn Klenner, an intellectual property paralegal in Mason’s Office of Technology Transfer. Klenner assisted them with the patent application.

Keep your eye on these young inventors.
By Bernd-Peter Paris, Director, MS in Telecommunications

By just about any metric, the graduate program in telecommunications (TCOM) continues to be popular and successful. Within the Volgenau School, the program is among the graduate programs with the strongest enrollment and largest numbers of graduates. These graduates continue to find jobs with corporations such as Lockheed Martin, Intelsat, Hughes Network Systems, Juniper, Cisco, and Qualcomm.

The success of the TCOM program rests on three cornerstones: 1) the talent and hard work of our graduates; 2) the program’s emphasis on developing and maintaining a curriculum focused on relevant, practical aspects of telecommunications; and 3) a cadre of excellent adjunct faculty who bring their experience and insight to the classroom every week.

One of those faculty members, adjunct professor Saeed Agbariah, completed his doctoral studies in May by defending his PhD dissertation “Automated Policy Compliance and Change Detection in Data Networks.” Many of you have taken the Switching Lab (TCOM 514) with Saeed, and I encourage you to congratulate him on this outstanding accomplishment.

On the topic of doctoral research, TCOM graduate Sudhanshu Chandekar has recently been advanced to doctoral candidacy, the last hurdle before defending his thesis in the area of IP geolocation. He is expected to complete his research and defend his thesis next year.

One event that stands out from the academic year that illustrates our strong connection to industry is the Annual Engineering Student Competition. This event, sponsored by the Mid-Atlantic chapter of the Society of Satellite Professionals International (SSPI), has been held for five years and has grown in participation and attendance every year. More than 100 students and satellite professionals attended the student presentations we hosted last April, and teams from local universities competed for prizes sponsored by SSPI. Students benefit academically, and possibly financially, from the experience to present to a panel of industry experts and obtain the feedback they provide. The event also creates awareness among students about the challenges that exist in their field and allows them to interact with future graduates.

I would like to conclude this first installment of the news column with a reminder that the TCOM program office wants to stay in touch with you. Look for us on LinkedIn and on Facebook — both links can be found at telecom.gmu.edu. If you have not joined either of these groups, we encourage you to do so.

Protect Data From Unwanted Exposure

Bob Osgood, Director, Computer Forensics

The media has been rife with reports of computer wiping. What is computer wiping? How does it affect the recovery of data? Why should the ordinary person have some knowledge of data wiping?

Digital media should never be disposed of without wiping, or physically destroying or degaussing, the drive. The risk of exposing sensitive and personally identifying information is too great. It’s better to be safe than sorry.

When users delete a file, the file is not removed from storage (hard drive). Instead, the operating system removes the listing of that file from the directory and releases the file’s space for use. Until the operating system overwrites that space with a new file, the old deleted file data remains.

The amount of time it takes to overwrite a file varies, but it is possible that data from a deleted file could remain for a considerable amount of time. On an active server, this residual latency is much shorter. The recovery of a deleted file is often possible with easily obtainable software, but there is no guarantee that a file can be recovered.

To remove data permanently, the space on the media must be wiped. Wiping means intentionally overwriting disk space and obliterating what was originally there. A file or file system that is wiped is no longer recoverable. The disk can be overwritten with a random pattern or with all 0’s or 1’s. It’s 0’s and 1’s, or the binary representation of our data, which are encoded on the media.

It gets even more interesting when a user moves a file to the recycle bin. That file is not deleted, but is marked for future deletion. In this case the operating system tracks the recycled file, which allows users to recover the file if needed. It isn’t until the recycle bin is emptied that the deletion process actually occurs.

Once people have a better understanding of what is needed to wipe or destroy a computer drive, they will be more likely to use the proper tools to protect themselves from unwanted data exposure.
Electrical and Computer Engineering—Points of Pride (aka Fast Facts)

- National Science Foundation CAREER Award winners: 7
- Degree programs (3 bachelor’s, including interdisciplinary cybersecurity engineering; 4 master’s, including interdisciplinary data analytics engineering; and 1 PhD): 8
- Articles published in 2015: 47
- Active grants: $7M+
- Patents: 35+
- Years in existence: 30
- Conference presentations worldwide: 30+