MECHANICAL
ENGINEERING
Technology that moves the world
THE MAGAZINE OF ASME
No. 02
137

HOW FICTION PUTS THE SCIENCE IN ENGINEERING

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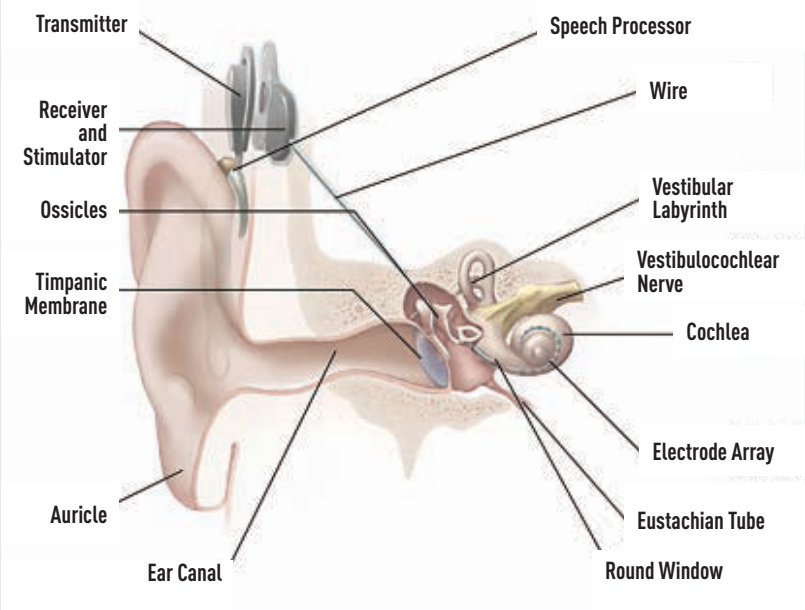
FEBRUARY 2015

THE COCHLEAR IMPLANT



30 YEARS OF BIONIC EARS

THE COCHLEAR IMPLANT, as close as it gets to a true bionic ear, hit the U.S. market following approval by the U.S. Food and Drug Administration in 1984-85. For people with profound deafness, cochlear implants open a world of sound. After 30 years, the implants are still making significant noise in the medical device world. Today more than 350,000 people who once lived in silence now use implants to understand conversational speech and hear environmental sounds.

For these articles and other content, visit asme.org.

VIDEO: ACHIEVING ENERGY EFFICIENCY WITH ADVANCED MANUFACTURING

MARK JOHNSON, DIRECTOR of the Advanced Manufacturing Office, discusses the progress of the U.S. Department of Energy's Clean Energy Manufacturing initiative.

SAILING THE ICY BLUE

MECHANICAL ENGINEER STEFAN DALBERG hopes to break records in the sport of iceboating with his new boat, which uses wings instead of sails.

A lumber safe-room wall during testing is impaled with 2x4 missile.

WOODEN TORNADO SHELTER WITHSTANDS HIGH WINDS

BUILDING TORNADO SHELTERS CAN BE EXPENSIVE. However, a more affordable safe room may be on the market, made from a basic, low-cost construction material: wood.

NEXT MONTH ON ASME.ORG

VIDEO: USHAHIDI AND SOCIAL ENTREPRENEURSHIP

Juliana Rotich, co-founder and executive director of Ushahidi Inc., a non-profit technology company, talks about the challenges of being a social entrepreneur.

PODCAST: ADVANCES IN SMALL MODULAR REACTORS

Fatih Aydogan of the University of Idaho's mechanical engineering department discusses the advantages of light-water small modular nuclear reactors.

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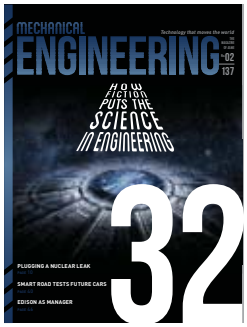

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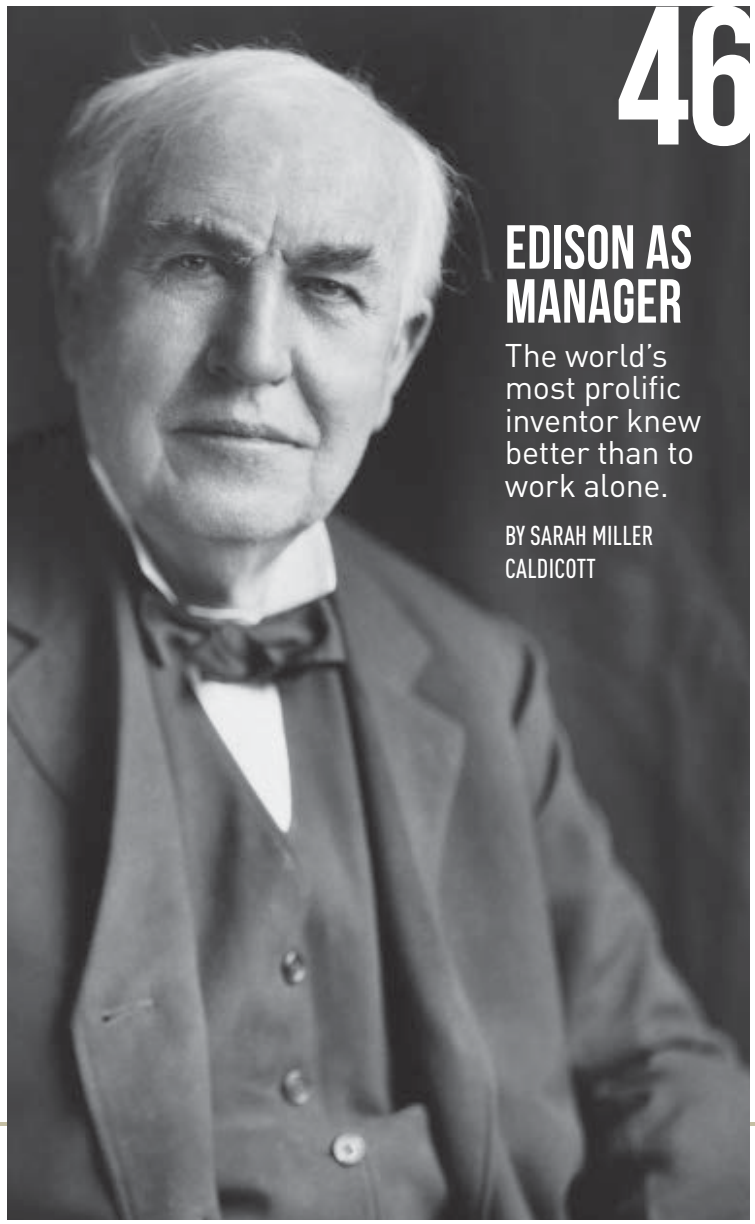

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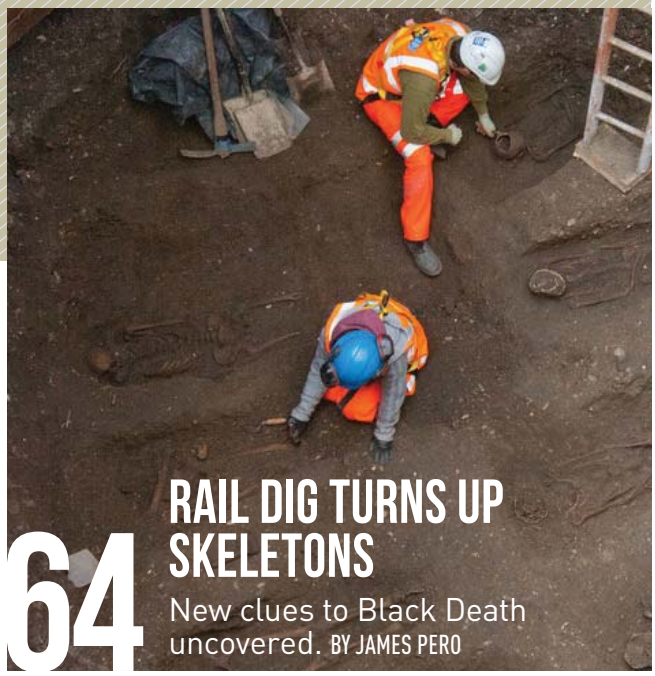

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Give me the place to stand, and I shall move the earth
—Archimedes

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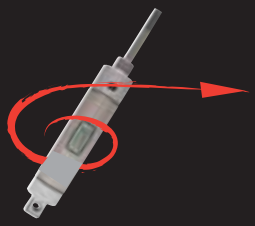

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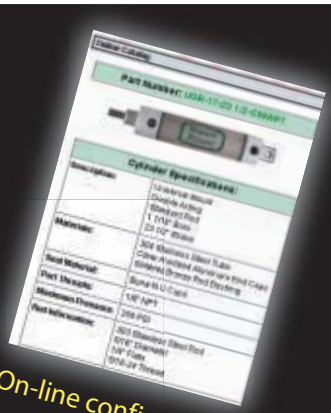

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John G. Falcioni
Editor-in-Chief

THE NONFICTION OF SCIENCE FICTION

When viewed through an engineering lens, science fiction deals in dubious possibilities that become conceivable when reason and know-how are applied. Science fiction emboldens the aspirations of innovators and of dreamers, and it drives the pursuit of tools that will reach the far ends of the world and beyond.

Science fiction has been coined "the literature of ideas" because it feeds the process of ideating the future. It does not predict it, however. It simply contemplates it.

Last year, two professors at the famed MIT Media Lab, who believe that current students don't read as much science fiction as they did in the past and, therefore, have lost some of the benefits that come from it, began teaching a course called "Science Fiction to Science Fabrication." The focus was on developing physical prototypes and code-based interpretations of technology based on classic science fiction—films, books, television, and even comics. Among other selections, the class studied urban surveillance as depicted in DC Comics' late-1990s *Transmetropolitan* and also the 1974 short story, "The Day Before the Revolution," which tackled aging, death and grief, and even sexual conduct.

As groundbreaking as it was, there are many examples of technology imitating science fiction outside of the Media Lab. In his 1865 novel, *From the Earth to the Moon*, for example, Jules Verne proposed the notion of light-propelled spaceships. Not surprisingly, technologists today are actively working on solar sails. If you're a fan of Stanley Kubrick's 1968 epic science fiction film *2001: A Space Odyssey*, you felt a tinge of nostalgia when a robotic probe launched by the European Space Agency's mission control in Germany landed on a comet last November. Consider also the symbiosis of science fiction and IBM's recent $3 billion R&D investment in technologies like non-silicone computer chips, quantum computing research, and computers that mimic the cognitive function of the human brain.

At the rapid rate of technology innovation, some of what is considered science fiction today will become reality in the next 50 years. Soon enough, replacement organs could grow in labs, and drones might fly over our cities and towns delivering packages. To many of us, the prospect of these types of emerging technologies sounds exciting, but a recent study by the Pew Research Center shows that even while recognizing the benefits of sci-fi technologies, many in the United States do not embrace these advances.

The study shows that 59 percent of Americans are optimistic that scientific and technological changes will improve quality of life, but 30 percent are afraid the changes will make life worse. In the findings, 81 percent of respondents think that it will be possible to grow organs in labs, and 51 percent think computers will be able to create artwork just as well as humans. But fewer than 40 percent expect that teleportation will be possible in the next 50 years and only 33 percent say they expect that humans will be colonizing other planets.

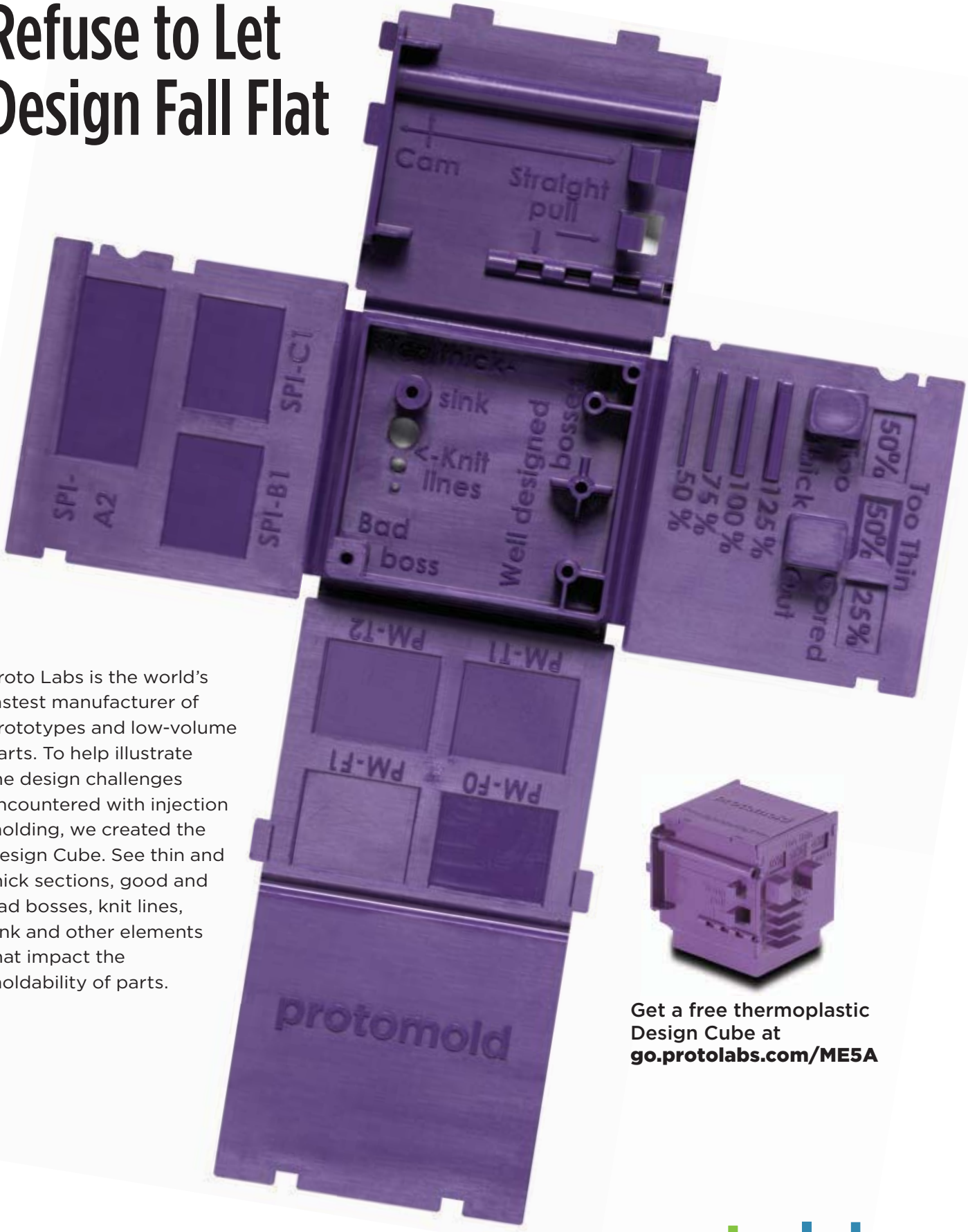
In this month's cover story, associate editor Alan Brown and contributor Brittany Logan talk with several innovators who tell us how science fiction informed their work. For them, the future represents an open canvas where they can paint their vision of reality inspired by the unrestraint of fiction. **ME**

FEEDBACK

Has science fiction impacted your life? Email me.

falcionij@asme.org

Refuse to Let Design Fall Flat



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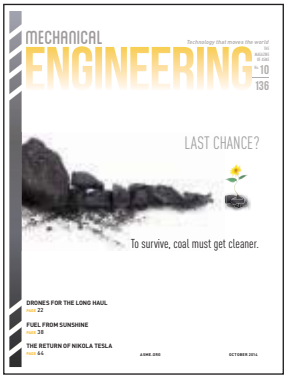


OCTOBER 2014

Reader Blair clarifies what it takes for a boiler to be supercritical.

« One reader reminds us that simulation requires validation. And in a comment, a retired engineer recalls his slide rules.

NOISE, SIMULATION, AND PAIN

To the Editor: Thank you for Jean Thilmany's article "The Quiet Forefront" (August 2014). Acoustic simulation is a powerful tool when it works. One reason for the secrecy surrounding acoustic simulation is that it is seldom accurate. Those that have been successful with it probably don't want to discuss the pain that it requires.

A key component missing from the article is validation. Without validation, simulations may be misleading, or even pure fantasy. When the need arose to investigate vibrational modes of loudspeaker diaphragms in 3-D, we looked at several software solutions, but in the end, we chose to buy a Klippel 3-D scanner and measure actual prototypes. It worked so well that we now represent Klippel in North America.

We went several rounds with simulation software comparisons, but the simulations would not generate the right answers unless we gave them the measured data first. The problem is that the material properties, particularly Young's modulus and the loss factor, are frequency dependent. Datasheet values for these properties are determined using essentially static loading. Hence the difficulty.

This work led to the development of the Modal Parameter Identification software for the Klippel. This module automates fitting of the numerical models to the reality of a measured prototype, providing optimized frequency dependent parameters for each component.

Laser vibrometer scanning is now an essential part of our toolbox, for transducers and for enclosures. The vibrational data of a surface can be used to develop an acoustical model to indicate the sound pressure level contribution of the surface. This would be impossible to determine using traditional acoustical measurement since the signal would be swamped by the transducer's sound output.

For more information on vibration scanning of enclosures see our website:

www.warkwyn.com/test-measurement/vibration/.

Tim Gladwin, *Pakenham, Ontario*

COMMENT

SLIDE RULE MEMORIES

A retired engineer recalls the occasions when his life and career intersected with his slide rules.

The article written by Mike Konshak, "Calculators Before the CPU" (Input Output, September 2014), reminded me of my own experience with slide rules.

At the age of 14, I won a scholarship to attend one of Liverpool's three junior technical institutes. When I received my text books, I was given a slide rule. It was made of celluloid and wood; it had a cursor and came in a cardboard container.

During my two years at the school, I was never to use it. I often wondered why I had it, but was soon to find out.

In March 1942, when I was nearly sixteen, I entered an apprenticeship in a large city mechanical maintenance shop. I was to spend five years learning to become a mechanic and machinist.

The company allowed its apprentices to attend Liverpool's senior technical college one day per week. The courses were decided by Britain's Ministry of Education and the Institution of Mechanical Engineers, which held the Monarch's Royal Charter for the examination of engineers in the King's Realm.

Studies included mathematics, applied mechanics, geometry and engineering drawing, and thermodynamics (under the name "heat engines"). As we progressed, we began to examine our slide rules.

My fellow students and I relied on our slide rules all the way to taking the final extensive written examinations required to qualify as a mechanical engineer.

My first job was fifth engineer on a passenger ship. My duties didn't require the use of a slide rule.

Then I became an assistant to the manager of inspection at a large manufacturer of products ranging from kitchen products to internal combustion engines. We used seven-figure logarithms in our calculations, so once again my slide rule stayed in its cardboard box

I held other jobs, too, such as assistant engineer for a municipal water works and senior assistant engineer for the city of Derby. I used logarithmic tables, but rarely, if ever, used the slide rule on the job.

Then I took a design engineering position with the United Kingdom Atomic Energy Commission.

I was now engaged in the work that I hoped that one day I would do. Yes, at last I could use the slide rule given to me dur-

REMEMBERING THE PATIENT

To the Editor: I want to congratulate *Mechanical Engineering* on the article "Upper Extremity Exoskeletons for Robot-Aided Rehabilitation" in the September issue of *Dynamic Systems & Control*. This paper is an exemplar of the high-quality engineering journalism that *ME* should be publishing. But it's also more than that: It combines rigorous engineering and clear writing with a high level of empathy for the psychological and physiological welfare of the user of the technology: the patient. As an ASME Fellow and a National Institutes of Health Fellow with a number of medical patents, I have a special concern for this too-scarce and much-needed concatenation.

I also notice that there are two women on this team. While the evidence is anecdotal and I can't prove causality, I believe that the admirable integration of calculation and concern on this project is especially due to their participation. This is one more reason why the gender expansion of our profession is a benefit for all concerned.

To *ME*: Great publishing! To Drs. Sergi, Blank, and O'Malley: High five! And keep up the good work!

Morton Grosser, *Menlo Park, Calif.*

WEIGHING IDEAS

To the Editor: While some technical information may be presented without reference to politics or philosophy, this society is very active in the public arena knowing technology and engineering have a huge world impact. Bias invariably plays a significant part in any discussion, and thus everyone should be welcome at the table and each idea carefully weighed, not shouted down or rubber stamped.

I, for one, was appalled at the June 2012 article "Design in Nature," in which the author so often (and so obviously) confuses design and intent with path of least resistance. Regardless of prior peer review, the so-called "constructal law," which the author claims to be able to predictively apply to all aspects of existence including politics and philosophy, should be soundly refuted and struck down rather than blindly embraced by the mechanical engineering community.

Either that, or we should demand he correctly predict important future events, both near and far, so that we can ready ourselves or prevent them.

Craig R. Norris, *Memphis, Tenn.*

FEEDBACK Send us your letters and comments via hard copy or e-mail memag@asme.org (subject line "Letters and Comments"). Please include full name, address and phone number. We reserve the right to edit for clarity, style, and length. We regret that unpublished letters cannot be acknowledged or returned.

SUPERCRITICAL BOILERS

To the Editor: I would like to offer a technical clarification to the "Coal's Last Chance" article (October 2014) in regards to supercritical boiler efficiency and terminology.

Supercritical boilers operate at pressures and temperatures above the critical point for water of 3,206 psia and 705 °F. Think back to thermodynamics 101: this point is the top of the steam dome.

When operating above this point, water liquid and vapor are an indistinguishable fluid. By operating at pressures and temperatures above the critical point, higher enthalpy can be achieved (more energy in the steam). This is where the gain in efficiency comes from, not from avoiding the process of boiling as the article states.

By adding more energy to the steam, the more energy is available to do work in a steam turbine before the water is condensed and the cycle starts all over. Also, it should be noted that "ultra-supercritical" is an industry term and has no thermodynamic meaning.

Charles Bair, *White Bear Lake, Minn.*

CORRECTION

Yongxing (John) Zhang received his Ph.D. from Old Dominion University in 1991. The listing of 2014 Fellows in the November issue reported the year incorrectly.

ing my youth.

In 1956 my wife, Doreen, and I emigrated from the British Isles for a new life in the United States. I still had my friendly celluloid and wood slide rule, although the cardboard box was no longer in a condition to hold it.

When we reached the United States I found that if I was to use the title engineer I would be required to sit for written examinations to become what is known as a Professional Engineer. I thought, "Dare I use the celluloid and wooden slide rule once more?"

In 1956, I took the initial examination, Engineer in Training. I used my old slide rule and passed.

For the next examination I was able to borrow a much more sophisticated rule from an associate.

Wow! Using this rule made my celluloid and wood slide rule seem like driving a dune buggy. With this elegant instrument I was driving the Rolls Royce of slide rules.

Later, after I had returned this excellent slide rule to its owner, I received a letter from the State of California affirming that I was recognized as a Professional Engineer. The rule had done its job.

So I went and purchased the best slide rule available, which has remained in its case since the purchase, now more than fifty long years.

I take it out and look at it now and then, and remember that fourteen-year-old boy looking at his celluloid and wood slide rule and thinking, "What is this used for?"

It's been a great career. Studying and being examined using that simply made slide rule and at last finishing off with the super slide rule. ME

WILLIAM L. DEAN, P.E., is an ASME Life Fellow who lives in Sherman Oaks, Calif..

PLUGGING REACTOR LEAKS

SPECIALLY DESIGNED ROBOTS EXAMINE AND REPAIR FUKUSHIMA DAIICHI UNIT 2

Steel jaws of the Fukushima Inspection Manipulator at the Kurion engineering operations in Loveland, Colo.

Image: Kurion

A U.S. firm known for its cleanups of contaminated nuclear materials is building a robotic manipulator to fix a leak at the tsunami-crippled Fukushima Daiichi power generation complex in Japan.

The company, Kurion Inc., treats radioactive wastewater at dozens of reactor sites around the world. The manipulator is in development at Kurion's Robotics Systems Group in Loveland, Colo., which has built more than 170 robotic manipulators, mostly for the nuclear industry.

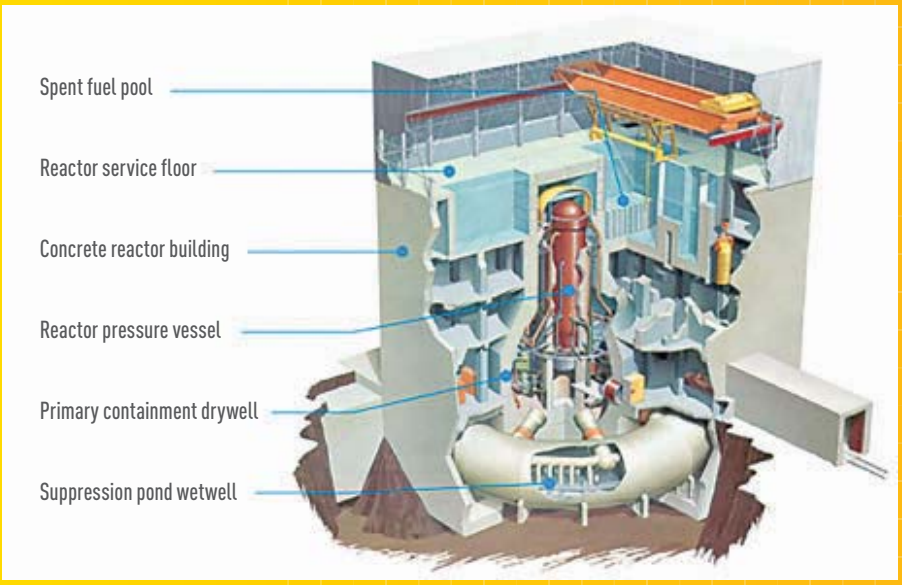
The manipulator is being bought by IHI Corp., a key subcontractor in the cleanup of Fukushima Daiichi Unit 2. (IHI used to be known as Ishikawajima-Harima Heavy Industries Co., Ltd.; the name was condensed in 2007.) IHI is already using one Kurion machine, called the Fukushima Inspection Manipulator, to help pinpoint leaks in the pressure containment vessel surrounding Unit 2's reactor.

The reactor, with the rest of the massive Fukushima Daiichi power generation complex, was shut down after extensive damage caused by the Tohoku earthquake and tsunami. On March 11, 2011, Tohoku battered the northeastern coast of Honshu, the largest of the Japanese islands.

Kurion's Fukushima Inspection Manipulator, or FIM, was used in the summer of 2014 to help map the locations, sizes, and shapes of leaks in Unit 2's pressure containment vessel. This is a steel structure a few dozen meters high. Each of Fukushima Daiichi's six reactors is inside a reactor pressure vessel, each of which is enclosed by a pressure containment vessel. Matt Cole, Kurion's engineering director, compares the containments to Russian matryoshka dolls.

Mapping the leaks was done with remotely operated vehicles, which IHI engineered and built. Equipped with on-board vision systems, the ROVs were lowered into place and retrieved by Kurion's FIM. The manipulator can reach nearly 10 meters; the ROVs were lowered into the pressure containment vessel by cables.

Getting the ROVs into position re-



The Fukushima Daiichi Unit 2 reactor, a General Electric Co. Mark 1 boiling water reactor designed in the early 1960s. It began commercial operation in 1975.

Image: World Nuclear Association.

quired using steel jaws on the end of the Kurion machine's arm to cut through structural steel, piping, and cables.

Kurion said the leak meant that every day thousands of gallons of reactor cooling water had to be pumped through the pressure containment vessel. The water cools the outside surface of the reactor containment vessel. (In normal operations the pressure containment vessel is dry.)

The second Kurion manipulator, now being engineered in Colorado, will seal the leaks in the pressure containment vessel with grout pumped through its arm. The manipulator itself will be installed on the reactor service floor above the reactor. Its arm will reach into the pressure containment vessel through a hole in the floor.

The grouting work will be done within a steady stream of cooling water—no divers allowed. The manipulator itself stays dry on the floor above.

Due to Fukushima 2's radioactivity, workers who installed the Kurion machine were limited to as little as 10 minutes' exposure per workday. The installation was done by IHI employees; radiation exposure specifics were not shared with Kurion.

The March 11, 2011, Tohoku earthquake and tsunami comprise one of the biggest catastrophes on record anywhere, directly causing nearly 16,000 confirmed deaths. Thirty-foot waves destroyed countless homes, businesses, schools, hospitals, and offices; property damage is estimated at $300 billion. Hundreds of thousands of people were evacuated and most have not returned. **ME**

JACK THORNTON is a freelance writer based in Santa Fe, N.M.

U.S FUNDS NEXT-GEN GASIFICATION RESEARCH

FOUR PRIVATE-SECTOR PROJECTS look to develop technologies that can significantly reduce the cost of producing hydrogen-rich syngas derived from fossil fuels.

The U.S. Department of Energy has granted about $16 million to four private-sector projects that are researching next-generation gasification systems, which promise cleaner uses of carbon-based fuels with fewer greenhouse gas emissions. The various processes under study aim to convert materials like coal into syngas for use as fuel and chemicals.

A statement by the DOE quoted the Energy Secretary, Ernest Moniz, who said, "By partnering with industry on promising pathways for high-efficiency, low-pollution power generation and syngas production, the department is demonstrating its commitment to innovative solutions for growing the economy and using coal while protecting the environment. Advances in the gasification process will allow industry to develop technologies that may open pathways to carbon use in beneficial new ways while also advancing an important method for reducing greenhouse gas emissions."

According to the DOE, gasification plants have the potential for greater power generation efficiency and environmental performance than conventional coal-fired plants.

According to the DOE, gasification plants have the potential for greater power generation efficiency and environmental performance than conventional coal-fired plants, and serve as the basis for integrated gasification combined cycle power generation and co-production plants capable of 90 percent carbon dioxide capture. The funded research projects will focus on developing technologies that can significantly reduce the cost of producing hydrogen-rich syngas derived from fossil fuels, enabling coal resources to both improve U.S. economic competitiveness and provide global environmental benefits.

In one of the projects, Aerojet Rocketdyne Inc. is working with Coanda Research & Development, the Gas Technology Institute, RTI International, and Nexant Inc. to develop an advanced pilot-scale gasifier integrated with RTI's Warm Gas Clean Up, a process that removes contaminants such as sulfur and heavy metals from syngas. The project will conduct research on advanced water-gas shift processes and catalysts, and analyze the technical and economic benefits of the proposed technologies.

Alstom Power Inc. is researching a limestone-based chemical looping gasification, trademarked LCL-G, to convert coal to high-hydrogen syngas or liquid fuel. Alstom is working with NewCO2Fuels Ltd. and the Illinois Clean Coal Institute on bench-scale testing and eventually will run tests in a 3 MW (thermal power) chemical looping facility. The group plans to assess the LCL-G technology to see that the system can meet DOE cost and performance goals.

Praxair Technology Inc. is conducting an analysis of an IGCC power plant with CO_2 capture with an integrated oxygen transport membrane syngas converter. The technology will be evaluated in a scalable panel array module that will be field tested for 500 hours at the National Carbon Capture Center using syngas from a coal-fed gasifier. Other process variables will include using natural gas as a secondary feedstock and evaluating the conversion

continued on p. 27 »

LIGHTS, CAMERA, VEHICLE SAFETY

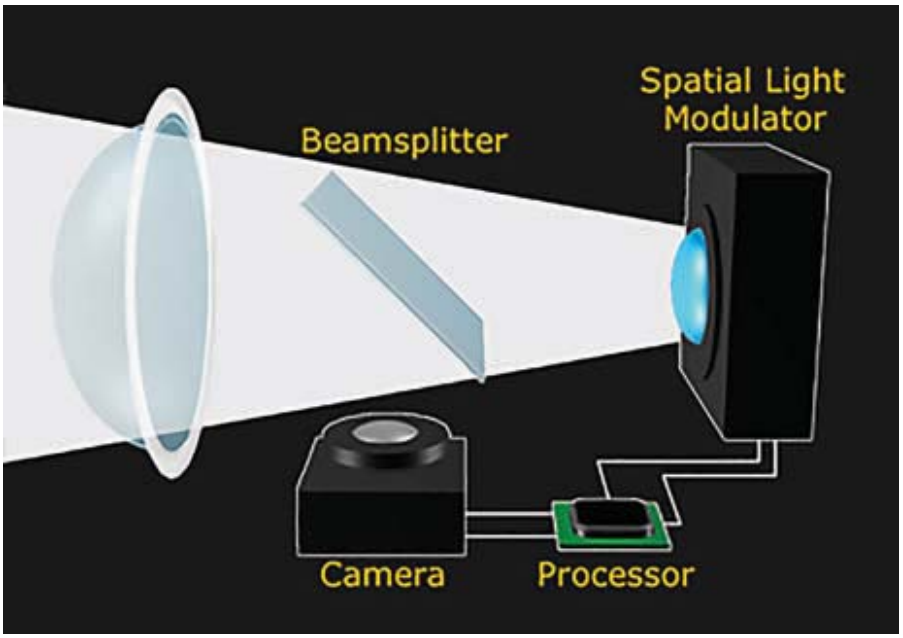
The prototype of Narasimhan's headlight system (above) is mounted to the hood of a vehicle for road testing. The system relies on a beam splitter (see schematic below) to enable the axes of the camera and the light source to be co-located. *Image credit: Carnegie Mellon University.*

Srinivasa Narasimhan, an associate professor at the Robotics Institute at Carnegie Mellon University, is part of a team working on programmable automotive headlights to make poor visibility conditions on the road easier to manage by sensing, reacting to, and adapting quickly to any environment while moving at highway speeds. "We're looking at post-processing images," he says. "If the rain or snow is so bad that you can't instantly post-process it, you want to control the lighting to improve the situation. That's where the headlights came about."

Initially, the team had two cameras and a small projector but it was very slow. "We tried to show some simple proof of concept in the lab and realized the big challenge is keeping it working while moving at high speed," Narasimhan says. "To do this, we had to bring down the latency of the system. Right now, the reaction time is 1-1.5 milliseconds, which is 500 times faster than an average driver's reaction time if we want to stop at a red light or stop sign."

One big change from the initial version is that the camera and the light source are now co-located. "Co-location means essentially at the same spot; so we did that by using a beam splitter and it allows us not to have to calculate the distance of objects in front of the car," Narasimhan says. "Some other methods can be pretty erroneous and using erroneous data to process and change the lighting would make it flicker much worse than an ordinary headlight. We also wanted to make sure that the data flows well from the camera. You don't want any buffering or road hums anywhere, just moving the data from one component to another. Optimizing that speed was very important and it's now 10 times faster than a year and a half ago."

Surprisingly, the researchers are still using basic technology. The *continued on p. 15 »*



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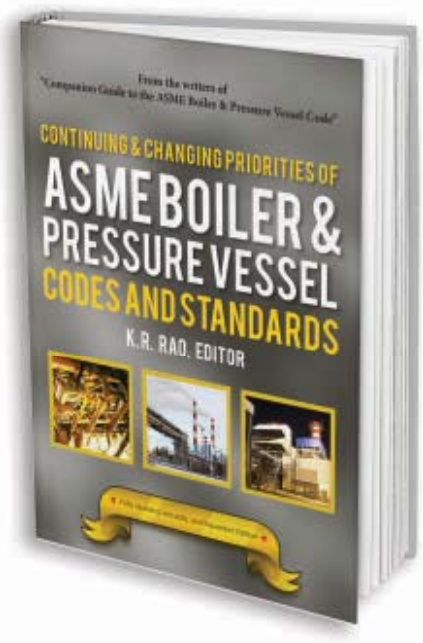

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LIBERIA AFTER EBOLA

THE EPIDEMIC IS AN IMMEDIATE crisis. But the health care needs in West Africa will continue long after the Ebola virus has been eradicated.

It may seem implausible now, but someday the news crews will go home. The infection rate will drop and, slowly, the people of Liberia will begin to construct a new sense of normalcy for their health system after the Ebola outbreak subsides.

The U.S. Army is providing a clinic and two mobile centers; and China has pledged to work with international partners to help rebuild the nation's entire health system. Altogether, hundreds of millions of dollars have been rallied—much more than Liberia's normal annual spending on health care.

So, how can we use Ebola-related funding to design for the future? Here are a few ideas:

DONATE TO LASTING INSTITUTIONS.

It's not flashiest strategy. Good, old-fashioned capacity building will win no innovation challenges. But it's the most important. Private volunteers and emergency teams play an important role, but health organizations that have been working in Liberia since before the crisis will be the ones picking up the pieces when it is over. One is Last Mile Health, which has invested in frontline health workers in Liberia since 2009.

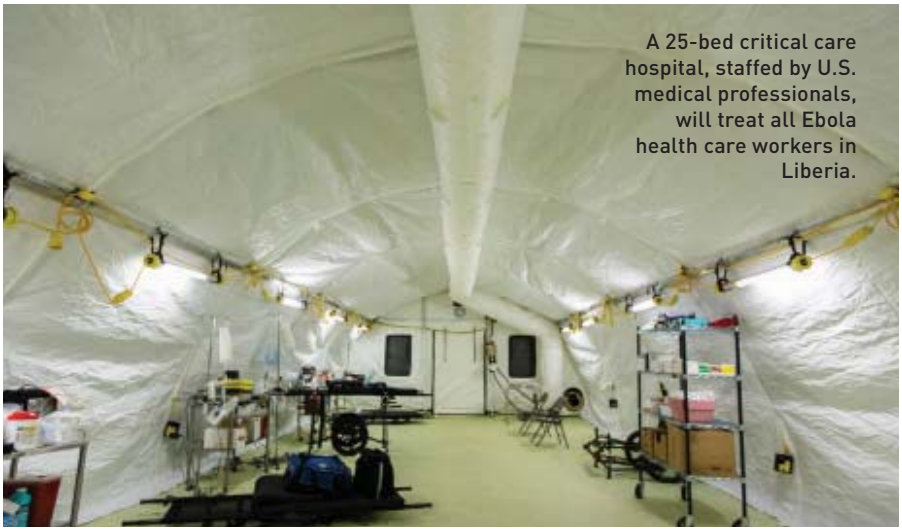
If you're donating to an NGO or health provider in Liberia, it may also be helpful to refrain from earmarking your donation for the Ebola crisis. Trust the local organization to know what is needed most.

DESIGN FOR REMOTE CONSULTATIONS AND TASK-SHIFTING.

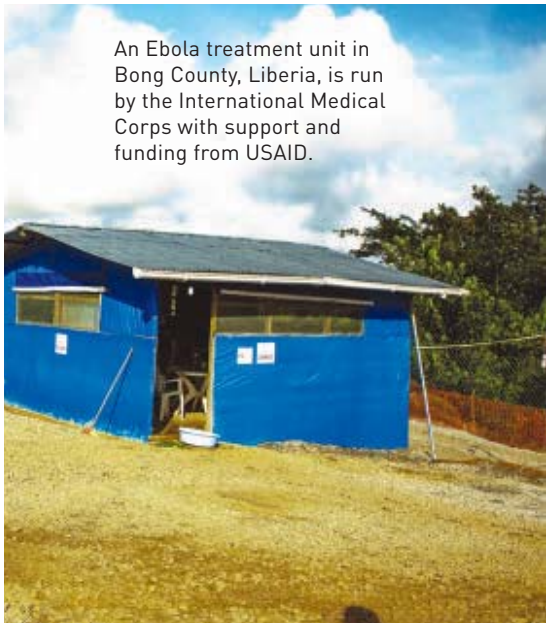
Prior to the outbreak, Liberia had an estimated 60 doctors serving its four million people. Several of those doctors have since died, as have many nurses, community health workers, and other staff. Those people cannot be replaced quickly. Their local experience, institutional knowledge, and relationships with one another were all critical in such a small health system. That means nurses will be taking over roles traditionally assigned to doctors, with community volunteers pulling more weight in rural areas.

Improving the region's communications infrastructure can ease these constraints. Mobile phones for rural community health workers are useful for tracking medical emergencies and for maintaining ties to those communities once the aid workers leave. Computers for cataloging surveillance data serve a similar purpose.

Higher-tech donors should absolutely consider incorporating video infrastructure for remote consultations into their new facilities. This would allow Liberia's few remaining doctors to provide support



A 25-bed critical care hospital, staffed by U.S. medical professionals, will treat all Ebola health care workers in Liberia.



An Ebola treatment unit in Bong County, Liberia, is run by the International Medical Corps with support and funding from USAID.

Photos: Morgana Wingard

remotely to their colleagues and their patients in hard-to-reach places. It would also allow international experts to provide their expertise without having to travel.

MAINTAIN MOMENTUM ON HYGIENE AND SANITATION.

Reminders for hand washing and good sanitation practices have been plastered all over Liberia, played as bite-sized educational snippets and even full musical productions on every radio station—all with a focus on preventing the spread of Ebola.

Fortunately, those same methods also help protect us from colds, the flu, and food-borne pathogens. It would be an enormous missed opportunity to halt these messages when the outbreak ends.

Diarrheal disease and other sanitation-related infections are huge problems in Liberia. Hospitals, clinics and health organizations shouldn't toss out the hand sanitizer and sound bites once new infections stop. Instead, they should channel this momentum to tackle other diseases.

New facilities should include sanitizer dispensers at every door. Rural villages will benefit from keeping chlorine dispensers full even after the threat of Ebola has passed. With the right messaging and incentives, these new positive behavior changes just might prove infectious. ME

JORDAN SCHERMERHORN
ENGINEERINGFORCHANGE.ORG

continued from page 12 »

LIGHTS, CAMERA: SAFETY

camera Narasimhan categorizes as "a regular Sony," the processor is an Intel, much as you'd have in any PC, and the projector is essentially a digital light processing unit that they "hacked up."

They've already shown actual performance on a vehicle. "We put it on the hood and drove it around," Narasimhan says. The anti-glare improves visibility of the road and the system highlights lanes where the road doesn't have markings in it and can even spot bicyclists, he says. "The capability of the system allows us to do anti-glare at very high speed—70 mph even and it can deal with pothole turbulence."

Still, challenges coming up include making the system fit in the headlight slot. "Right now our sizes are for the space of a Ford F-150 pickup truck and we obviously want to miniaturize it," he says.

For Narasimhan, this multi-year odyssey has been incredibly exciting, especially when he considers the possibilities. "To its fullest potential, it could improve the stress of driving at night and could increase beam brightness," he says. "Many people need to be on the road and we want to give them more confidence and better reaction time. That means we need to keep on working on improvements." ME

> **"MANY PEOPLE NEED TO BE ON THE ROAD AND WE WANT TO GIVE THEM MORE CONFIDENCE AND BETTER REACTION TIME."**
> **—SRINIVASA NARASIMHAN, CARNEGIE MELLON UNIVERSITY**

ERIC BUTTERMAN, ASME.ORG.

TWO NEW STANDARDS COMMITTEES ARE RECRUITING VOLUNTEERS

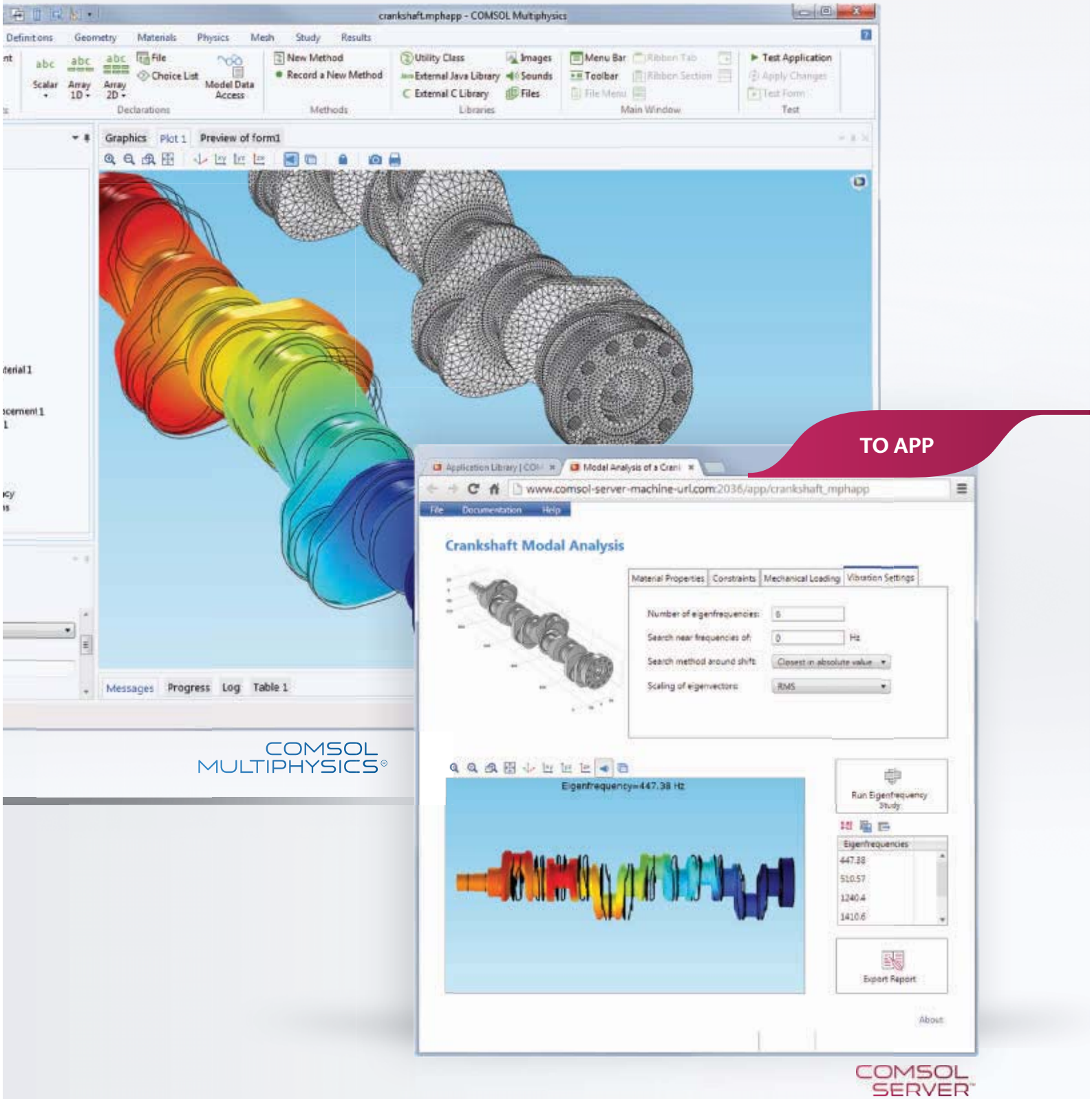
ASME IS SEEKING subject matter experts and other stakeholders to join two new standards committees—one addressing design for additive manufacturing and the other for testing energy storage devices.

ASME's Y14 Standards Committee, which issues several standards, including those covering conventions for drawings, CAD files, and related markup information, and dimensioning and tolerancing, is adding a committee to develop a standard on additive manufacturing. The new standard, Y14.46, will cover dimensioning, tolerancing, and related practices for designs specifically intended for additive manufacturing.

According to ASME, the standard will establish methods to describe structures being designed into complex parts; complex internal geometric features such as internal matrices and engineered voids; build orientation; fill patterns; local toolpath orientations; and integrated components manufactured at the same time. It will also establish methods of specifying geometric placement of the material and material gradients.

The energy storage committee comes under ASME's Performance Test Code Standards Committee. The new unit, the Performance Test Codes Committee on Energy Storage, PTC 53, will provide uniform test methods and procedures for determining the performance of energy storage systems in electric power applications. ASME said the standard will provide a method to compare performance across technology platforms and offer explicit methodologies for determining such results as energy performance, energy storage loss, and stored energy capacity

Prospective volunteers are invited to contact Fredric Constantino at ConstantinoF@asme.org. ME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FROM LOVE AFFAIR TO OPEN RELATIONSHIP

Americans devote an enormous amount of energy and resources to their automobiles. Computing power can make car services a better deal than ownership.

For more than a century, the American automobile has been a sign of freedom. Cars have been essential for a teenager's Saturday night out and the archetypal road trip to parts unknown. They are the most liberating object a person can own.

But that freedom has a cost. For a car intended to be driven around 10,000 miles per year, a typical American car owner pays an average of $30,000 up front, plus another $2,000 or more each year for fuel, insurance, and maintenance. The car is parked 95 percent of the time, and even when being driven, it's competing against a highway full of other vehicles going in the same direction, nearly all of which are carrying just one person.

In this light, the American relationship with its cars seems downright dysfunctional. In most cases, what we want isn't the car, but the services provided by the car.

Imagine an alternative: We all have our own chauffeur who picks us up at our door the minute we're ready and drops us off at work or the grocery store, driving along roads with smooth traffic and sparing us the hassle and time of finding a parking spot. En route, we can read, text, think, sleep, or talk on the phone without fear of causing an accident. It might be a private car and private chauffeur if we could afford it, or there could be a few others in the same vehicle if we wanted to save costs by carpooling. Regardless, the service is still door-to-door.

As we move towards a world where computing is essentially free, bandwidth is essentially infinite, and sensing is ubiquitous, our transportation system will change dramatically. We've seen the first glimpses of this in the DARPA Grand Challenge and Google's driverless cars. Privately owned, dumb cars that we use a fraction of the time will be replaced by smart mobility services that are in perpetual use, tapping into this powerful information technology to drive down costs and improve the value of mobility.

These services will save energy in a number of ways. Robotic drivers will be programmed to follow the best practices of driving. They won't have lead feet and bad habits. Embed more information into the cars and the surrounding infrastructure, and traffic will move more smoothly, reducing congestion, smog, and energy consumption. Safety will improve because each car will automatically know where the others are headed, reducing the risk of collision, just as planes do in the sky.

WHAT WE WANT ISN'T THE CAR, BUT THE SERVICES PROVIDED BY THE CAR.

And since the cars will be better matched to the needs of the riders, there won't be lone commuters in gas-guzzling SUVs that only make sense on the occasional weekend. (When you need to tow a boat, you could arrange for a robot-driven truck.)

The cost of the vehicles will be shared through the mobility service company, keeping ownership costs down per mile traveled. Rather than each of us paying 100 percent for a $30,000 car we use 5 percent of the time, we will all pay for a more expensive car, but only when we need it, with one car meeting the needs of many. Auto insurance companies will likely have lower rates to reward the improved safety of chauffeured cars compared to self-driven cars, creating a nice market incentive to get a ride. Once these technologies and market signals align to point in the same direction, the trends will be irreversible.

While this vision seems incompatible with "American car culture," from what I can see, the culture is ready for the change. While the driver's license was a threshold of adulthood for me and my peers when we came of age, many teens today would rather be texting than driving. And it isn't just the kids: Look around the next time you're stopped at an intersection. Most of the adult drivers in the cars next to you will be texting or looking at their smart mobile devices. How many would be happier with their eyes off the road?

If you love to drive and worry that society will lose this critical skillset as we hand our transportation needs over to machines, it will be OK. Some clever entrepreneur will sell you the opportunity to drive old beat-up cars in a circle on a dusty ranch while reliving a nostalgic view of the past. After all, that's what we do when we want to teach our kids how to ride horses. ME

MICHAEL E. WEBBER is the Josey Centennial Fellow in Energy Resources and associate professor of mechanical engineering at the University of Texas at Austin.

UNDERGROUND HYDROGEN STORAGE FEASIBLE IN SOME CITIES, SANDIA STUDY SAYS

MANUFACTURERS MAY BE gearing up production of fuel cells for automobiles, but the hydrogen supply infrastructure is still underdeveloped. With an energy density per volume less than a thousandth of gasoline, storing uncompressed hydrogen would be prohibitively expensive. Even compressed hydrogen takes up more space per unit of energy than gasoline.

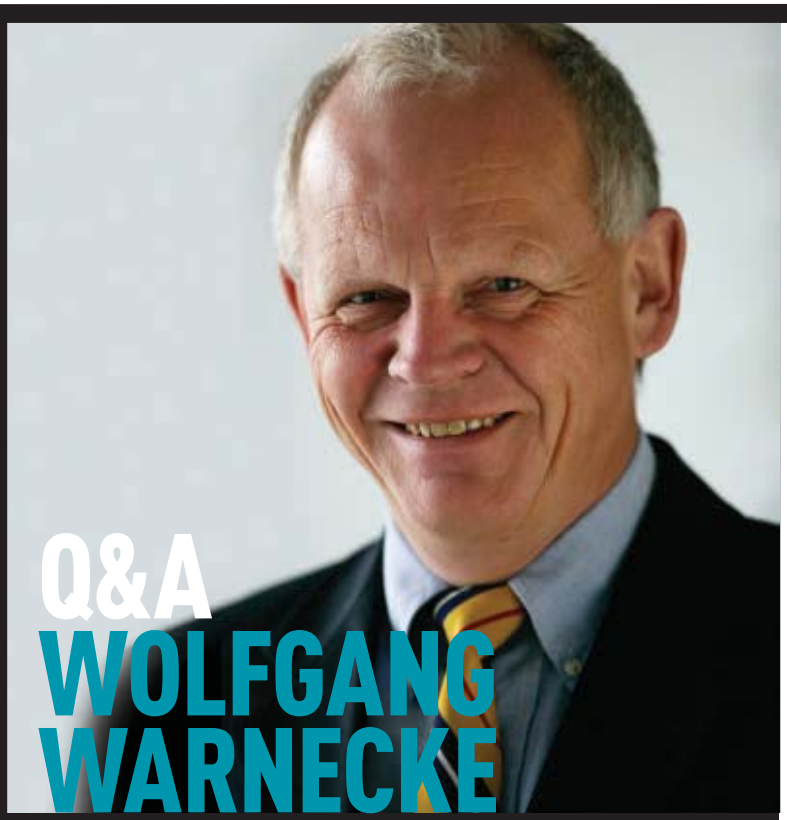
A recent study by researchers at Sandia National Laboratories in Albuquerque has looked at the hydrogen storage problem. The research suggests that the best place to store hydrogen gas is in underground caverns carved from salt formations.

Salt caverns are already used for storing natural gas and oil, and they are impervious enough to contain hydrogen gas, which because of its small molecular size is prone to leaking.

The research team, led by Sandia geologist Anna Snider Lord, examined the cost and practicality of underground hydrogen storage in the Los Angeles, Houston, Pittsburgh, and Detroit metropolitan areas. The team looked at storing enough hydrogen to cover between 10 percent and 100 percent of the fuel needed for a summer peak driving season.

Houston was found to have the best conditions, with large salt formations nearby. Although Detroit sits over some salt domes, Lord and her colleagues determined that the formations are so thin that many small caverns would have to be excavated, raising costs. Indeed, storing enough hydrogen to meet the summer driving needs of Los Angeles—which would have to transport its hydrogen from large caverns in Arizona—would cost a third of what it would take for Detroit.

The best salt formations for hydrogen storage are not easy to come by, the researchers wrote. Although they are common along the Gulf Coast of the United States, formations are relatively rare in other regions of the U.S., such as the Pacific Northwest and the East Coast. If hydrogen ever becomes a mainstream fuel for transportation, these differences in storage potential may help it develop faster in some regions than in others. ME



Q&A WOLFGANG WARNECKE

WOLFGANG WARNECKE, is Shell's chief scientist for mobility and heads the company's technology center in Hamburg. Not only is Warnecke Shell's top expert in combustion engines, fuels, and lubricants, he has been passionate about driving since he was a teenager. Warnecke collects cars and motorcycles, and restores them in his own workshop. He's even competed in a 24-hour race at Germany's Nürburgring.

Warnecke studied mechanical engineering at the Technical University of Hannover, and holds a Ph.D. in automotive engineering.

ME: With mobility technology heading down so many different parallel paths, how do you decide where to invest your R&D resources?

W.W: That's a challenge for all of us. We work closely with our partners in the auto industry. One thing we have come to understand is that there is no silver bullet. The next ten to twenty years will be a very exciting period. We're working on clean diesel, improved gasoline, gas-to-liquids, biofuels, LPG, CNG, LNG, especially for larger engines, and we're looking into hydrogen, and even electricity.

ME: You've done a lot of work on smog-related emissions. What lessons can we apply from that experience to today's carbon emissions challenge?

W.W: Regulations that led to catalytic converters and the need for unleaded fuel are a good example of what can be done. Through this refining of the engines, including three-way catalysts, we were able to reduce smog-related emissions by 99.5 percent. To reduce carbon we need to improve fuel economy. But to ensure operation of three-way catalysts, you need lean operation, which sacrifices about 10 percent fuel efficiency. So by driving down smog-related emissions, you are increasing GHG emissions.

ME: How do alternative fuels fit into this picture?

W.W: With ethanol, the energy content per volume is lower. E85 fuel loses about 25 to 30 per cent in fuel economy for a given engine. But ethanol also has very high octane. So if you increase the compression ratio, you can see a big improvement. That is why it is so important that we work hand in hand with the auto industry. As engine engineers, what we'd like to see is an engine that can vary its compression ratio. That way, depending on the fuel you are running, the compression ratio would adapt. Everybody is working on that concept, but it is not on the market yet.

ME: What about on the diesel side?

W.W: There is nothing really very nice from an engineering perspective with biodiesel. Biodiesels have different properties that the modern, clean diesel engines cannot cope with. That is why gas-to-liquids is important. GTL yields longer chain hydrocarbons similar to paraffin, so it can be used as a one-to-one replacement for diesel. It also has the huge benefit of being sulfur-free. Costly desulphurization can be eliminated with GTL.

ME: What about electric vehicles?

W.W: For mobile applications, you need high energy density. At the moment, if you look at the energy content in a kilogram of gasoline versus the amount of energy you need in a battery, it's a factor of about one to a hundred in weight. And while hydrogen's energy density is not as high as gasoline, it is far higher than what is possible today in a battery.

I think a big car with a heavy battery is the wrong approach. I think it's better to go for a hydrogen fuel cell for long distance and a battery for short distance. People also need to look at total well-to-wheel emissions. It's not accurate to call electric cars carbon-free, unless the electricity comes from carbon-free sources.

ME: Fifty years from now, will we still be using gasoline?

W.W: In twenty years, I'm sure the majority of vehicles will have combustion engines requiring gasoline or diesel. In fifty years, I think that there is huge potential for renewable, carbon-free fuels. I think there will be very few hydrocarbon-, crude oil-, maybe even natural gas-based fuels left. ME

R.P. Siegel, P.E., is a professional writer based in Rochester, N.Y.

EUROPEAN LEADERS OK STEEP CARBON CUT

DURING AN OCTOBER MEETING, leaders of the countries of the European Union agreed to a binding target for reductions in greenhouse gas emissions as well as an increase in renewable power production.

The emissions target calls for a 40 percent reduction in greenhouse gas emissions by 2030, compared to a 1990 baseline. The target is to be met by the most cost-effective method possible, according to an official communication detailing the policy, with most of the cuts being accomplished through a reformed emissions trading system.

Also by 2030, the share of energy coming from renewable sources is to rise to at least 27 percent.

Not all European countries are capable of producing renewable energy, or may only be suited for production of one kind, such as wind, and not others. Part of the effort to support increasing the share of renewable energy will involve increasing the level of interconnectedness between national energy grids as well as developing appropriate back-up systems.

A recent study by the consultancy Ecofys and the European Union may suggest which ways Europe will meet these targets. The study looked at the levelized cost of electricity from various fossil and renewable sources. Among renewable sources, hydropower, geothermal, and onshore wind produced electricity at costs the same as or less than hard coal. Other carbon-free energy sources—nuclear, biomass, solar, and offshore wind—had costs that were a little to a lot higher. ME

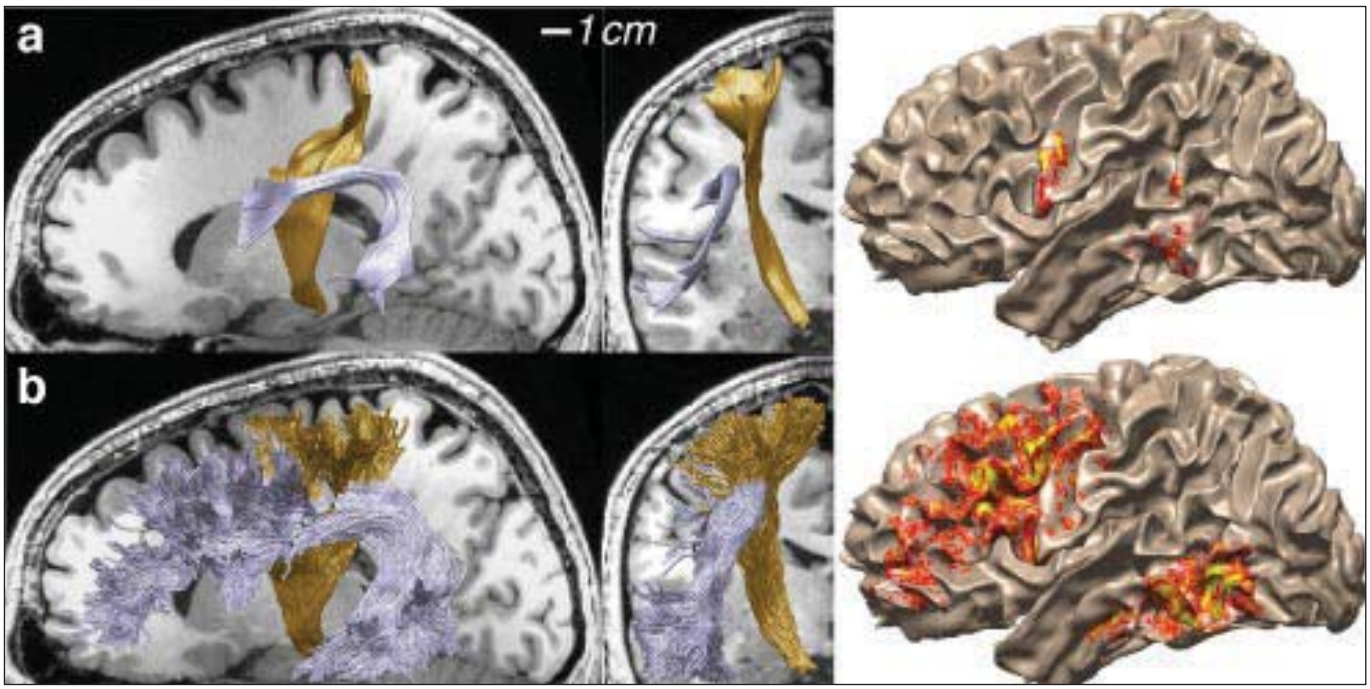
INDIAN UTILITY PREPARES FOR BOOST IN SOLAR POWER

THE TRANSMISSION UTILITY in the Indian state of Rajasthan has placed a $24 million order to upgrade two sub-stations to handle an increase in solar power.

Rajasthan Rajya Vidyut Prasaran Nigam Ltd., the Rajasthan state transmission utility, has placed an order worth 1,515 million rupees with Alstom T&D India for a new sub-station in Bhadla and to expand an established sub-station in Bikaner.

Alstom T&D India will design, install, and commission twenty 400 kV bays and seventeen 220 kV bays at Bhadla. The Bikaner expansion calls for eight 400 kV bays with related equipment. All equipment will be made by Alstom T&D India.

Rajasthan is one of the states chosen by India's Ministry of New and Renewable Energy as models for large solar parks, whose nameplate capacity may total 100,000 MW by 2022. ME



Two different algorithms produce two very different estimates of the shape of the same white matter connection in Franco Pestilli's brain. LiFE software, developed in the Wandell Lab, aims to produce more precise estimates. *Image: Wandell Lab/Stanford*

GRAY MATTER MATHEMATICS

ENGINEERS AND THE COMPUTATIONAL SOFTWARE THEY HELP CREATE have a role to play in uncovering the secrets of the human brain. Here, we look at one lab that is mapping connections within the brain and another that's found a link between what had been thought of as quite separate brain events: the migraine and the seizure.

Researchers at a Stanford University laboratory have developed a mathematical and computational technology to enable researchers to more accurately map the large, long connections within the white matter tissue of human brains. The methodology is called LiFE, short for "linear fascicle evaluation."

To let us see, think, or feel, the 100 billion neurons in our brain must exchange messages, which are transmitted over more than 100 trillion specialized connections, known collectively as the connectome. Most connections are short, carrying information a few hundred-thousandths of an inch. But many important connections are longer, winding as much as a foot from one end of the brain to the other.

Understanding the human connectome will help clarify the fundamental organizing principles of structure and function of the human brain, lab director Brian Wandell said. That in turn helps scientists understand the mechanisms behind diseases like multiple sclerosis, Alzheimer's, and schizophrenia, all regarded as brain diseases affecting the connectome.

To test the LiFE method, Franco Pestilli, a laboratory research associate, analyzed MRI scans of two long connections within his own brain. In one analysis, the two structures—the arcuate fasciculus, which is involved in reading and language, and the corticospinal tract, which plays a role in motor coordination—appeared short and fairly smooth. In the other, the ridged tendrils within the tracts spread far longer and wider.

"Previously, scientists had no method for deciding which of the two representations of the human brain is correct," Pestilli said. "As a result, different research groups using the same data often came to different conclusions. The new technology provides a mathematical analysis and open-source software to decide which of the two estimates is better."

MIND MAPPING

THE LAB The Wandell Lab, Stanford University, Stanford, Calif.; Brian Wandell, director.

OBJECTIVE Developing devices and algorithms for magnetic resonance imaging and digital imaging.

DEVELOPMENT A method to map long connections within the brain.

It does this by matching a simulated MRI result against actual results to find the most accurate portrayal of a connectome.

Many representations of the human connectome can be created using available fiber tracking technology and candidates like Pestilli. LiFE interprets these pathways and uses them to simulate synthetic MRI signals.

The candidate's connectomes can then be evaluated to find the one that generates a synthetic signal that most closely matches the actual data, Pestilli said.

"I think about each candidate connectome as a prototype," Pestilli said. "We can learn much by building many prototypes and finding the one that best represents the measured MRI signal. Once we have this optimized prototype, we can more accurately study the function of the actual pathways.

"We hope other investigators use the code and improve it," Pestilli said.

"Code and data sharing can be a very important contribution as we try to understand the human brain." ME

The energy required to restore the ions to their proper places is much greater after seizures or migraines, according to researchers at a Penn State lab who found a link between the two brain events.

BRAIN PHYSICS

THE LAB Penn State Center for Neural Engineering, The Pennsylvania State University, State College, Pa.; Steven Schiff, director.

OBJECTIVE Fostering interdisciplinary research and collaboration among faculty in the life sciences, materials research, neuroscience, engineering, physics, mathematics, and biology.

DEVELOPMENT Finding a link in the brain between seizures and migraines, which may help predict the onset of either.

Seizures and migraines have always been considered separate physiological events in the brain, but a team of engineers and neuroscientists from the Penn State Center for Neural Engineering looked at the brain from a physics viewpoint and discovered a link between those events and related phenomena.

The ability to better understand the difference between normal and pathological activity within the brain may lead to the ability to predict when a seizure or a migraine might occur, said Steven Schiff, director of the center.

Scientists believed these two brain events were separate phenomena because they outwardly affect people very differently.

Seizures are marked by electrical hyperactivity, but migraine auras—based on an underlying process called spreading depression—are marked by a silencing of electrical activity in part of the brain. Also, seizures spread rapidly, while migraines propagate slowly, Schiff said.

"We wanted to make a more realistic model of what underlies migraines, which we were working on controlling," he said. "We realized that no one had ever kept proper track of the neuronal energy being used and all of the ions, the charged atoms, going into and out of brain cells."

Potassium and sodium contribute the ions that control electricity in the brain, Schiff said. The Penn State researchers added fundamental physics principles of conservation of energy, charge, and mass to an older theory of this electricity.

They kept track of the energy required to run a nerve cell and kept count of the ions passing into and out of the cells.

The brain needs a constant supply of oxygen to keep everything running because it has to keep pumping the ions back across cell membranes after each electrical spike. The energy supply is directly linked to oxygen concentrations around the cell. The energy required to restore the ions to their proper places is much greater after seizures or migraines, Schiff said.

The researchers, who also included Yina Wei, recent Penn State Ph.D. in engineering science and mechanics, explored extending older models of brain cell activity with these basic conservation principles.

They found that adding basic conservation principles to the older models immediately demonstrated that spikes, seizures, and spreading depression were all part of a spectrum of nerve cell behavior.

The researchers have found within a single model of the biophysics of neuronal membranes that they can account for a broad range of experimental observations, from spikes to seizures and spreading depression, Schiff added.

"We are not only interested in controlling seizures or migraines after they begin, but we are keen to seek ways to stabilize the brain in normal operating regimes and prevent such phenomena from occurring in the first place," Schiff said. ME

TAKING THE STRESS OUT OF 3-D PARTS

A RESEARCH TEAM AT LAWRENCE LIVERMORE NATIONAL LABORATORY in California has learned how to make stronger, more reliable parts through additive manufacturing, thanks to a quick testing method it developed.

Additive manufacturing may be the most advanced means for making critical parts. But the method is not without its problems. One of those issues is residual stress in metal parts produced via powder-bed fusion.

The process relies on high-power lasers to selectively melt and fuse a thin layer of metal particles. After each sweep by the laser, the build platform is notched lower and a new layer is deposited on the workspace, ready to be melted.

The process can produce parts and components with a high degree of accuracy. But the rapid heating and cooling of the powder—and the repeated local expansion and contraction within the part during each laser sweep—can cause thermal stresses to build, leading to reduced mechanical performance and structural integrity. The stresses may even distort a 3-D printed part to the point where it may not fit in the place where it was designed to go.

The Lawrence Livermore team led by mechanical engineer Amanda Wu developed a method to measure the residual stresses in parts manufactured via powder-bed fusion.

The team uses digital image correlation. A speckle pattern is projected on a part while it's still attached to the build plate and the part is imaged by two cameras. Then the part is cut off of the build plate and re-imaged with the projected speckled pattern.

When the two images are compared, any residual stresses will cause an apparent distortion close to the cut. The team validated the reliability of its method by comparing its results to those obtained through neutron diffraction, which is very accurate but requires a high-energy neutron source. There was good agreement between the two methods, the team said.

"Developing a fast and simple residual stress measurement technique was necessary for advancements in this field," Wu said. "But without Don Brown and the scientists operating the Spectrometer for Materials Research at Temperature and Stress neutron diffractometer at Los Alamos, this level of experimental validation would not be possible."

Using quantitative data obtained through their testing method, Wu and her colleagues demonstrated that shorter laser scans, rather than one continuous run, reduced the amount of residual stress in the 3-D printed part. Changing the direction of the scan helps, too.

Researchers hope that, by being able to measure the residual stresses quickly, they will be able to optimize powder-bed fusion additive manufacturing methods to produce higher-quality, better-performing parts and components.

The work was published in the journal, *Metallurgical and Materials Transactions A*. ME

continued from page 11 »

NEXT-GEN GASIFICATION

of coal and natural gas-derived syngas to liquid fuels.

TDA Research Inc. is developing an integrated water-gas shift pre-combustion CO_2 capture technology to eliminate CO_2 emissions from IGCC power plants. The project team includes Gas Technology Institute; University of California, Irvine; Indigo Power Systems LLC; the National Carbon Capture Center; and CB&I/Lummus Technology. The team will develop the design of a reactor using computational fluid dynamics and kinetic modeling to achieve optimum CO_2 removal and hydrogen recovery. The team will also design a test unit to demonstrate the technology's viability. In addition, field tests will be conducted at the Power Systems Demonstration Facility at the National Carbon Capture Center in Wilsonville, Ala., and at the Wabash River IGCC plant in Terre Haute, Ind.

Managed by the Office of Fossil Energy's National Energy Technology Laboratory, the Gasification Systems Program focuses on developing technologies to reduce cost and increase the efficiency of producing syngas. The program works with other Energy Department programs and private organizations to ensure that gasification research projects are integrated with other efforts and to ensure efficient technology development with minimum cost to taxpayers. ME

U.S. AUTOMAKER EXPANDS IN CHINA

CHONGQING, A LARGE MUNICIPALITY in central China near Sichuan, has become Ford Motor Co.'s largest manufacturing area outside Detroit.

A joint venture of Ford and a Chinese state-owned partner, Changan Automobile Group, has begun production at a new plant in Chongqing, the venture's third in the municipality.

According to the joint venture, Changan Ford, the plant is producing a new model Ford Escort designed for the Chinese market and has a capacity to make 360,000 vehicles a year. Changan Ford's other two plants in the area turn out an average of 600,000 vehicles a year.

The plant, Chongqing 3, cost the equivalent of $600 million, Ford said. It is the fifth assembly plant producing Ford vehicles in China and is designed to produce vehicles besides the Escort.

Ford also recently launched a new Chongqing engine plant and a new Chongqing transmission plant. It also expects to open a passenger car assembly plant in Hangzhou in 2015.

Ford said it will introduce 15 new vehicles to China by the end of this year. ME

THE PROBLEM OF THE COLORADO RIVER

LOOKING BACK

Mighty Hoover Dam was not even a blueprint when this article was published in February 1925.

BY WILLIAM F. DURAND, STANFORD UNIVERSITY, CALIFORNIA

Flood control, in addition to irrigation and the potential for hydroelectricity, was seen as a powerful argument for building a giant dam in the American Southwest, according to ASME's president.

In the first place, it should be observed that the menace to the Imperial Valley arises from two conditions:

1. The silt burden which is laid down in the lower stretches of the river just below the California line, and in consequence of which it is constantly building up the level of its bed and banks, thus raising the actual river level above that of the surrounding land.

2. The possibility of unusual floods which may overtop the present river borders, cut great channels through the light silt banks, and submerge the surrounding lands.

Relief from this menace is seen to depend upon two conditions:

1. Reduction of the amount of silt carried by the river, and thus of the rate of uplift of the river channel.

2. Control of the river during the flood period and a limitation of the maximum flow to an amount which can be safely carried by the channel.

It is obvious that both of these conditions can be met by a suitable dam and storage reservoir at some point on the river, naturally in the cañon division.

The best location for such a dam, taking all considerations into account is still a matter of debate among those having contact with the problem and I shall not enter into this controversial phase the question. The general character of the problem and the possibilities of its effective treatment will, however, be admirably illustrated by assuming such dam and reservoir to be located at the so-called Boulder Cañon site. This site in point of fact offers two available locations for a dam, one at Boulder Cañon proper and the other some 12 miles down the river at Black Cañon. In either case the reservoir site, its capacity and extent would be substantially the same.

Speaking then of this general locality as the Boulder Cañon site, it appears to be entirely feasible to build, in a narrow cañon, a dam 550 or 600 feet above present mean low-water level, or roughly 650 to 700 feet above bedrock in the channel bottom, and thereby to impound from 25,000,000 to 31,000,000 acre-feet of water.

I speak of this range of possibilities not as restrictive but as indicating that study of the various elements entering into the problem seems to indicate a solution in the neighborhood of these figures.

Time will not permit of any detailed consideration of the technical questions entering into the design of the dam or its appurtenant structures. It must suffice to say that there is abundant engineering opinion based on careful exploratory work and supporting the project as one entirely feasible from the engineering point of view.

It may be of interest to note the magnitude of the reservoir which it is thus proposed to create. The three largest similar reservoirs in the world at the present time are the Assuan reservoir, the Roosevelt reservoir, and the Arrowrock reservoir. These are each of the general order of 2,000,000 acre-feet. **ME**

HYDROPOWER IN THE SOUTHWEST

While Durand was advocating for what would become Hoover Dam, a similar project was being finished 250 miles to the southeast. The Mormon Flat Dam on the Salt River near Phoenix tops out at 224 feet high and impounds 950-acre Canyon Lake. The dam was part of the Salt River Project, which provided water and electricity that enabled Phoenix to develop into a major metropolitan area.

An original hydroelectric unit (left) for the Mormon Flat Dam (above), completed in 1925.

NUCLEAR EXPORT REVIEWS RUN TOO LONG, GAO SAYS

A REPORT FROM THE GOVERNMENT Accountability Office supports concerns raised by a House committee that practices in the Department of Energy and the National Nuclear Security Administration may be impeding U.S. competitiveness abroad. According to the report, the Energy Department and NNSA do not have a clear, timely, and efficient review process for the export of nuclear technology.

The report, *Nuclear Commerce: Additional Actions Needed to Improve DOE's Export Control Process,* provided several recommendations to the Secretary of Energy and the Administrator of the NNSA to improve the process and reduce authorization delays.

DOE, which concurred with the report, is expected to issue revised regulations and is taking steps to implement other reforms.

The GAO reported that reviews can take a year or more before companies are authorized to export nuclear technology. In some cases, companies cannot enter into substantive commercial negotiations during the review period.

The House Energy and Commerce Committee in July 2013 requested that the GAO examine the effects of forthcoming revisions to the nuclear technology export regulations and how the DOE planned to implement the rules.

The full report is available at tinyurl.com/nuclear-commerce. ME

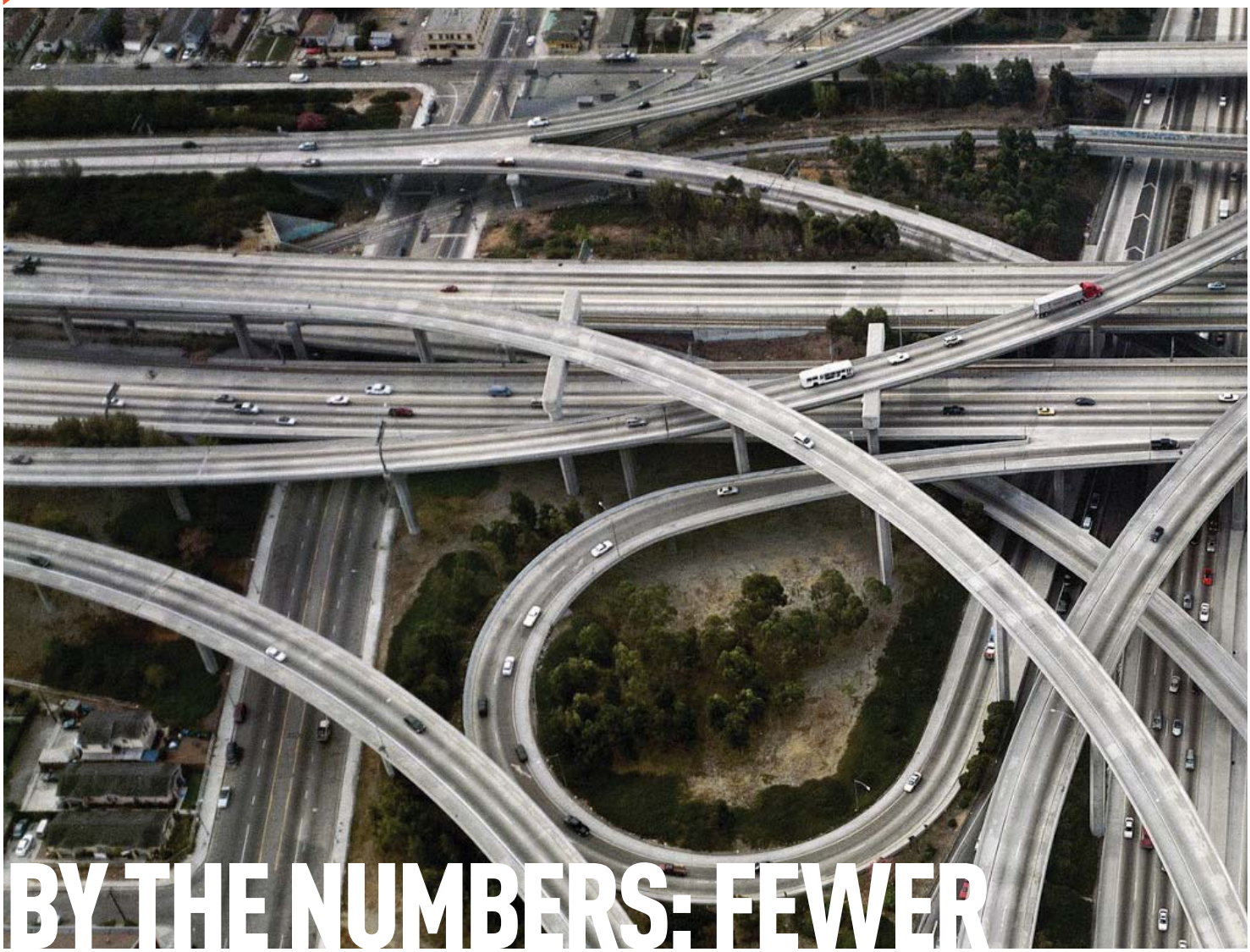
U.S. OIL RESERVES RETURN TO 1975 LEVEL

THE U.S. ENERGY INFORMATION ADMINISTRATION reported in December that U.S. proved reserves of crude oil and lease condensate increased for the fifth year in a row in 2013 and exceeded 36 billion barrels for the first time since 1975.

Proved reserves are estimated volumes of hydrocarbon resources considered with reasonable certainty to be recoverable under existing economic and operating conditions. The estimates change from year to year as new discoveries are made, existing fields are more thoroughly appraised, existing reserves are produced, and prices and technologies change.

According to the report, *U.S. Crude Oil and Natural Gas Proved Reserves, 2013*, a sharp increase in proved natural gas reserves in 2013 led to a new record (354 trillion cubic feet) for U.S. natural gas proved reserves.

Proved reserves of North Dakota's crude oil and lease condensate surpassed those of the Federal Gulf of Mexico, ranking it second only to Texas among U.S. states. ME



BY THE NUMBERS: FEWER MILES FOR AMERICAN CARS

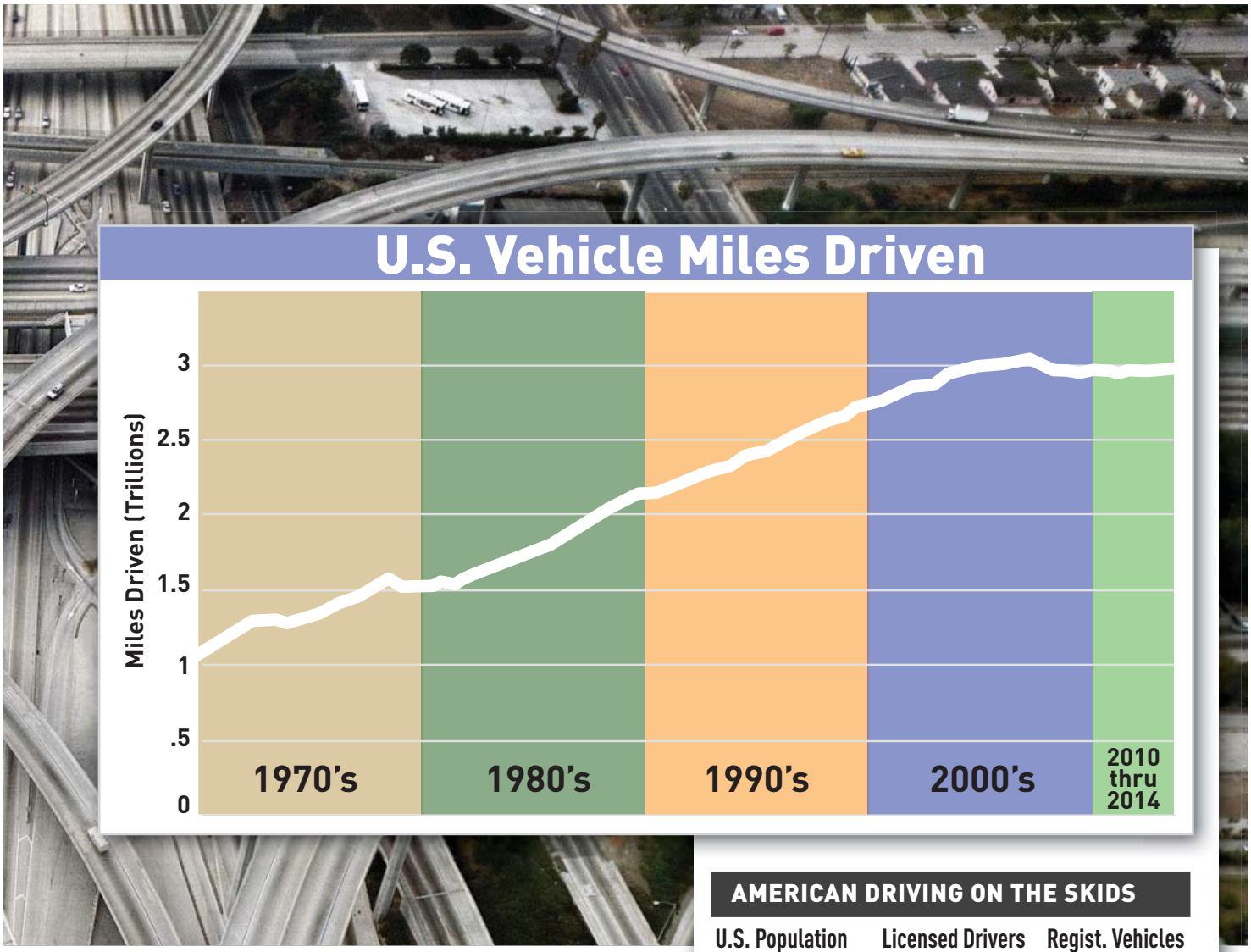
FOR DECADES, THE NUMBER of licensed drivers and vehicle miles driven in the United States had grown steadily. In recent years, that pattern has ended. Is it part of a new trend, or a reaction to a temporary set of events?

Since the end of the Second World War, the American faith in the automobile has been largely unquestioned. Every year, there were more drivers—and more drivers as a percentage of the population—and virtually every year, the number of miles driven on U.S. streets and highways increased. Indeed, one of the few guaranteed crowd-pleasers in American politics, even more so than mom and apple pie, was building new and bigger roads.

Roads may still be popular, but driving has apparently become less so. In the years since November 2007, the last month before the start of the Great Recession, the 12-month total for vehicle miles traveled, as calculated by the Federal Highway Administration, has fallen from a peak of 3,038,886 million miles. Unlike the relative potholes following the oil crises of 1974 and 1979, the number of miles driven has stayed relatively flat in spite of a larger driving-age population and a growing (albeit sluggish) economy.

As of August 2014, the 12-month total for vehicle miles traveled was still more than 2 percent below the 2007 peak.

It isn't just miles driven that is off. For years, the number of licensed drivers had tracked or even gained on the overall population. But data from the Office of Highway Policy Information, a group within the Federal Highway Administration, shows that starting in 2008, the percentage of licensed drivers stalled and has failed to keep up with population growth. Not only that, but the number of registered vehicles actually declined during the recession and still has not passed the previous peak.



This break from the trend is coincident with the economic troubles that started in 2007, and other factors may be in play. One that has been widely reported is the apparent disdain of the so-called Millennial generation—those born since 1983—who seem more attracted to compact, walkable cities than are older Americans. According to a recent report by the United States Public Interest Research Group, a non-profit based in Boston, younger Americans are taking fewer trips, shorter trips, and a larger share of trips via public transportation.

"Today's young people drive less than previous generations of young Americans," the report stated, "even when economic and other factors linked to vehicle ownership or driving are taken into account."

Millennials may just be taking longer to follow their parents into the suburbs and onto the roads. But Millennials are the largest generation in the nation, and if their preference for non-automobile transportation is the beginning of a long-term trend, then streetcar lines and bicycle racks may become the way politicians in the future pander for votes. ME

JEFFREY WINTERS

AMERICAN DRIVING ON THE SKIDS

	U.S. Population (Millions)	Licensed Drivers (Millions/pct.)	Regist. Vehicles (Millions)
2000	281.4	190.6/67.7%	221.5
2008	304.1	208.3/68.5%	248.2
2012	313.9	211.8/67.5%	245.2

According to the U.S. Federal Highway Administration, more people than ever have licenses, but the total number of vehicle miles driven each year is not growing with population.

Leading innovators talk about how stories of

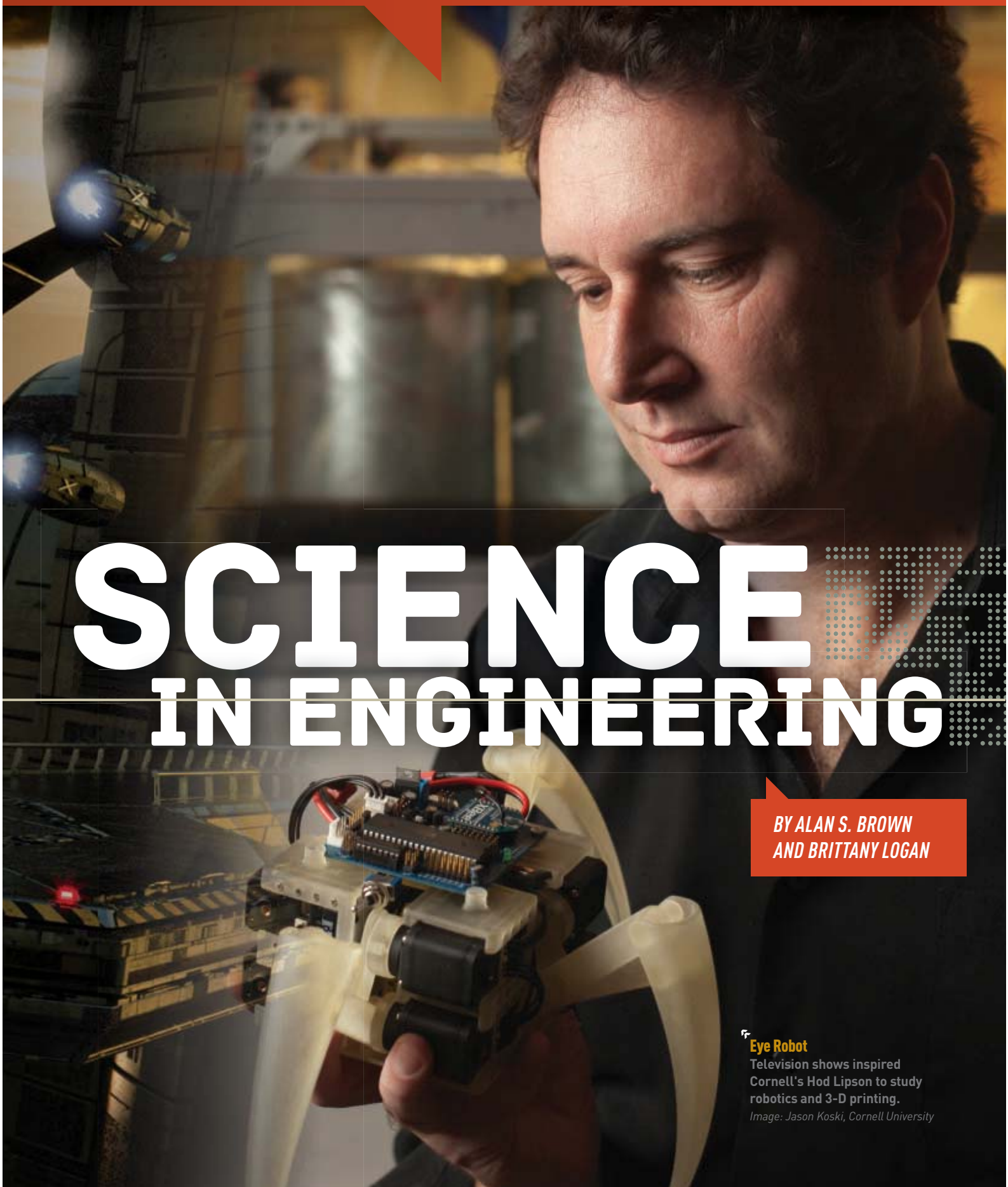
HOW FICTION PUTS THE

SOME PEOPLE DISMISS SCIENCE FICTION AS FRIVOLOUS KID STUFF OR A POOR SUBSTITUTE FOR SERIOUS LITERATURE.

It's just as easy to defend the genre by concentrating on how it can "predict" the future. There's a long list of gadgets and inventions that were first discussed in science fiction: geosynchronous communications satellites, computer worms, Segways, wall-mounted home theaters, exoskeletons, flip phones, virtual worlds, and organ harvesting, to name just a random sample. It's said the chief reason Charles Prior Hall could not defend his patent for the waterbed was that Robert Heinlein had first described it more than 25 years earlier.

Science fiction makes imaginary worlds sometimes too real. In 1944, the magazine *Astounding Science-Fiction* published a story that described the workings of an atomic bomb (based on published papers) and illustrated it with a mushroom-shaped cloud. The magazine received a visit from the FBI agents looking for a security breach.

the future inspired them to reimagine the present.



SCIENCE IN ENGINEERING

BY ALAN S. BROWN AND BRITTANY LOGAN

Eye Robot
Television shows inspired Cornell's Hod Lipson to study robotics and 3-D printing.
Image: Jason Koski, Cornell University

Even so, looking at the science fiction that way misses the larger point. "A good science fiction story should be able to predict not the automobile but the traffic jam," Frederik Pohl, a master of the craft, once said.

What makes science fiction valuable is not that it produces predictions, but that it provides inspiration.

It's easy to see this in the names of companies and products. For example, iRobot, maker of the ubiquitous Roomba as well as military robots, is a sly nod toward Isaac Asimov's groundbreaking book, *I, Robot*. (The modem manufacturer U.S. Robotics took its name from a company in that book.) Big data pioneer Palantir Technologies is named after the seeing stones in *Lord of the Rings*. "TASER" was originally an acronym for "Thomas A. Swift's Electric Rifle." Even the terms robot and android were popularized in fiction before they were adopted by technologists.

Science fiction's power of inspiration also comes up in discussions with engineers and innovators. Ask them, and they will tell you how it unlocked their dreams and set free their imaginations.

We know that because we asked. On the following pages, seven engineers and inventors explain how science fiction affected their futures.

ADAM STELTZNER

***CURIOSITY* LEAD ENGINEER**
NASA JET PROPULSION LAB

***INFLUENCES:* LUCIFER'S HAMMER, RINGWORLD, CONTACT**
***CURRENT FIELD:* AEROSPACE ENGINEER**
***BIGGEST SURPRISE:* INTERNET, SMART PHONES**

I could not have predicted the path to my profession at age 18 or age 25. I did poorly in high school, and wanted to be rock star. The head of one school informed my parents that their boys weren't very bright and should go to trade schools.

In my twenties, I became intrigued by the motion of the stars. In class, I had paid so little attention that I missed the part in high school about the Earth rotating and revolving around the sun. Before I could take astronomy, I had to take physics. That's when I discovered that the universe was governed by a set of laws that were ultimately knowable, and I wanted to explore them.

That's when I started reading science fiction. I was a big fan of Larry Niven's *Lucifer's Hammer, Ringworld,* and his *Known Space* stories. I really liked Carl Sagan's *Contact*. I was intrigued by having a job where somebody might put you in a helicopter and send you somewhere exotic because you could tell them what is going on.

Science fiction gave me models of smart people using their smarts, usually in some technical way, to figure out problems and exploit that. That model of a smart guy as a hero motivated me.

Science fiction also allows me to ponder what might be. My favorite stories have me trying to figure out what is far out and what might actually be possible.

If I could have any sci-fi invention, it would be a flying car. It would give me the ability to use all the three-dimensionality of this world to get around all the bumps and wrinkles and curves.

As for the biggest surprise that I didn't see coming, it has to be the Internet and smartphone. It lets us access instantly, from any setting, almost any information created by humanity. If you lived in ancient Rome, you would have had to journey to the library in Alexandria. Now, that information is in your hands. ■

Curiosity Cat: Steltzner demonstrates how a NASA probe would land on Mars. *Image: NASA*

INFLUENCES: STAR WARS
CURRENT FIELD: ROBOTICIST
BIGGEST SURPRISE: INTERNET'S BOOST TO MACHINE INTELLIGENCE

HELEN GREINER

CEO, CYPHY WORKS INC.
CO-FOUNDER AND CHAIRMAN, iROBOT

I saw *Star Wars* when I was 11, and I wasn't enthralled by Princess Leia. I was really, really taken with R2-D2. He was one of the main characters, he had an agenda, he was cute, he was funny, and he was more than a machine.

I decided that I wanted to build R2-D2 and I ended up building robots for a living. It's a pretty direct correspondence. My dad had an early RadioShack computer, so I could see that computer technology could be the basis of building a robot. It had a cassette drive, so I could see how you could control a mechanical device.

But I had no idea how hard building robots would be. At MIT, I learned about everything, from computer chips and electronic design to dynamic controls and real old-school mechanical design. But it gets even harder when you have to integrate all these things while considering price point, user interface, and user experience.

After school, we started a company called iRobot. Our best known products are the Roomba vacuuming robot and the military robot that blows up bombs. I claim that between the two of them, we're closer to R2-D2 than anybody's gotten. That's because the Roomba's got the beeps and boops and a little bit of the personality—people name them—and the military robots are very capable, and can go out and save people's lives.

If I could choose a sci-fi invention to make real, well, I'd like to see R2-D2 invented. There is not a lot that has really surprised me about today's technology, but if I had to pick one thing, it would be the machine intelligence gains through web searching. We are able to use the contents of the entire Internet to provide intelligence for machines, and also, hopefully at some point, for robots. ■

> "I DECIDED THAT I WANTED TO BUILD R2-D2 AND I ENDED UP BUILDING ROBOTS FOR A LIVING.

More Than Machines: Star Wars characters R2-D2 and C-3PO (right) inspired Greiner (inset above) to develop real-life robots that are both capable and personable. *Images: Helen Greiner (inset), iRobot (above), Copyright Lucasfilm Ltd. (right)*

“AT THEIR BEST, BOTH HOLLYWOOD AND ENGINEERING HAVE SIMILAR GOALS—TO EXPLORE WHAT COULD, ONE DAY, BECOME REALITY.

Tea. Earl Grey. Hot: Lipson (inset below) thought he could outdo Star Trek's replicator.

HOD LIPSON

PROFESSOR, MECHANICAL & AEROSPACE ENGINEERING AND COMPUTING & INFORMATION SCIENCE
DIRECTOR, CREATIVE MACHINES LAB
CORNELL UNIVERSITY

In our apartment building's large back yard, dozens of kids were chasing each other around in a frenzy. But there was something odd about their expressions and the way they moved. They all ran in slow motion, making strange clicking sounds as they awkwardly tried to leap through the air.

It was the late '70s, and we were emulating Steve Austin, the half-human/half-machine *Six Million Dollar Man*. Those episodes paled in comparison to today's lucid animatronics. They left a lot to the imagination, and that, exactly, was their power.

Steve Austin got me thinking about robotics, what I would do if I had access to "bionic" technology, and how I would make it better. Over time, though, realism (and the laws of physics) set in. I realized that fiction sometimes gets it wrong: Some things can't be done, like time machines or *Star Wars*' gravity-defying hovering carts. But there were also good surprises, where fiction underestimated what we could do.

Take 3-D printing. Everyone compares *Star Trek*'s replicator to today's 3-D printers. But I was disappointed as *Star Trek*'s crew used the replicator to make Earl Grey tea or, on a good day, a slice of cheesecake. But why settle for replicating existing things when you have a machine that can make anything? We could do better, and we have.

Robots have an interesting duality in science fiction. On one hand, sci-fi often portrays robots as practical, useful machines for factories, home, remote planets, and intergalactic warfare. But it also portrays robots with a more humanistic nature, intelligent machines that learn, have feelings and opinions, and exhibit empathy, curiosity, and even creativity. These two roles reflect our lab's own research goals, and drive our thinking today.

Perhaps, Hollywood directors, sci-fi writers, and engineering researchers are not that different. At their best, both Hollywood and engineering have similar goals—to explore what could, one day, become reality. ■

INFLUENCES: ***SIX MILLION DOLLAR MAN, STAR TREK***
CURRENT FIELD: ***ROBOTICS, 3-D PRINTING***
BIGGEST SURPRISE: ***MACHINE INTELLIGENCE***

GARRETT BROWN

INVENTOR OF THE STEADICAM AND HOLDER OF 50 CINEMATOGRAPHY PATENTS
MEMBER, INVENTORS HALL OF FAME

INFLUENCES: *TOM SWIFT, JULES VERNE, ROBERT HEINLEIN, ISAAC ASIMOV, A.E. VAN VOGT*
CURRENT FIELD: *INVENTOR*
BIGGEST SURPRISE: *JUST ABOUT EVERYTHING*

I was a reader from way back. My grandmother had a wonderful library, where I read everything from *Diary of Samuel Pepys* to the Tom Swift books and Edgar Rice Burroughs. There was not a shred of science in any of their fiction. I also read a lot of Jules Verne with the original illustrations, and later discovered A. E. van Vogt, Robert Heinlein, and Isaac Asimov.

The story that really got to me was Fritz Lieber's "A Pail of Air." Every part of the science was understandable to a 10-year-old kid. The Earth had been wrested away from the sun by an interloping body, and the atmosphere freezes. The only way the protagonists survive is by walling off a space and insulating it, then constructing a fireplace with a miniscule draft and feeding it with pails of frozen oxygen.

The protagonist had invented something he wanted and needed himself. That principle stuck with me. If you try to invent something for money, you're stuck if it doesn't sell. But if you invent it for yourself, at least you have one customer.

> "EVERY PART OF THE SCIENCE WAS UNDERSTANDABLE TO A 10-YEAR-OLD KID.

Sweet Science: Brown (left) used his first invention, the Steadicam, on location with Sylvester Stallone during the filming of Rocky. *Images: Garrett Brown*

After dropping out of school to be a folk-singer, I decided to make videos. So I bought some books, which were all from the 1940s, and taught myself to be a 1940s filmmaker with a huge dolly. My first invention was the Steadicam, because I wanted to ditch the dolly and make something hand-held that was smooth enough to use professionally.

Just about everything I imagined has been so surpassed by reality, it would have shocked me when I was a kid. But if I could have anything from the books I read when I was young, it would be antigravity. I would name my craft *La Gondola*. It would be a polished aluminum disc with windows, and it would be stable enough to have a pool table. ■

Ice Cream Social: There are elements of Star Wars in all of Hong's robots. *Image: UCLA*

"I FULLY EXPECTED STAR WARS AND STAR TREK TO BE THE FUTURE.

Nothing He Cannae Do: Pettis (inset right) realized that affordable 3-D printing could help bring about a Star Trek-style world.

I grew up with *Star Wars*. I grew up with *Star Trek*. I just fully expected that to be the future.

I've always been a tinkerer just because I'm a tinkerer. So once I realized 3-D printing was possible at an affordable level, I got really excited about it. It meant that we could live in a *Star Trek* world, as if that world was real. You could think it and have it there in a moment.

As for science fiction inventions, I got started as a kid with the Apple II Plus. So for me, the future was already here. Computing existed; the game was on. Of course, I would also like to have human space flight worked out. And time travel would be nice. I would like to explore the worlds they opened up.

What has surprised me? It has to be all the electronics and software that are in the world right now. There are just so many possibilities. And we're just at the beginning. ■

INFLUENCES: *STAR WARS, STAR TREK*
CURRENT FIELD: *TECH ENTREPRENEUR*
BIGGEST SURPRISE: *ELECTRONICS AND SOFTWARE*

BRE PETTIS

LEADER, INNOVATION WORKSHOP, STRATASYS
FORMER ART TEACHER AND PUPPETEER

Image: Makerbot

DENNIS HONG

PROFESSOR, MECHANICAL AND AEROSPACE ENGINEERING
DIRECTOR, ROBOTICS AND MECHANISMS LABORATORY (ROMELA)
UNIVERSITY OF CALIFORNIA, LOS ANGELES

I watched the first *Star Wars* movie when I was seven years old, and it completely blew my mind. Not only the spaceships and all the battles, but really the two robots, R2-D2 and C-3PO. That very day, on the way home in the car, I told my mom and dad that I'm going to become a robot scientist. And I'm here today. If you look at all the robots that I've created, you can see traces of R2-D2 and C-3PO in my work.

I started out with, "Whoa, this is cool stuff!" Now I see them as inspirations for new technologies that can actually benefit people's lives. For example, I'm developing a humanoid disaster relief robot. If there's a nuclear power plant disaster, radiation will keep people away. Instead, we can send in the robot without risking human lives.

On the other hand, the killer robots in *Terminator* led me to raise ethical questions about my work. I do a lot of military projects, but I personally don't build weaponized robots.

I'm not saying that weaponizing robots is necessarily wrong.

INFLUENCES: *STAR WARS, TERMINATOR, ALIENS*
CURRENT FIELD: *ROBOTICS*
BIGGEST SURPRISE: *SMART PHONE*

Some people argue that robots could actually reduce civilian casualties [by identifying and reacting to enemies faster and less emotionally than humans]. I do not disagree. I just personally do not want to build robots that can hurt people. But *Terminator* made me realize that someone could use the firefighting robot I'm building to point a gun instead of a fire hose. Once it leaves my hands, I have no control over the technology.

What sci-fi invention would I want? That's a dangerous question. A time machine is likely to create more headaches than benefits. So maybe an exoskeleton like the one Ripley wears in *Aliens*.

The smartphone is the invention that surprised me. It's mindboggling how much they cram into such a small device. My robots have to obey physical laws, but information does not, so the advancements come much faster. ■

ADRIAN BEJAN

PROFESSOR OF MECHANICAL ENGINEERING
DEVELOPER OF THE CONSTRUCTAL LAW OF DESIGN EVOLUTION
DUKE UNIVERSITY

I grew up in Romania under communism, in Galati, a city on the Danube Delta. There were no passports, and we could not leave the country. But I could see ocean-going ships, their names and colors, and the foreign sailors in port. How they nourished my imagination!

I was deeply into the novels of Jules Verne and other writers of my parents' generation. Under communism, these old novels were the only stuff worth reading. The kids in my neighborhood passed them from hand to hand.

Forget about my imagination! The books by Jules Verne had the original illustrations of Captain Nemo and the *Nautilus*, *Five Weeks in a Balloon, Around the World in 80 Days,* all these faraway places.

From these books I learned that the movement of the world was flowing. I could see it around me. When I was growing up, there were steamboat sidewheelers traveling the Danube. As I grew older, they were replaced by diesels. Right before I left, hydrofoils appeared. I saw for myself the evolution that was visible in the imagination of Jules Verne and the machines of Da Vinci.

I never had an urge to see my books' inventions in reality, perhaps because that urge was satisfied by progress as I was growing up. I saw sidewheelers become hydrofoils and the horse-drawn wagons on my street replaced by cars. Even though I did not have a car, I could ride in one and feel the wind blow in my face. The train was a thrill. I was in awe of airplanes. You could say that I was rooted in the 1800s.

What surprises me today are the Internet and the web. Now, human beings are part of a living system as big as the globe. The human and machine species are evolving every second, and I know it will get even better. It's all flowing, and really, really surprising. ■

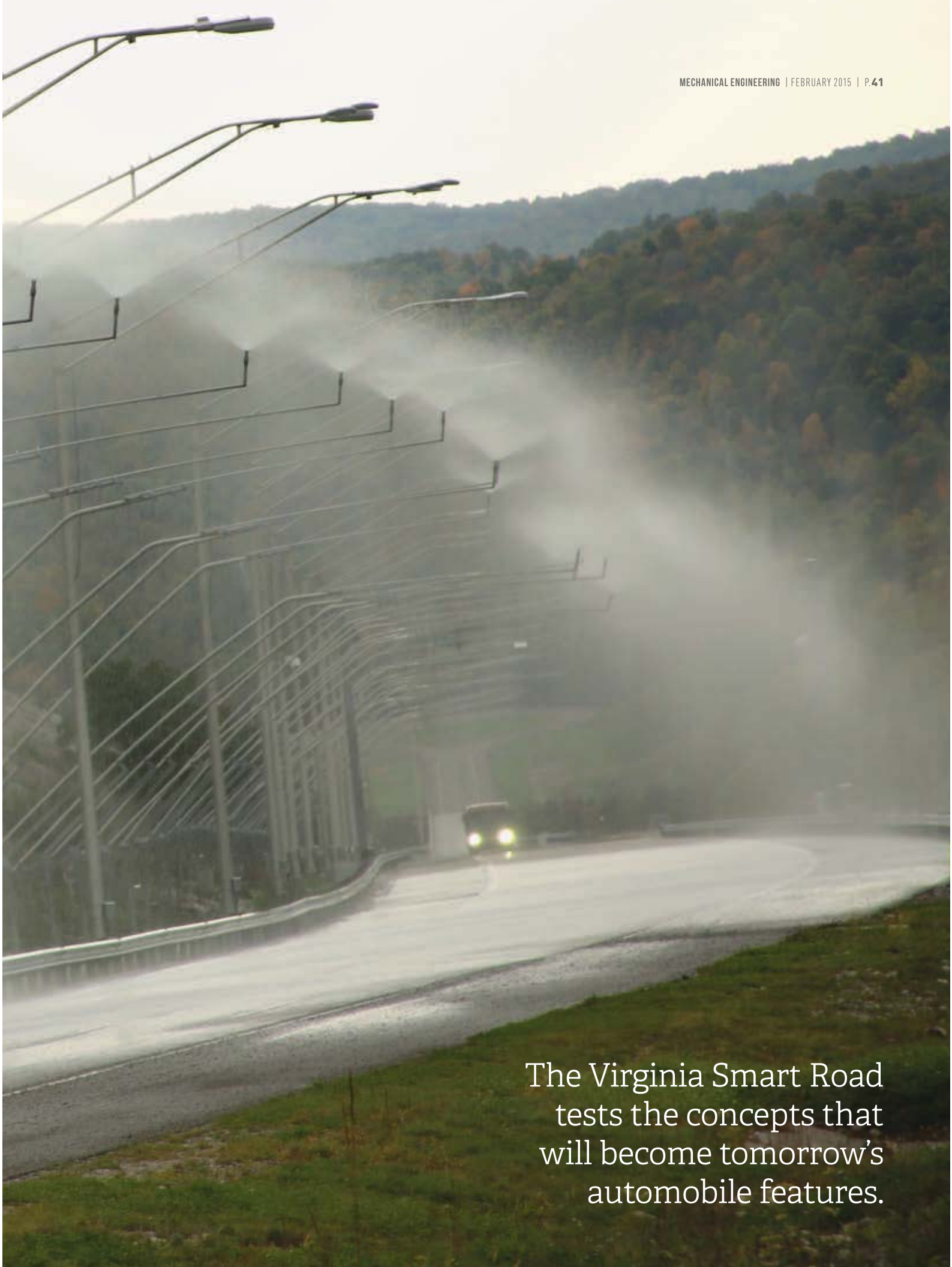
INFLUENCES: *20,000 LEAGUES UNDER THE SEA, FIVE WEEKS IN A BALLOON, AROUND THE WORLD IN 80 DAYS*
CURRENT FIELD: *DESIGN ENGINEERING*
BIGGEST SURPRISE: *INTERNET AND WEB*

Untethered Imagination: By reading books such as 20,000 Leagues Under the Sea (illustrated above) Bejan could travel far beyond his city's limits.
Inset image: Duke University

Rain on Command: Virginia Tech's Smart Road creates its own weather challenges.

SHORT ROAD TO THE NEXT RIDE

By Tom Gibson



The Virginia Smart Road tests the concepts that will become tomorrow's automobile features.

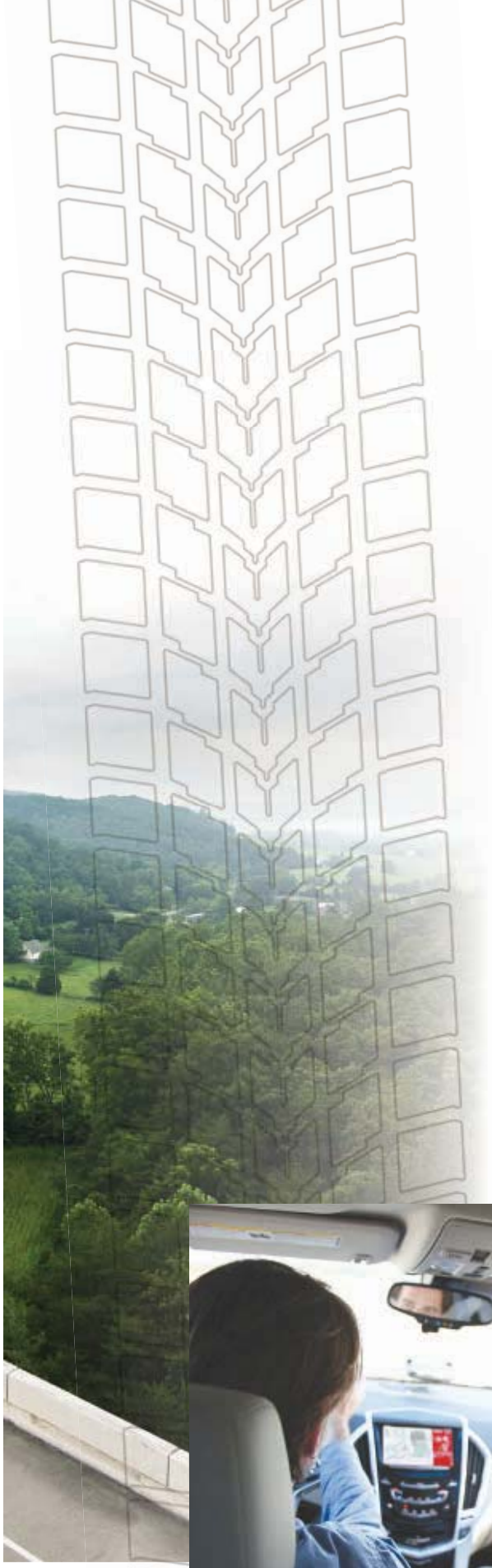
Most drivers tend to avoid rain-slicked roads if they can. But there's a road in the mountains of rural southwest Virginia where engineers can create awful road conditions any time they want.

Running along the Virginia Smart Road is a weather-making system that features a 500,000-gallon water tank on the ground below the road feeding 75 25-foot-high towers mounted on the road with a 400-horsepower pump pressurizing the water. The system can create snow, fog, freezing rain, and heavy downpours. The rain and fog setups were developed in house, while the snow towers are off-the-shelf versions like those at a ski resort.

Jared Bryson and other engineers at the Virginia Tech Transportation Institute use city water and fill the tank at times of low demand, so it acts as a buffer against the huge demands of the system. Two 700-horsepower, 3-stage centrifugal air compressors generate compressed air that runs to each of the towers, atomizing the water for fog- and snowmaking.

Test Road: The university's Transportation Institute studies new technology in a variety of vehicles. At right, Zac Doerzaph demonstrates a connected vehicle for Kenneth Leonard, director of Intelligent Transportation Systems at the U.S. Department of Transportation.

Photos: Logan Wallace



Creating your own weather can be spectacular. The compressors sound like a jet turbine winding up, "a loud and a very distinct whine," Bryson said.

"The weather-making towers are shielded by slopes on both sides of the roadway. As the fog runs, it settles and fills this valley. The fog begins to slowly flow, river-like, down the road. The snow arcs from the towers, and drifts to the roadway. On a cold night the snow drifts more freely, and dusts all of the surroundings."

Making rain, on the other hand, is quieter.

"The rain system does not utilize compressed air," Bryson said, "and so the towers begin much more quietly. As water reaches the nozzles, the towers flex and buck. They quickly settle down and produce a shower of large droplets. On a sunny day, there is often a faint rainbow that accompanies the rain."

Operating a system like this has its rewards, according to Bryson. "It becomes a place to test any new and crazy idea to see what we can make work. It's fun and exciting from that aspect. Getting to make weather; it's fun to go out there and crank the system up wide open and see what we can do."

> "It becomes a place to test any new and crazy idea to see what we can make work."

Located a couple of miles from the Virginia Tech campus, the Virginia Smart Road looks like a conventional highway if you stand in the middle of it. But if you venture to either end of the 2.2-mile-long thoroughfare, you'll see that it actually goes nowhere, at least for now.

The result of a grandiose plan conceived back in the 1980s, the Virginia Smart Road is a unique, state-of-the-art, closed test-bed research facility managed by the Virginia Tech Transportation Institute and owned and maintained by the Virginia Department of Transportation.

Today, it's a laboratory that is moving us toward the future of the automobile.

Tom Dingus serves as director of the Virginia Tech Transportation Institute, which manages the Smart Road and research carried out on it. He is a professor in the Civil and Environmental Engineering Department at Virginia Tech—more formally, the Virginia Polytechnic Institute and State University. He said the road actually goes a long way—in improving transportation technology, that is.

According to Dingus, "It has exceeded everybody's expectations." In 2013, the

Smart Road logged the highest number of paid hours of research since its inception. "It's getting more and more popular."

Over two dozen major non-proprietary research projects use the Smart Road for testing in a given year. Participating organizations include heavy hitters like car manufacturers, the Department of Transportation, the National Highway Traffic Safety Administration, and the Federal Highway Administration's Research and Innovative Technology Administration.

The Smart Road features two paved lanes and three bridges, one of which ranks, at 175 feet, as the tallest state-maintained bridge in Virginia. It also has a signalized intersection; in-pavement sensors for moisture, temperature, strain, vibration, and weighing in motion; a lighting test bed; and the half-mile-long weather-making section. The list of features goes on: an on-site data acquisition system, a high-bandwidth fiber network, a differential GPS base station, and traffic signal phase and timing using remote controls.

> *"'Connected vehicles' is really the large buzz. ... It's a very open field right now."*

According to Zac Doerzaph, director of the Center for Advanced Automotive Research at VTTI, "The Smart Road provides a unique facility for testing transportation systems because it is limited access for research yet is built to the standards of an actual interstate."

VTTI offices house the Smart Road Control Room used to schedule and oversee on-road research, and dispatchers monitor the road from here. Researchers can observe highway traffic and driver performance using surveillance cameras. Engineers can also control the lighting and the weather on the road.

To operate the Smart Road, VTTI employs a team of multidisciplinary researchers, engineers, technicians, support staff, and students. They recruit electrical and mechanical engineering students as graduate research assistants to serve as employees. According to Dingus, "We have over 100 undergraduates that work here doing research projects. That really helps Virginia Tech students get good jobs having that practical experience."

Bryson added, "A good number get hired full time, myself included."

Indeed, Bryson received his B.S.M.E. from Virginia Tech, and he went straight to work at VTTI in 1998. As Smart Road mechanical systems group leader in VTTI's Center for Technology Development, he oversees the mechanical side of the Hardware Operations Group.

"My counterparts and I develop all the systems that go into our studies, whether that be the electronics, mechanical mountings, devices used in conjunction with the vehicles, or infrastructure to support different research projects," he said. "The researchers find projects to bid on, and if they're awarded, we have to make them work."

Over the years, Bryson has developed a perspective on the intricate role mechanical engineers play in the Smart Road's research activities. "We test on everything from bicycles, motorcycles, cars, and SUVs to pickup trucks, commercial vehicles, and tractor trailers," he said. "With the sheer breadth and varied nature of proposals coming in, there's always some aspect that has to be modified or created to facilitate each study. Everything from body work to the manufacture of fixtures and parts to the design of the actual equipment to test."

Having been in operation for 20 years, the Smart Road has accrued a list of accomplishments that have made their way into today's production vehicles. According to Doerzaph, "We have influenced technologies such as forward collision warnings, backing cameras, and crash-imminent braking—wherein the vehicle will automatically apply the brakes to avoid a crash."

Dingus said, "Active safety systems in vehicles is the latest thing. For example, we do a lot of work with 11 different car companies, the biggest one General Motors. If you look at the new Cadillacs that came out last year, they have half a dozen of these active safety systems, all of which were tested on the Smart Road before they were deployed. That's a way we have a pretty big impact."

Active safety systems include any system that helps you avoid a crash, in contrast with passive safety systems, like air bags or seatbelt restraints, that protect you in a crash. Active systems are things like forward collision warnings, automatic braking, backup cameras, and blind spot warnings you see in the mirrors.

Bryson points out another technology pioneered on the Smart Road: adaptive cruise control. This uses forward-looking radar to detect the speed and distance of the vehicle ahead of it. Cruise control maintains a vehicle's preset speed, but adaptive cruise control automatically adjusts the speed to maintain a proper distance between vehicles in the same lane.

A couple of notable technologies are being developed now that may follow this same path. "'Connected vehicles' is really the large buzz in developing projects," Bryson said. "It's a very open field right now, and that's exciting in that we're trying to investigate different directions it could take."

Doerzaph has made a specialty of connected vehicle technology. He has followed a similar path to Bryson, except he got his B.S.M.E. from the University of Idaho and then came to Virginia Tech for his master's and doctoral degrees in industrial and systems engineering. "In a way, the Smart

High Tech: The Smart Road includes the tallest bridge maintained by the State of Virginia.

Road enabled my career," he said.

His center develops and tests prototype systems that focus on the integration of driver and vehicle to improve driver and occupant safety. "Although we have conducted a wide-range of research ranging from fatigue evaluation to infotainment acceptance, the majority of our Smart Road studies involve testing and evaluating collision avoidance and driver assistance systems," he said.

Connected vehicles use low-latency dedicated short-range communications (DSRC) and GPS to predict crashes and warn the driver. Doerzaph points out that his thesis focused on a DSRC-enabled application to stop intersection violations and he performed his research on the Smart Road.

In simple terms, connected vehicles are equipped with radios, so they can communicate with each other as well as with the infrastructure. If a car is in a collision, it can broadcast that it just experienced a high-g load, indicative of a crash or incident, and all the vehicles around it would know there is a problem. The processing power on every vehicle would figure out if it's in the path and what action the vehicle should take, such as alerting the driver or applying the brakes and bringing the vehicle to a stop.

According to Doerzaph, "While there is still work to do, most of the major technology hurdles for connected vehicles have been overcome. Some interesting challenges remain in determining the best methods to deploy a reliable and secure system that will be interoperable for the long term."

Doerzaph pointed out that the National Highway Traffic Administration released an Advanced Notice of Proposed Rulemaking. Published in the Federal Register on August 20, it proposes a process to consider a mandate for including DSRC technology and associated vehicle-to-vehicle communication on new vehicles.

In addition, at the Intelligent Transportation Systems World Congress last fall, General Motors announced plans to install DSRC technology in the 2017 model year Cadillac.

"These two exciting developments point to the possibility of widespread deployment in the coming years," Doerzaph said. "This could have a large safety benefit over time as the technology proliferates and eventually provides other benefits such as improved mobility and reduced environmental impact."

According to Dingus, active safety systems will lead not only to safer and more intelligent cars, but also eventually to automated cars. "The next generation is working on lane-centering systems, where you can actually drive hands off the wheel, and if the car sees an obstacle in front, it will brake to avoid a crash," he said. "Those are coming out very soon; in the next few years, they'll be in production."

Roadway lighting is another area that has come under evaluation, with some unique twists. "We may actually do something where a connected vehicle could trigger rolling lights, and these come on at the appropriate time to light the highway, not running at, say, 4 a.m. if there's no traffic," Bryson said. This would bring energy savings as well as increased safety.

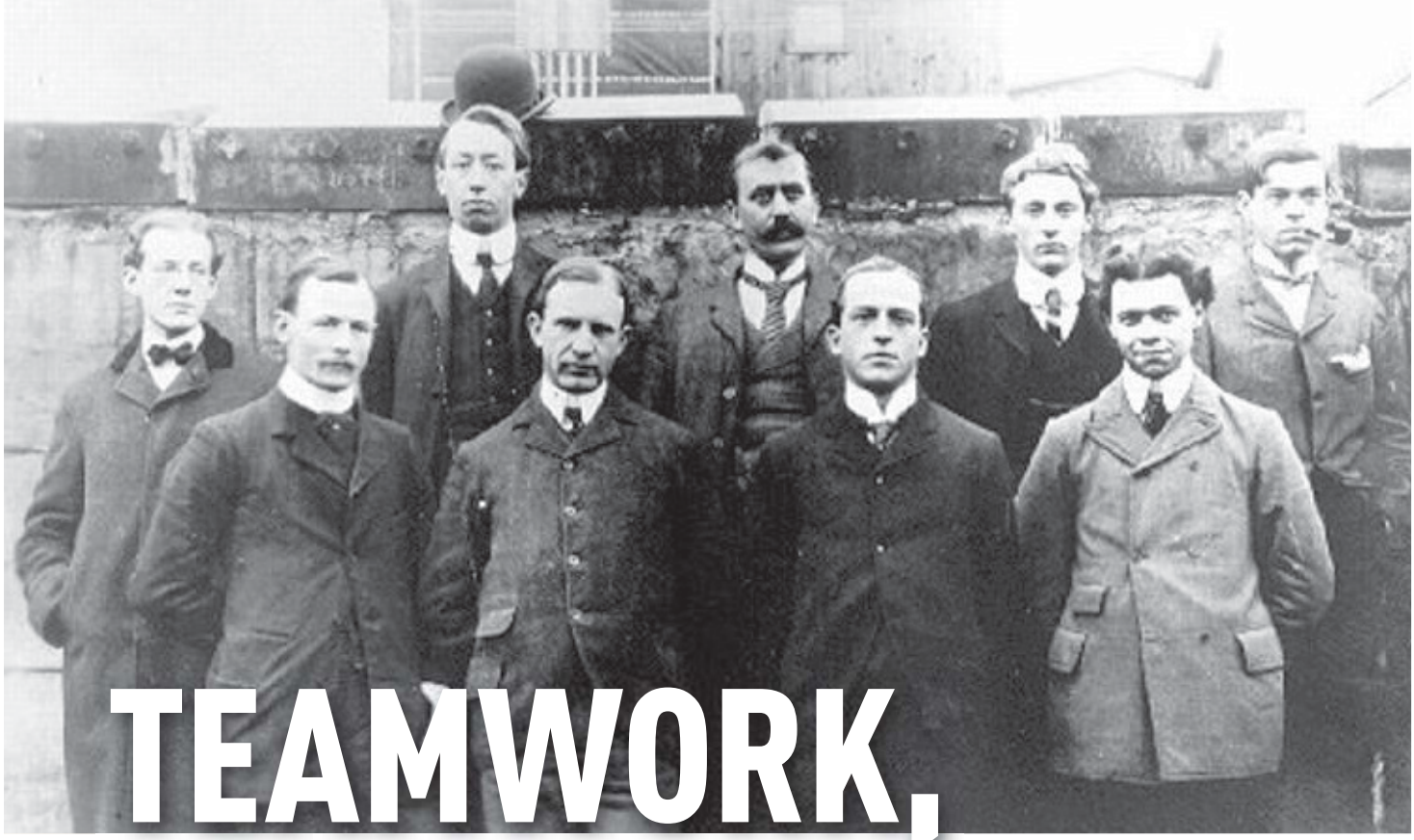
Planning for the Smart Road actually began as far back as 1985. In early 1992, the Virginia Department of Transportation began designing it, working closely with the Federal Highway Administration and Virginia Tech's Center for Transportation Research. Groundbreaking took place in 1997, and construction on the current section was completed in 2002.

Where will the Virginia Smart Road go from here? Eventually, it will provide the motoring public a direct route between Interstate 81 and Blacksburg to facilitate a link between Roanoke, 25 miles east, and Virginia Tech.

The timetable for extending the road to become part of the public transportation system will depend on growing traffic demands on the Route 460 Bypass and on state and federal transportation funding. It will eventually become six miles of four-lane road designed and built in a series of test beds with the ability to shut down two lanes in off-peak hours for testing.

As it continues to play out, this unique public-private-academic project should continue to advance transportation technology for years to come. **ME**

TOM GIBSON, P.E., is a consulting mechanical engineer specializing in machine design and green building, and a freelance writer based in Milton, Pa. He publishes *Progressive Engineer*, an online magazine and information source (www.ProgressiveEngineer.com).



TEAMWORK, EDISON STYLE

THE WORLD'S MOST PROLIFIC INVENTOR KNEW BETTER THAN TO WORK ALONE.

BY SARAH MILLER CALDICOTT

IN 1882, WHEN THOMAS EDISON WAS CONSTRUCTING THE WORLD'S FIRST POWER STATION at Pearl Street in lower Manhattan, he positioned small teams around the entire city.

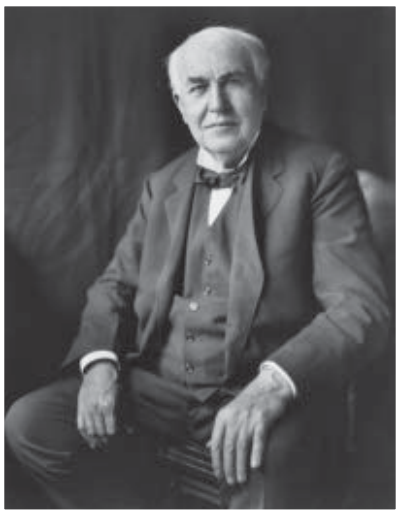
Some were working on site to manage the construction process, while others were in the field laying insulated wire, or trouble-shooting system bugs in the small laboratory Edison rented on the top floor of Bergmann and Co. just blocks away from Pearl Street. Still others labored at the Edison Machine Works in yet another part of Manhattan, where they designed the dynamos that would power the station itself.

A man who preferred streamlined structures more than unnecessarily convoluted ones, Edison relished the rapid exchange and high impact that communication within a small team afforded. He found small teams ideal for making decisions rapidly and nurturing collegiality.

Many people don't realize that Edison's innovations were generated through focused approaches to teamwork and collaboration. He viewed collaboration as the beating heart of his laboratories, a sustaining resource that fueled the knowledge assets of his innovation.

Although created in a different era, the underlying mechanisms of Edison's collaboration process are highly applicable to today's businesses.

Edison designed a process of collaboration that was used across his entire enterprise of more than 200 companies worldwide. Because Edison believed that individuals are vital to collaborative success, he placed emphasis on the contributions of each team member as a critical component of the team's joint efforts.



Thomas Edison

THE "MUCKERS"

Some of Edison's team, nicknamed Muckers, were photographed in West Orange in 1902. The boss expected them to collaborate in small teams, but also to work independently.

When assembling his teams, Edison focused less on a person's résumé and more on the innate, untapped knowledge and creative potential the individual possessed.

Because he believed that a diverse group of individuals offered the best chance for collaborative success, Edison consistently created teams that had members from several disciplines. The famous group that drove the breakthrough thinking behind the incandescent electric light consisted of a glassblower, a machinist, a chemist, a mathematician, an instrument maker, and a textile worker, along with Edison himself.

Additionally, Edison favored small teams rather than large ones. Most of his collaborations involved just two to eight people.

To help foster the social connections among his employees, Edison used what today we would call employee rituals. The most notable of these was the midnight lunch.

"MIDNIGHT LUNCH" IS THE TERM EDISON'S MENLO PARK workers gave to gatherings Edison sponsored for employees who were staying after hours to complete their experiments. Never shy about rolling up his sleeves and laboring with his workers, Edison created a collegial connection with team members during these gatherings, bonding them in a way few other processes could.

At a midnight lunch, Edison encouraged people from different project teams to share their experiments, trade notebooks, and engage in spirited dialogue.

Edison believed in using a combination of individual learning and hands-on activities to work on potential solutions. In Edison's breakthrough invention of motion pictures, he worked with a photographer in his employ, William Kennedy Laurie Dickson, to construct a prototype movie studio near the front gate of the West Orange laboratory.

Known as the Black Maria, the studio was built on a swivel base, so that it could rotate to follow the sun. This was essential to providing light during filming sessions.

The design of the Black Maria and its proximity to the lab enabled Edison and his teams to go to the studio, physically test equipment, alter their hypotheses, and refine their questions about capturing motion on film.

Edison stressed collaboration, which is different from teamwork. An important difference that characterizes collaboration is that someone works as part of a group and also on one's own.

Edison viewed collaboration as a learning continuum, not a stop-and-start process. Solo work was important to him because it signaled the individual was mentally preparing for the work that would be done jointly, and thereby improving the total output of the team.

One way Edison urged his employees to prepare for their collaborations was to read texts from the libraries at Menlo Park and West Orange. The West Orange facility housed over 10,000 volumes covering mathematics, physics, chemistry,

MIDNIGHT LUNCH

Bonding at gatherings after hours, team members were encouraged to share ideas on their projects.

AT THE "MOVIES"

William Dickson, who worked with Edison on moving pictures, appeared in a brief film. The Black Maria, the tar-paper studio that could track the sun, rotated on a track.

acoustical science, the classics, science fiction, and scientific journals. Edison often asked employees what they had read, and queried them on their thoughts on a given subject.

Following individual preparation, the collaborative team would come together to discuss insights into the problem at hand.

EDISON BELIEVED IT WAS IMPORTANT NOT TO PERPETRATE FALSE LOGIC across a team. He thus asked each member to have a point of view on a subject, but address that point of view from the perspective of neutrality—holding open the possibility that the thinking was in some way skewed or biased.

For example, in devising the first working incandescent electric light, Edison built upon data from experiments that had been conducted over the prior 40 years. But he realized the hypotheses of earlier researchers had focused on the length of time a substance would burn rather than how the substance burned.

This shift in perspective enabled Edison's teams to ask questions about the evenness of burning, rather than merely the amount of time a substance would burn.

Edison hit upon the need for the radiating surface to be small—not large, as prior scientists had hypothesized. A small radiating surface of a resistive filament powered by a current offered the crucial combination that had eluded others, yielding the first practical working electric light.

If Edison's team members had not expanded the context of their thinking to include the nature of burning rather than merely the length of time a substance could burn, they would likely have missed the breakthrough solution that the filament represented.

LIGHT AT THE END

The incandescent lamp came about only after the development team began to look at problems from new angles—considering how evenly, for instance, rather than how long a material burned.

To improve collaboration, Edison laid the groundwork for team members not only to draw inspiration from the collective endeavors of the group, but also to find inspiration within themselves.

LIKE GRAVITY, COHERENCE CONNECTS TEAM MEMBERS WITH A GLUE that allows the team to keep functioning even if there are disruptions to its momentum. Even in Edison's time difficulties like budget cuts, a slower than expected pace of results, or the loss of a team member were part of doing business.

Edison's groundbreaking work on the storage battery, for example, required five years of intensive effort and more than 10,000 experiments.

Edison took a major financial hit in the 1890s during his decade-long pursuit of an iron ore mining and ore grinding technology that never panned out. In hopes of winning back his reputation as a ground-breaking innovator, he set about creating a portable battery that did not use lead and involved no liquid chemicals.

The result was the world's first alkaline storage battery. It could easily be picked up by hand and used in motor cars (which were themselves quite revolutionary) as well as trucks. But the process of designing and testing the battery nearly broke the spirit of his workforce.

Edison recognized coherence as a force that united his teams in a common purpose, driving each member forward with resolve and persistence.

Team members came to realize that they could fuel their efforts with inspiration from Edison when he was present, but they also had to sustain creative momentum when Edison was absent. To create new points of inspiration beyond himself, Edison often placed promising employees in leadership positions, intentionally stretching their abilities by giving them assignments that lay beyond anything they had previously endeavored. In this way, he created catalysts within the organization that evangelized and propelled innovation in positive ways.

For example, Charles Batchelor—Edison's right hand man at the Menlo Park lab and later West Orange—began working with Edison as an assistant experimenter and a prototyper. But over time, Batchelor rose to become someone who could envision new concepts with great clarity, and he could motivate others to consistently push the boundaries of their thinking.

Edison assigned Batchelor to head the installation of the first electrical power station in Europe—in Paris—where he managed all the logistics for the design of the station such as the contract-

ing of suppliers. This was a completely new form of work that took Batchelor beyond the familiar confines of the lab. Ultimately, Batchelor's success enabled Edison to propel his electrical power innovations to new markets, and Batchelor served as a crucial agent in this effort.

By laying out big challenges for individuals, Edison pushed team members beyond their comfort zone. This forced them to develop new abilities and bring discovery learning into their daily efforts.

Edison recognized that complexity was a factor ever-present in the collaborations of his employees and in his broader business operations. Just as Edison favored smaller teams as a starting point for his collaborations, he valued fewer steps and rules that could hinder rapid development of a solution. He put a premium on processes that encouraged streamlining, transparency, and simplicity.

TURNING TO TRUSTED EXPERTS OUTSIDE THE LABORATORY ACCELERATED learning and project timetables in an environment where designing new, disruptive technologies was the norm. Edison made efforts to stay in contact with outside firms that were innovative in their dealings with markets and products.

Edison's relationship with Ansonia Brass & Copper—a major metals supplier—aided in the speed and scale of Edison's complex work. As Edison and his teams experimented with copper wire as a primary conduit for his new power station on Pearl Street, they realized that their results varied even when the experimental conditions were identical.

Frustrated that his teams could not consistently verify and reproduce their results, Edison hypothesized that the source of the variation might be the copper wire itself. He proceeded to slice various sections of copper wire used in these experiments, and noted black specks in several samples—signaling imperfections and impurities in the wire.

Edison brought the wire to Ansonia Brass & Copper, and asked the company to address the problem. Ansonia worked for weeks with Edison's teams in a collaborative fashion before it arrived at a solution.

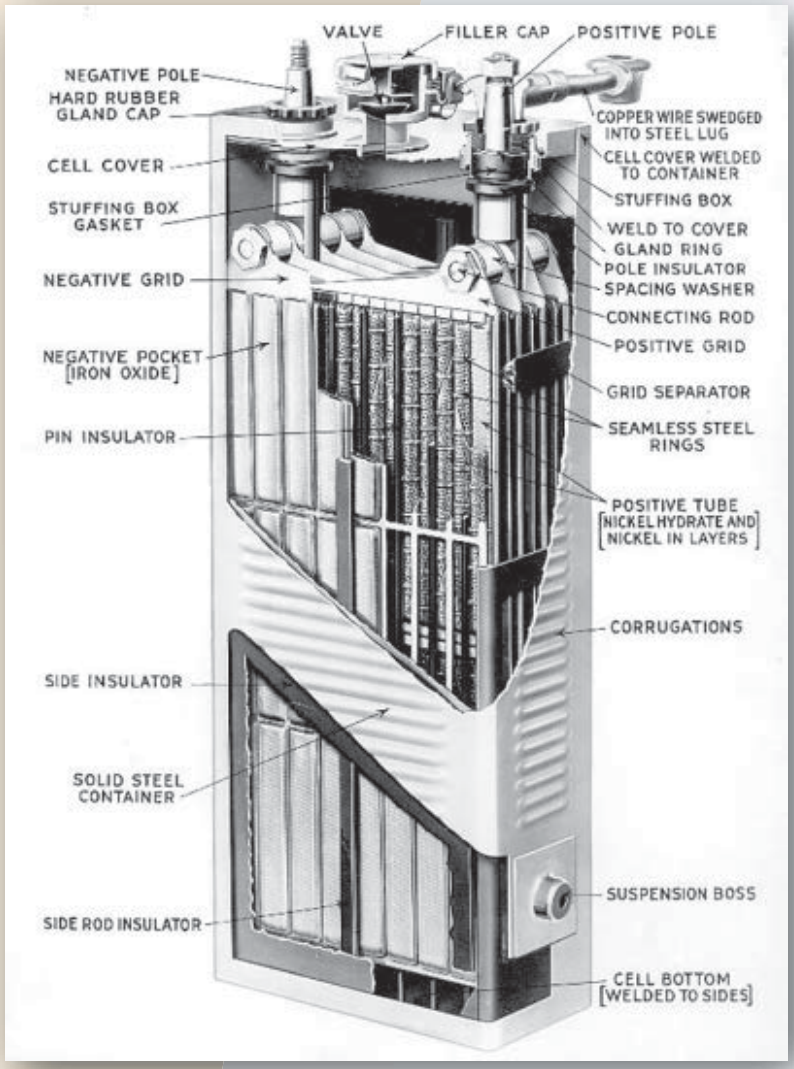
Edison also emphasized the importance of keeping records of project activity. Teams would need to look back at the successes and failures of their current projects, and they could benefit by studying projects that had gone on years before. Today, we would describe this as creating "collective intelligence."

Today, it's possible to use notebooks, videos, sound recordings, prototypes, stories, and other media to capture the heart and soul of a project. Collective intelligence remains one of the most powerful outputs a collaboration can yield.

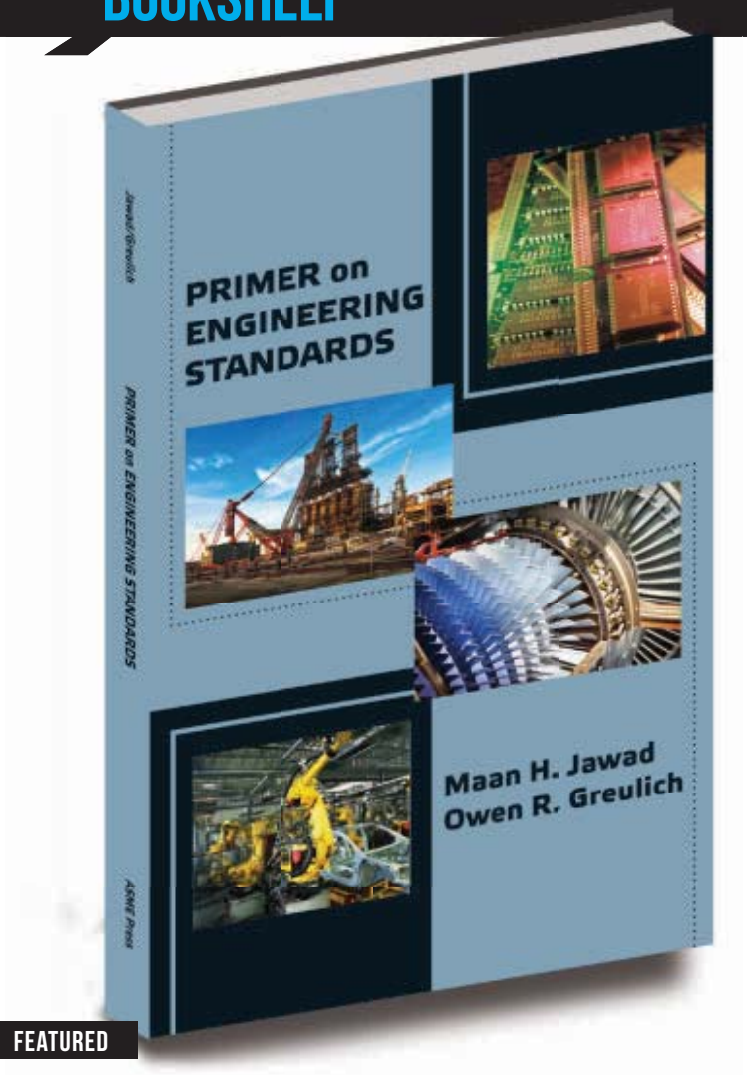
Edison fundamentally viewed collaboration as a connecting force, a transformational force that facilitated and made possible the development of new knowledge. Without a deep and broad network, Edison could not have rapidly tackled the complex challenges he faced. ME

STORING ENERGY

The advent of automobiles in the late 1890s spurred Edison to develop a storage battery to power them. Weight issues with lead acid batteries led to experiments with alkaline electrolytes, but after 10 years developing a commercially viable iron-nickel battery, the internal combustion engine had become dominant in the automobile industry.



SARAH MILLER CALDICOTT, a great grand-niece of Thomas Edison, heads her own consulting firm, The Power Patterns of Innovation, in which she translates Edison's innovation methods for use today.



FEATURED

PRIMER ON ENGINEERING STANDARDS

MAAN H. JAWAD AND OWEN R. GREULICH

ASME Press Books, Two Park Avenue, New York, NY 10016-5990. 2014.

Standards often supplement the design process by guiding the designer to create consistent products with safe and reliable operation. In their book, Jawad and Greulich introduce the impact and value of standards in the successful design, fabrication, and operation of a product. They begin with a brief introduction to the general concepts of procedures, rules, standards, regulations, codes, and jurisdictional requirements, then discuss the consensus process of standards development and its limitations. Other sections talk about the types of standards, where they have jurisdiction, the need and processes for exemptions from existing standards, and finally, what makes for a good standard. The appendices provide assistance in identifying a few of these engineering standards, who developed and maintains them, and contact information to help the reader obtain further information.

100 PAGES. $49; ASME MEMBERS, $39, ISBN: 978-0-7918-6034-2.

IMPINGEMENT JET COOLING IN GAS TURBINES

R. S. Amano and B. Sundén, editors
WIT Press, 25 Bridge Street, Billerica, MA 01821. 2014

Modern gas turbine engines require enhanced cooling technologies. This need has led to advanced research and development in thermal engineering. Among gas turbine cooling technologies, impingement jet cooling is one of the most effective in terms of cooling, manufacturing, and cost. *Impingement Jet Cooling in Gas Turbines* is one of the first books to focus on this technology as applied to gas turbines. Amano and Sundén have collected papers that describe research on state-of-the-art advanced cooling technologies that have been developed, or that are being researched, with a variety of approaches from theoretical, experimental, and CFD studies. The chapter authors are some of the most active researchers and scientists on the subject.

252 PAGES. $216. ISBN: 978-1-8456-4906-7.

FUEL AND COMBUSTION SYSTEMS SAFETY: WHAT YOU DON'T KNOW CAN KILL YOU!

John R. Puskar
John Wiley & Sons Inc., 111 River Street, Hoboken, NJ 07030-5774. 2014.

Puskar has 30 years of hands-on experience working in the field of industrial fuel systems and combustion equipment safety. He intends for this book to teach about fuels, piping, combustion, controls, and risks using more than fifty "real-life stories" integrated into the chapters. (The incidents depicted resulted in forty-six deaths, hundreds of serious injuries, and billions of dollars in losses.) Each example is followed by lessons learned, with the aim of helping readers understand what could have been done to avoid disaster or minimize the resulting destruction of life and property.

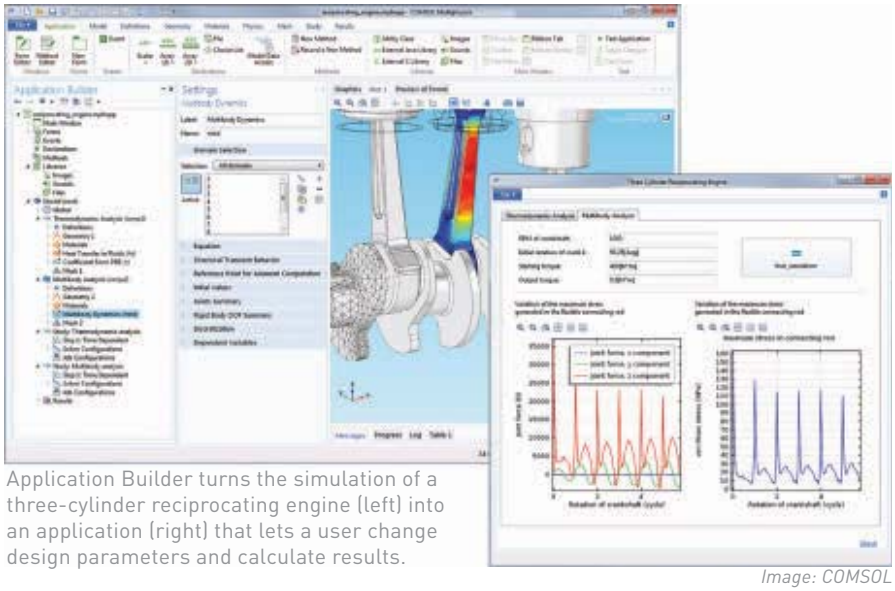
346 PAGES. $89.95. ISBN: 978-0-4705-3360-4.

MAKING MULTIPHYSICS HANDIER

COMSOL INC., BURLINGTON, MASS.

COMSOL Multiphysics version 5.0 now features the Application Builder, which lets users build applications based on their models for use by engineering and manufacturing departments. Based on the project at hand, engineering experts use the Application Builder to turn their models into a specialized application that includes only the parameters relevant to the design of a specific device or product. The application can then be shared with anyone, expanding accessibility to cutting-edge simulation solutions

Other new features available include the Ray Optics Module, for analyzing systems in which the electromagnetic wavelength is smaller than the smallest geometric detail in the model; the Design Module, which expands the CAD functionalities of the COMSOL software; and LiveLink for Revit, which allows users to interface with Autodesk's building information modeling software.



Application Builder turns the simulation of a three-cylinder reciprocating engine (left) into an application (right) that lets a user change design parameters and calculate results.

Image: COMSOL

SYSTEMS ENGINEERING

EPLAN, FARMINGTON HILLS, MICH.

The EPlan Platform 2.3 for engineering process efficiency integrates electrical engineering, automation, fluid engineering, mechatronics, complex-process, production, and control application suites.

Applications within the platform include the EPlan Electric P8 for electrical project planning, documentation, and management; EPlan Harness proD for wire harness design; and an application for the design and documentation of circuits in fluid power installations.

DESIGN IN 2-D AND 3-D

COREL, OTTAWA, CANADA.

The 2-D and 3-D CAD software CorelCAD 2015 includes support for Drawing (.dwg) files and CorelDRAW graphics and automation capabilities. New features include parametric drawing capabilities, a pop-up dimension palette, and enhanced in-place text editing tools. The software runs on both Windows and Macintosh platforms.

HAPTIC DESIGN

3D SYSTEMS, ROCK HILL, S.C.

The GeomagicSculpt 3-D modeling software includes the developer's Touch haptic 3-D stylus. The application helps users design complex, curved, and organic shapes. The stylus offers positioning input and instant force feedback that mimics the sense of physical sculpting. Users can tug, ridge, emboss, and form to create their designs. The software works with users' existing CAD systems and allows them to maintain existing workflows.

PHYSICS AND ENGINEERING PLATFORM

MSC SOFTWARE, NEWPORT BEACH, CALIF.

The computer-aided engineering platform MSC Apex can serve as the platform for a range of physics and engineering applications that the company plans to introduce. In the simulation environment, users can carry out end-to-end simulation workflows with full associativity between geometric and analysis data, including generative behavior, to ensure all aspects of the model are consistent and up to date following design changes.

The platform is powered by a direct modeling and meshing engine that accelerates the CAD-to-mesh process, according to the developer. It also includes integrated solver methods that allow users to validate parts and sub-subsystem models. Because the platform is computational-parts-based, users can incrementally run analysis of complex assemblies and groups of users can exchange mathematical models throughout the supply chain without compromising intellectual property.

CAD ACCESS FOR DEVELOPERS

TECH SOFT 3D, BEND, ORE.

Hoops Exchange 2015 allows software developers to bring 3-D CAD data access to multiple file formats. The latest version includes an upgrade that lets developers add 3-D CAD data access to mobile applications. The new version also includes a Parasolid connector, which brings imported data to the B-Rep modeler found within many applications and prepares it for modeling within the Parasolid 3-D geometric modeling kernel from Siemens PLM of Plano, Texas.

SUBMISSIONS

Submit hard copy or e-mail memag@asme.org, using subject line "Software Exchange." *ME* does not test or endorse software described here.

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TRAINING COURSES FOR ENGINEERS AND TECHNICAL PROFESSIONALS

2015 SPRING

MARCH 2015 – HOUSTON, TEXAS USA

PD387	Understanding Chiller Performance, Operation & Economics	2 Mar
PD570	Geometric Dimensioning and Tolerancing Fundamentals 1	2-3 Mar
PD583	Pressure Relief Devices: Design, Sizing, Construction, Inspection and Maintenance ASME CODE COURSE	2-3 Mar
PD190	BPV Code, Section IX: Welding, Brazing and Fusing Qualifications ASME CODE COURSE	2-4 Mar
PD268	Fracture Mechanics Approach to Life Predictions	2-4 Mar
PD349	Design and Applications of Centrifugal Pumps	2-4 Mar
PD370	B31.8 Gas Transmission and Distribution Piping Systems ASME CODE COURSE	2-4 Mar
PD683	Probabilistic Structural Analysis, Design and Reliability-Risk Assessment	2-4 Mar
PD394	Seismic Design and Retrofit of Equipment and Piping	2-5 Mar
PD603	Geometric Dimensioning and Tolerancing Combo Course SAVE UP TO $380!	2-5 Mar
PD657	HVAC Systems and Chiller Performance Combo Course SAVE UP TO $475!	2-5 Mar
PD013	B31.1 Power Piping Code ASME CODE COURSE	2-6 Mar
PD432	Turbo Machinery Dynamics: Design and Operation	2-6 Mar
PD027	Heating, Ventilating and Air-Conditioning Systems: Sizing and Design	3-5 Mar
PD561	Geometric Dimensioning Tolerancing Advanced Applications with Stacks and Analysis Top Seller	4-5 Mar
PD606	NQA-1 Requirements for Computer Software Used in Nuclear Facilities ASME CODE COURSE	5-6 Mar
PD706	Inline Inspections for Pipelines NEW!	5-6 Mar

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MARCH 2015 – LAS VEGAS, NEVADA USA

PD475	The New Engineering Manager: Engaging Today's Workforce	16-17 Mar
PD531	Leadership and Organizational Management	16-17 Mar
PD539	Bolted Joints and Gasket Behavior	16-17 Mar
PD077	Failure Prevention, Repair and Life Extension of Piping, Vessels and Tanks ASME CODE COURSE	16-18 Mar
PD395	API 579-1/ASME FFS-1 Fitness-for-Service	16-18 Mar
PD618	Root Cause Analysis Fundamentals	16-18 Mar
PD633	Overview of Nuclear Codes and Standards for Nuclear Power Plants ASME CODE COURSE	16-18 Mar
PD685	The New Engineering Manager: Engaging Today's Workforce and Strategic Thinking Combo Course SAVE UP TO $465!	16-18 Mar
PD702	Process Safety and Risk Management for Mechanical Engineers NEW!	16-18 Mar
PD720	Layout of Process Piping Systems NEW!	16-18 Mar
PD014	ASME B31.3 Process Piping Design ASME CODE COURSE Top Seller	16-19 Mar
PD184	BPV Code, Section III, Division 1: Rules for Construction of Nuclear Facility Components ASME CODE COURSE	16-19 Mar
PD632	Design in Codes, Standards and Regulations for Nuclear Power Plant Construction ASME CODE COURSE	16-19 Mar
PD192	BPV Code, Section XI: Inservice Inspection of Nuclear Power Plant Components ASME CODE COURSE	16-20 Mar
PD581	B31.3 Process Piping Design, Materials, Fabrication, Examination and Testing Combo Course ASME CODE COURSE SAVE UP TO $575!	16-20 Mar
PD601	Bolting Combo Course SAVE UP TO $1,260!	16-20 Mar
PD686	Layout of Process Piping Systems and Optimization of Plant Layouts Utilizing 3D CAD/CAE Systems Combo Course NEW! SAVE UP TO $635!	16-20 Mar

CONTINUED, MARCH 2015 – LAS VEGAS, NEVADA USA

PD386	Design of Bolted Flange Joints	18 Mar
PD676	Strategic Thinking	18 Mar
PD631	Manufacturing, Fabrication and Examination Responsibilities in Codes, Standards and Regulations for Nuclear Power Plant Construction ASME CODE COURSE	18-20 Mar
PD115	The Gas Turbine: Principles and Applications	19-20 Mar
PD575	Comprehensive Negotiating Strategies®: Engineers and Technical Professionals	19-20 Mar
PD577	Bolted Joint Assembly Principles Per PCC-1-2013 ASME CODE COURSE	19-20 Mar
PD591	Developing Conflict Resolution Best Practices	19-20 Mar
PD634	Comparison of Global Quality Assurance and Management System Standards Used for Nuclear Application ASME CODE COURSE	19-20 Mar
PD721	Optimization of Plant Layouts Utilizing 3D CAD/CAE Systems and 3D Laser Scanning Technology NEW!	19-20 Mar
PD457	B31.3 Process Piping Materials Fabrication, Examination and Testing ASME CODE COURSE Top Seller	20 Mar

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MARCH 2015 – COPENHAGEN, DENMARK

PD391	ASME B31.4 Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquids ASME CODE COURSE	23-24 Mar
PD634	Comparison of Global Quality Assurance and Management System Standards Used for Nuclear Application ASME CODE COURSE	23-24 Mar
PD146	Flow Induced Vibration with Applications to Failure Analysis	23-25 Mar
PD389	Nondestructive Examination - Applying ASME Code Requirements (BPV Code, Section V) ASME CODE COURSE	23-25 Mar
PD442	BPV Code, Section VIII, Division 1: Design and Fabrication of Pressure Vessels ASME CODE COURSE Top Seller	23-25 Mar
PD645	BPV Code, Section IX: Welding, Brazing and Fusing Qualifications ASME CODE COURSE	23-25 Mar
PD616	API 579 /ASME FFS-1 Fitness-for-Service Evaluation	23-26 Mar
PD642	ASME B31.1 Power Piping Code ASME CODE COURSE	23-26 Mar
PD679	Selection of Pumps and Valves for Optimum System Performance NEW!	23-26 Mar
PD716	BPV Code, Section 1: Power Boilers ASME CODE COURSE	23-26 Mar
PD443	BPV Code, Section VIII, Division 1 Combo Course ASME CODE COURSE SAVE UP TO €800!	23-27 Mar
PD635	ASME NQA-1 Quality Assurance Requirements for Nuclear Facility Applications ASME CODE COURSE	25-27 Mar
PD441	Inspections, Repairs and Alterations of Pressure Equipment ASME CODE COURSE Top Seller	26-27 Mar

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MARCH 2015 – ORLANDO, FLORIDA USA

PD100	Introduction to the Maintenance and Inspection of Elevators and Escalators	30-31 Mar
PD313	Fundamentals of Fastening Systems	30-31 Mar
PD456	Tools and Methods of Finite Element Analysis	30-31 Mar
PD389	Nondestructive Examination - Applying ASME Code Requirements (BPV Code, Section V) ASME CODE COURSE	30 Mar-1 Apr
PD506	Research and Development Management	30 Mar-1 Apr
PD515	Dimensioning and Tolerancing Principles for Gages and Fixtures	30 Mar-1 Apr
PD619	Risk and Reliability Strategies for Optimizing Performance	30 Mar-1 Apr
PD359	Practical Welding Technology	30 Mar-2 Apr

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CONTINUED, MARCH-APRIL 2015 – ORLANDO, FLORIDA USA

PD675	ASME NQA-1 Lead Auditor Training	30 Mar-2 Apr
PD679	Selection of Pumps and Valves for Optimum System Performance NEW!	30 Mar-2 Apr
PD602	Elevator and Escalator Combo Course	30 Mar-3 Apr
PD665	BPV Code, Section I: Power Boilers ASME CODE COURSE	30 Mar-3 Apr
PD449	Mechanical Tolerancing for Six Sigma	1-2 Apr
PD102	ASME A17.1 Safety Code and ASME A17.2 Inspection Requirements ASME CODE COURSE	1-3 Apr

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APRIL 2015 – SACRAMENTO, CALIFORNIA USA

PD391	ASME B31.4 Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquids ASME CODE COURSE	13-14 Apr
PD570	Geometric Dimensioning and Tolerancing Fundamentals 1 ASME CODE COURSE Top Seller	13-14 Apr
PD624	Two-Phase Flow and Heat Transfer	13-14 Apr
PD146	Flow Induced Vibration with Applications to Failure Analysis	13-15 Apr
PD190	BPV Code, Section IX: Welding, Brazing and Fusing Qualifications ASME CODE COURSE	13-15 Apr
PD231	Shock and Vibration Analysis	13-15 Apr
PD442	BPV Code, Section VIII, Division 1: Design and Fabrication of Pressure Vessels ASME CODE COURSE Top Seller	13-15 Apr
PD467	Project Management for Engineers & Technical Professionals	13-15 Apr
PD506	Research and Development Management	13-15 Apr
PD615	BPV Code, Section III, Division 1: Class 1, 2 & 3 Piping Design ASME CODE COURSE	13-15 Apr
PD720	Layout of Process Piping Systems NEW!	13-15 Apr
PD603	Geometric Dimensioning and Tolerancing Combo Course SAVE UP TO $380!	13-16 Apr
PD620	Core Engineering Management	13-16 Apr
PD691	Fluid Mechanics, Piping Design, Fluid Transients & Dynamics	13-16 Apr
PD013	B31.1 Power Piping Code ASME CODE COURSE	13-17 Apr
PD443	BPV Code, Section VIII, Division 1 Combo Course ASME CODE COURSE SAVE UP TO $645	13-17 Apr
PD629	Project Management Combo Course SAVE UP TO $635!	13-17 Apr
PD686	Layout of Process Piping Systems and Optimization of Plant Layouts Utilizing 3D CAD/CAE Systems and 3D Laser Scanning Technology Combo Course NEW! SAVE UP TO $635!	13-17 Apr
PD561	Geometric Tolerancing Advanced Applications with Stacks and Analysis Top Seller	15-16 Apr
PD596	Developing a 10-Year Valve Inservice Testing Program	15-17 Apr
PD441	Inspections, Repairs and Alterations of Pressure Equipment ASME CODE COURSE Top Seller	16-17 Apr
PD496	Preparing for the Project Management Professional Certification Exam	16-17 Apr
PD706	Inline Inspections for Pipelines NEW!	16-17 Apr
PD721	Optimization of Plant Layouts Utilizing 3D CAD/CAE Systems and 3D Laser Scanning Technology NEW!	16-17 Apr

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APRIL 2015 – CHICAGO, ILLINOIS USA

PD107	Elevator Maintenance Evaluation	20-21 Apr
PD539	Bolted Joints and Gasket Behavior	20-21 Apr
PD583	Pressure Relief Devices: Design, Sizing, Construction, Inspection and Maintenance ASME CODE COURSE	20-21 Apr
PD077	Failure Prevention, Repair and Life Extension of Piping, Vessels and Tanks ASME CODE COURSE	20-22 Apr
PD349	Design and Applications of Centrifugal Pumps	20-22 Apr
PD395	API 579-1/ASME FFS-1 Fitness-for-Service	20-22 Apr
PD618	Root Cause Analysis Fundamentals	20-22 Apr
PD674	International Business Ethics & Foreign Corrupt Practices Act	20-22 Apr
PD702	Process Safety and Risk Management for Mechanical Engineers NEW!	20-22 Apr
PD711	ASME NQA-1 and DOE Quality Assurance Rule 10 CFR 830 ASME CODE COURSE NEW!	20-22 Apr
PD014	ASME B31.3 Process Piping Design ASME CODE COURSE Top Seller	20-23 Apr
PD394	Seismic Design and Retrofit of Equipment and Piping	20-23 Apr

CONTINUED, APRIL 2015 – CHICAGO, ILLINOIS USA

PD448	BPV Code, Section VIII, Division 2: Alternative Rules - Design & Fabrication of Pressure Vessels ASME CODE COURSE Top Seller	20-23 Apr
PD622	BPV Code: Plant Equipment Requirements ASME CODE COURSE	20-23 Apr
PD581	B31.3 Process Piping Design, Materials, Fabrication, Examination and Testing Combo Course ASME CODE COURSE SAVE UP TO $575!	20-24 Apr
PD601	Bolting Combo Course SAVE UP TO $1,260!	20-24 Apr
PD681	International Business Ethics and Foreign Corrupt Practices Act Combo Course SAVE UP TO $635!	20-24 Apr
PD386	Design of Bolted Flange Joints	22 Apr
PD410	Detail Engineering of Piping Systems	22-24 Apr
PD631	Manufacturing, Fabrication and Examination Responsibilities in Codes, Standards and Regulations for Nuclear Power Plant Construction ASME CODE COURSE	22-24 Apr
PD575	Comprehensive Negotiating Strategies®: Engineers and Technical Professionals	23-24 Apr
PD577	Bolted Joint Assembly Principles Per PCC-1-2013	23-24 Apr
PD606	NQA-1 Requirements for Computer Software Used in Nuclear Facilities ASME CODE COURSE	23-24 Apr
PD680	Understanding the Foreign Corrupt Practices Act	23-24 Apr
PD690	Economics of Pipe Sizing and Pump Selection NEW!	23-24 Apr
PD692	Communication Essentials for Engineers NEW!	23-24 Apr
PD457	B31.3 Process Piping Materials Fabrication, Examination and Testing ASME CODE COURSE Top Seller	24 Apr

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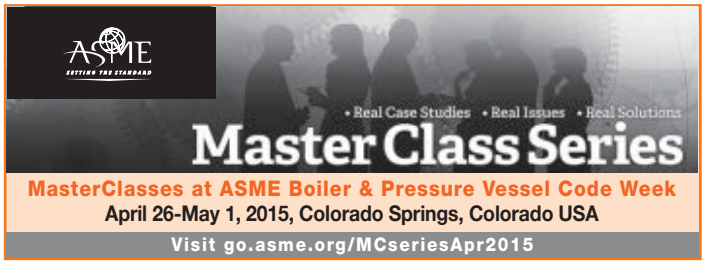

MAY 2015 – LAS VEGAS, NEVADA USA

PD100	Introduction to Elevators and Escalators	4-5 May
PD313	Fundamentals of Fastening Systems	4-5 May
PD456	Tools and Methods of Finite Element Analysis	4-5 May
PD370	B31.8 Gas Transmission and Distribution Piping Systems ASME CODE COURSE	4-6 May
PD389	Nondestructive Examination - Applying ASME Code Requirements (BPV Code, Section V) ASME CODE COURSE	4-6 May
PD513	TRIZ: The Theory of Inventive Problem Solving	4-6 May
PD515	Dimensioning and Tolerancing Principles for Gages and Fixtures	4-6 May
PD571	The Taguchi Design of Experiments for Robust Product and Process Designs	4-6 May
PD621	Grade 91 and Other Creep Strength Enhanced Ferritic Steels	4-6 May
PD683	Probabilistic Structural Analysis, Design and Reliability-Risk Assessment	4-6 May
PD632	Design in Codes, Standards and Regulations for Nuclear Power Plant Construction ASME CODE COURSE	4-7 May
PD644	Advanced Design and Construction of Nuclear Facility Components Per BPV Code, Section III ASME CODE COURSE	4-7 May
PD675	ASME NQA-1 Lead Auditor Training	4-7 May
PD679	Selection of Pumps and Valves for Optimum System Performance NEW!	4-7 May
PD432	Turbo Machinery Dynamics: Design and Operation	4-8 May
PD598	Developing a New Inservice Testing Program	4-8 May
PD602	Elevator and Escalator Combo Course SAVE UP TO $635!	4-8 May
PD665	BPV Code, Section I: Power Boilers ASME CODE COURSE	4-8 May
PD102	ASME A17.1 Safety Code and ASME A17.2 Inspection Requirements ASME CODE COURSE	6-8 May
PD584	Centrifugal Compressor Performance Analysis	6-8 May
PD619	Risk and Reliability Strategies for Optimizing Performance	6-8 May
PD445	B31 Piping Fabrication and Examination ASME CODE COURSE	7-8 May
PD567	Design, Analysis and Fabrication of Composite Structure, Energy and Machine Applications	7-8 May

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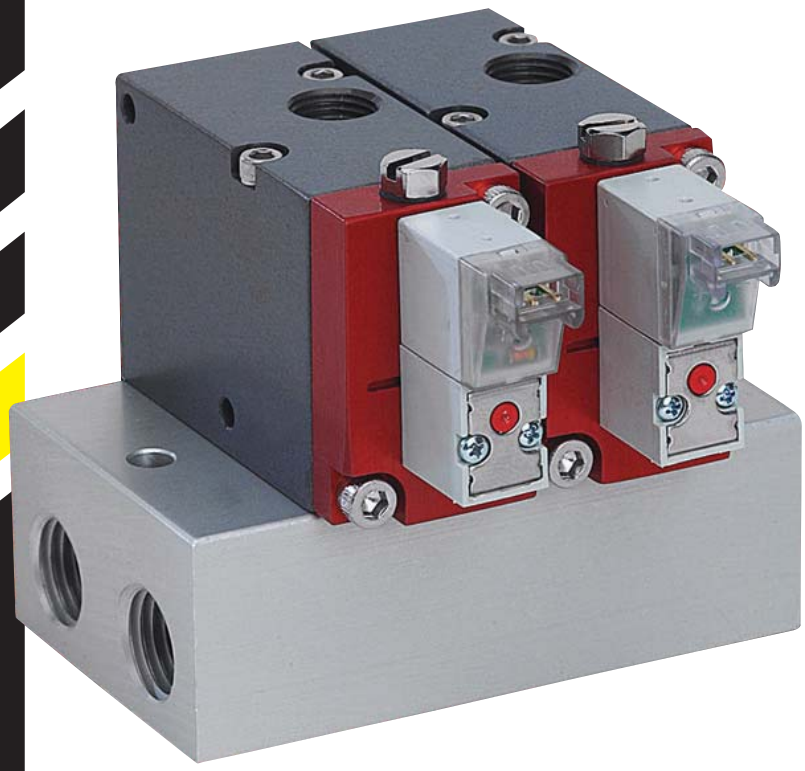

ELECTRONIC POPPET VALVES

CLIPPARD INSTRUMENT LABORATORY INC., CINCINNATI.

EGV Series valves are electronically piloted versions of the GV series valves, and are used for large flow, low leak applications. Available in 1/8-inch NPT ported and manifold mount, they utilize Clippard 10 mm or 15 mm valves, and offer numerous voltage and connection options. These two-way and three-way valves provide 10 times more flow than the company's MAV series and 2.5 times more flow than the MJV series. An externally piloted option is available for controlling lower pressures.

ANGLE SENSORS

NOVOTECHNIK U.S., SOUTHBOROUGH, MASS.

The Vert-X 32E Series of programmable rotary angle sensors are touchless magnetic angle sensors with a permanent magnet that can be secured to a rotating shaft. There is no direct mechanical linkage between the shaft and the measuring system, and therefore no wear. The CANopen Interface is provided. The Vert-X 32E Series can be programmed through a device connected between the sensor and a computer's USB port. Sampling rate is 500 Hz, and operating temperature range is -40 to +85 °C.

SWIVEL FITTINGS

EXAIR CORP., CINCINNATI.

New mini swivel fittings adjust the position of air nozzles and are available in three sizes. They provide a 50° total angle of adjustment so nozzles can be in an effective position. The 1/8 MNPT Mini Swivel Fittings work with the M4x0.5 Atto Super Air Nozzle, the M5x0.5 Pico Super Air Nozzle, and the M6x0.75 Nano Super Air Nozzle. Mini swivel fittings with Super Air Nozzles deliver a focused and forceful blowoff for applications in tight spaces or requiring a minimal amount of compressed air.

WELDING WIRES

ESAB WELDING & CUTTING PRODUCTS, FLORENCE, S.C.

The Dual Shield II 4130 SR is an all-position flux-cored wire for welding low-alloy, high-strength steels such as 4130. The wire is suitable for offshore oil and gas topsides and platforms requiring high corrosion resistance with stress-relieved high strength and low temperature impact toughness. Dual Shield wires also offer good welding performance in all positions with high deposition rates and efficiencies, reducing weld time and increasing productivity.

COMPACT GENERATOR

HIMOINSA POWER SOLUTIONS, CREWE, U.K.

The 640 kVA / 509 kW Power Cube offers a more compact, robust, quieter, and more efficient solution than a standard generator, making it good for the data center market where space is at a premium. As a modular product, the generator can also be coupled to 32 generators making a combined 16 MW power plant. The Power Cube is powered by a fuel-optimized MTU V-12 dual frequency engine complete with a Deep Sea DSE8610 controller.

INFRARED CAMERAS

OMEGA ENGINEERING INC., STAMFORD, CONN.

The OSXL-EX series compact infrared cameras have three views—thermal, visible, and MSX imaging—featured on their high-resolution color LCD displays. This thermal imager series offers compact infrared camera choices. Features include 2% accuracy, radiometric jpg file format, swappable Li-ion battery with 4-hour life, spot measurement mode, simultaneous storage of images, picture-in-picture image, and an operating range from -20 to 250 °C (-4 to 482 °F).

SUBMISSIONS

Submit electronic files of new products and images by e-mail to **memag@asme.org**. Use subject line "New Products." *ME* does not test or endorse the products described here.

AIR IMPACT WRENCHES

APEX TOOL GROUP, SPARKS, MD.

Cleco industrial air impact wrenches are engineered for applications ranging from general assembly and plant maintenance to shipbuilding and heavy equipment manufacturing. The new product family is available in three series: the CWC Premium Composite Series, the CWM Premium Metal Series, and the CV Value-featured Composite Series. Each model offers durability, leading torque performance and world-class ergonomics. The CWC Premium Composite Series delivers a combination of productivity, ergonomics, and durability.

THREE-MATERIAL 3-D PRINTERS

STRATASYS LTD., EDINA, MINN.

Multi-material 3-D printers include the compact Objet260 Connex1, Objet260 Connex2, and Objet260 Connex3, as well as the mid-size Objet350 Connex1, Objet350 Connex2, and Objet350 Connex3. Triple-jetting technology also allows users to build products with up to three base materials in a single run.

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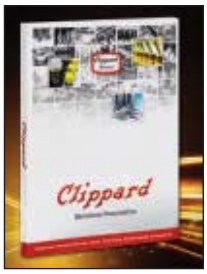

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MECHANICAL ENGINEERING, Chair, Associate Professor or Professor. Fall 2015. Ph.D. in Mechanical Engineering or a closely related discipline is required. Rank commensurate with qualifications and experience. Chair a department of seven faculty offering the B.S. in Mechanical Engineering and a Petroleum Engineering Certificate, teach nine credit hours a semester. MSU is a public liberal arts university serving approximately 6,000 students. Review of applications begins immediately and continues until the position is filled. This position is designated as security sensitive and requires the finalist to complete a criminal background check. Send letter of interest, a letter detailing teaching philosophy, a statement of research interests, CV, and contact information for three references to: Dr. Rodney Cate, Interim Dean, College of Science and Mathematics, Midwestern State University, 3410 Taft Blvd., Wichita Falls, TX, 76308. rodney.cate@mwsu.edu; www.mwsu.edu. EEO/ADAAA Compliance Employer

FACULTY POSITION IN THE GRADO DEPARTMENT OF INDUSTRIAL AND SYSTEMS ENGINEERING, VIRGINIA TECH. The Grado Department of Industrial and Systems Engineering at Virginia Tech invites applications for a **FULL-TIME TENURE-TRACK OR TENURED POSITION IN THE AREA OF ADVANCED MANUFACTURING.** Areas of interest include but are not limited to: additive manufacturing, smart manufacturing, design and innovation, human-robotic/machine interaction, cyber-physical security, and advanced process control. The appointment will be considered at the assistant or associate professor level and will begin at the start of the 2015-2016 academic year. Candidates

POSITIONSOPEN

for a tenured appointment must have a record of excellence in teaching, research, and service. Applicants should have achieved, or show potential to develop, a strong program of externally funded research and scholarship. The position requires a Ph.D. degree, with at least one degree in industrial engineering or a closely related field. We are seeking candidates with exceptional potential for leadership in research and education, and strong commitment to high quality research. The successful applicant will also be expected to provide skilled teaching of foundational and advanced courses at both the undergraduate and graduate levels. Applications must be submitted online at www.jobs.vt.edu (posting number TR0140152) and include a cover letter, current vita, research statement, teaching statement, up to three relevant research publications included as one document, and names of three references providing recommendation letters (these must be submitted separately by the references to ise-search@vt.edu). Details on how to prepare and submit all materials can be found under "Apply to this Job" on the website. Review of applications will begin on March 2nd, 2015. Applications submitted after this date may not be considered. The College of Engineering at Virginia Tech is undertaking a coordinated team hiring strategy for five interdisciplinary faculty in Advanced Manufacturing to further enhance a well-established manufacturing research team. This integrated team will share common space and equipment while also leveraging established labs and the Commonwealth Center for Advanced Manufacturing, a public-private partnership in the state. This position is one of the five positions to be hired for the Advanced Manufacturing team. Virginia Tech has a

strong commitment to the principle of diversity and inclusive excellence, and, in that spirit, seeks a broad spectrum of candidates including women, minorities, and people with disabilities. Virginia Tech is the recipient of a National Science Foundation ADVANCE Institutional Transformation Award to increase the participation of women in academic science and engineering careers.

THE DEPARTMENT OF MECHANICAL ENGINEERING AT THE UNIVERSITY OF ALASKA FAIRBANKS (UAF) invites applications for a tenure track faculty position at the **ASSISTANT PROFESSOR OR ASSOCIATE PROFESSOR** level in the area of fluid mechanics starting Fall 2015. Candidates should have a B.S. degree in Engineering and a Ph.D. degree in either Mechanical Engineering, Chemical Engineering, or closely related field with a strong evidence of research in fluid mechanics.For further information and to apply by March 1, 2015, applicants must follow the directions online at www.uakjobs.com/applicants/Central?quickFind=86045

Position Title: **ACADEMIC DEPARTMENT HEAD, TENURE TRACK RANK: PROFESSOR** Salary: Commensurate with education and experience Special Conditions: We seek a nationally and internationally recognized educator and researcher. The candidate will become the holder of the **BOB AND SHERRY MYERS CHAIR IN MECHANICAL AND AEROSPACE ENGINEERING**. The department has strong research programs in Aeroelasticity and Fluid Structure Interaction, Dynamics and Vibrations, Fluid Mechanics, Robotics and Controls, Solid Mechanics and Materials, and, Thermal Science and Energy. The MAE Department offers ABET Inc. accredited BSAE and BSME degree programs, as well as M.S. and Ph.D. programs in both mechanical and aerospace engineering. Detailed departmental information is available at http://mae.nmsu.edu . The department currently has 18 FTE faculty positions, over 650 undergraduate students, and over 45 graduate students. The department currently has 2 endowed professorships with a third to be available in Fall 2015. Qualifications: Candidates must have an earned doctoral degree in Mechanical or Aerospace Engineering or closely related field. The applicant must show a sustained record of scholarly activities and research as evidenced by archival publications, graduate supervision, and nationally competitive funding. Qualifications include a strong record of scholarly and professional accomplishments that merit appointment as a tenured full professor, a reputation for creating a positive people climate, a record of management in a complex organization, a demonstrated commitment to diversity and student success, and excellent interpersonal skills. Examples of Duties: Academic, administrative, budgetary and personnel decisions, sustaining the ABET accreditation, recruiting and retention of students and faculty, providing innovative and energetic leadership in teaching, research, extension, outreach, development activities and securing research sponsorship. The successful candidate must articulate and communicate a clear vision to lead the MAE Department towards academic excellence and must have excellent communication skills to proactively interface with a broad constituency in academia, government, industry and the community; a demonstrated record of organizational skills; knowledge of state, federal and private sector fund-raising; and the ability to develop R&D relationships. Benefits Offered: Group medical and hospital insurance, group life insurance, long-term disability insurance, state educational retirement, workers' compensation, sick leave, annual leave and unemployment compensation. Opportunities for educational advancement are available.Application: For a complete job description and to apply, visit http://jobs.nmsu.edu/postings/20169. Submit a detailed curriculum vita with a description of management philosophy and administration experience, a statement of vision for the department and a statement of research and teaching interests. Include a list of four references with contact information including name, address, telephone, and email. Deadline Date: January 19, 2015. NMSU is an equal opportunity/affirmative action employer. Women and minorities are strongly encouraged to apply. All offers of employment, oral and written, are contingent on the university's verification of credentials, individual's eligibility for employment in the United States and other information required by federal law, state law, and NMSU policies/procedures, and may include the completion of a criminal history check.

TEXAS A&M UNIVERSITY CORPUS CHRISTI

Faculty Position Announcement
TEXAS A&M UNIVERSITY-CORPUS CHRISTI
School of Engineering & Computing Sciences

Texas A&M University-Corpus Christi invites applications for 4 tenure-track engineering positions in the School of Engineering & Computing Sciences for Fall 2015. The School of Engineering & Computing Sciences prepares students to pursue productive careers and advanced degrees in engineering, computer science, or geospatial information science. Three of these positions will comprise a cluster hire focusing on unmanned systems: 1 with academic background in electrical engineering and 2 in industrial engineering. The fourth position is in mechanical engineering with expertise in thermal-fluids systems.

1. **Assistant Professor, Electrical Engineering (1)**
2. **Assistant Professor, Industrial Engineering (1)**
3. **Associate Professor, Industrial Engineering (1)**
4. **Assistant Professor, Mechanical Engineering (1)**

For specific details and qualification requirements on each position or to apply visit the following website, https://islanderjobs.tamucc.edu.
Positions open until filled (or recruitment canceled). Review of applications to begin as early as February 1, 2015.
Texas A&M University-Corpus Christi is a learning centered institution committed to making excellence inclusive. Located on its own island, we are surrounded by the water of Corpus Christi and Oso bays. The beautiful natural setting is enhanced by our modern, attractive, and state-of-the-art classroom buildings and support facilities, and our colorful landscaping, and plazas that lend a distinctive tropical feel to the campus. Our Hispanic Serving Institution status provides a foundation to attain significant impacts for improving the educational attainment of our regional students, and our strategic location on the Gulf of Mexico and on the cultural border with Latin America places the Island University in perfect position to help realize its national and international prominence goals. TAMU-CC is committed to becoming an emerging research institution with unparalleled commitment to student success, closing gaps in achievement, and creating robust campus experiences.
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COLLEGE OF ENGINEERING

Institute of Biomedical Engineering Director and Professor of Biomedical Engineering

The College of Engineering at the University of Tennessee, Knoxville is seeking exceptionally qualified candidates to serve as Director of the Institute of Biomedical Engineering (iBME, http://ibme.utk.edu/about-us/) and to hold a full professorship in biomedical engineering in the Department of Mechanical, Aerospace, and Biomedical Engineering (MABE, http://www.mabe.utk.edu/). The academic appointment is in MABE and is based at the UT Knoxville campus. The iBME Director reports to Dean of the College of Engineering regarding the leadership and coordination of biomedical research across the UTK College of Engineering, the Graduate School of Medicine, the College of Veterinary Medicine, and other UTK Colleges. The position is responsible for biomedical engineering graduate degree programs, curricula and activities. Applications and nominations are invited for this senior position. Prior academic experience is desirable but not required. Applicants with outstanding industrial biomedical research accomplishments are welcomed.

The successful candidate will have a doctorate in engineering or a related field, a proven track record of developing research funding, and a substantial and active research program with archival publications in biomedical engineering and science. The successful candidate must be qualified for tenure at the rank of full professor at the time of hire. Equally important, the successful candidate will be an internationally recognized leader in his or her area of specialty, a team player, and able to build and lead multi-participant research programs across colleges and departments.

Review of applications and nominations will begin February 1, 2015, and will continue until the position is filled. Applications should include (1) a concise letter of intent outlining the applicant's research and teaching goals and objectives; (2) a comprehensive curriculum vitae; and (3) the names, addresses and telephone numbers of at least five references. The preferred method of application or nomination is by e-mail to whamel@utk.edu. As an alternative, materials may be mailed directly to:

Dr. William R. Hamel, Professor, MABE Department
403 Dougherty Engineering Building, The University of Tennessee
Knoxville, TN 37996-2210

The University of Tennessee is an EEO/AA/Title VI/Title IX/Section 504/ADA/ADEA institution in the provision of its education and employment programs and services. All qualified applicants will receive equal consideration for employment without regard to race, color, national origin, religion, sex, pregnancy, marital status, sexual orientation, gender identity, age, physical or mental disability, or covered veteran status.

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CONSULTING

NORTH DAKOTA UAV CLAIMS DESIGN COMPETITION

Teams from around the world competed at the 2014 ASME Student Design Competition. The team from the University of North Dakota (above) won the contest. The team from the Hong Kong Polytechnic University (below) showed off their entry.

FOUR STUDENTS FROM THE UNIVERSITY of North Dakota in Grand Forks guided their radio-controlled drone prototype to victory during the final round of the 2014 ASME Student Design Competition. The team competed in the SDC finals, held during the ASME International Mechanical Engineering Congress and Exposition in Montreal in November.

The 2014 Student Design Competition challenge tasked the engineering students with designing and building prototypes of small unmanned aerial vehicles capable of completing a simulated fire-fighting mission by navigating through two stationary gates, dropping a payload on a target, and returning to the starting point. Extra points were awarded to the heaviest UAVs.

The team from North Dakota entered the heaviest vehicle in the contest—a large quad copter constructed of aluminum and steel that weighed in at more than 78 pounds. "It took quite a bit of time from start to finish" to build, according to team member **Scott McDaniel**, who added that the team had still been conducting flight testing a week prior to the finals.

McDaniel and his teammates, **Daniel Smith**, **Aric Glaser**, **Chris Borseth**, and **Alexander Heyd**, won the top prize of $3,000. The student section at the university will receive $1,000.

The team from California Polytechnic University in San Luis Obispo placed second in the competition with its entry, a 25-pound UAV made of aluminum, PVC piping, steel, and foam. Third prize went to the team from North Carolina State University in Raleigh.

Warren Weisler, a team member and graduate student from Raleigh, N.C., described the event as "the type of competition where you're seeing designs that are not standard, or for normal applications. It's very exciting to see, 'Okay, how are they going to solve this problem? How did this team do it? What worked? What didn't?'"

The final round of the SDC was an international competition. In addition to teams representing nine U.S. universities, teams also traveled from France, the United Arab Emirates, Mexico, Saudi Arabia, India, Taiwan, Pakistan, Turkey, and Hong Kong to take part.

To watch a video featuring highlights of the day's events at the 2014 ASME Student Design Competition finals, visit www.asme.org/career-education/media/student-competitions/video-may-best-drone-win.

PURDUE TEAM TAKES 3-D MANUFACTURING PRIZE

THE BEST OVERALL AWARD IN THE INAUgural ASME Innovative Additive Manufacturing 3-D Challenge went to a team from Purdue University and Brigham Young University for its FDM UAV, a 12-pound unmanned aerial vehicle that was designed to help farmers reliably monitor the condition of their crops over large areas.

Twenty one teams competed during the final round of the IAM3D Challenge, a new ASME competition designed to give undergraduate students the opportunity to re-engineer existing products or create new designs that minimize energy consumption or improve energy efficiency. The finals were held during the ASME International Mechanical Engineering Congress and Exposition in Montreal in November.

Students entered projects ranging in scope from new twists on the design and production of ketchup and water bottles to 3-D-printed wind turbine blades and goose decoys.

The FDM UAV is primarily composed of additive-manufactured parts. It was designed by **Eli Cohen** and **Jean Ruggiero** of Purdue University and **Aaron Inouye** of Brigham Young University. The team received a $2,000 prize for their invention. The team's two advisors, **John Sullivan** from Purdue University and **Steven Gorrell** from Brigham Young University, shared $1,000.

The prize for Most Innovative entry went to **Eric Chapin**, **Tyler Taschner**, and **Brandon Westrick** from South Dakota State University for their entry "Fishing Future," a 3-D printing process for fishing bobbers that enables the affordable customization in terms of bobber color, size, weight, and design, while eliminating the creation of scrap material that results from the traditional method of manufacturing bobbers.

The Best Presentation Award went to **Maggie Serra** of the Stevens Institute of Technology for her project, the "3-D Printed Granular Jamming Hand," an open-source, highly customizable hand and forearm prosthesis that combines the technology of additive manufacturing with granular jamming, creating a dexterous prosthesis able to perform many low-strength, high-dexterity everyday tasks.

SIMS POINTS TO PAST AND FUTURE

ASME President **J. Robert Sims** used his address at the President's Luncheon at the International Mechanical Engineering Congress and Exposition in Montreal to commemorate the 100th anniversary of the Boiler and Pressure Vessel Code and looked to the Society's current relevance in the new century.

The BPVC is a milestone, Sims said, that honors "the thousands of engineers who have volunteered to make a difference in the world through standards development" and "reminds us of everything engineers are doing today to bring the same sense of safety and reliability to technologies that are only beginning to emerge."

Sims noted that ASME was "aggressively addressing the needs of the global engineering market" through the efforts of ASME's Engineering for Global Development team and EngineeringForChange.org.

Sims pointed to ASME's activities in the fields of energy and advanced manufacturing, including such new programs as the ASME Hydraulic Fracturing Conference, the Advanced Design and Manufacturing Impact Forum, and the ASME Innovative Additive Manufacturing 3D Challenge student competition.

ASME's continued relevance requires an investment in the young people who will make up the next generation of engineers, Sims said.

"Investing in the next generation of engineers is important to setting the standard for excellence in quality engineering," Sims said.

HARARY TAPPED TO LEAD NIST LAB

Howard Harary has been appointed director of the National Institute of Standards and Technology's Engineering Laboratory, which develops the measurement tools and standards needed to support technology-intensive manufacturing, construction, and cyber-physical systems. The laboratory also conducts research to reduce the risks of fire, earthquakes, and other hazards.

Harary became the Engineering Laboratory's acting director in 2013.

Harary is an ASME member and sits on the ASME Council on Standards and Certification and the ASME Board on Standardization and Testing. He is also the government representative to the board of PDES Inc., an industrial consortium working in the area of the digital exchange of manufacturing information.

WEBINAR FOCUSES ON THE EMPOWERING TECHNOLOGY

An Engineering for Change webinar that provided an introduction to the Empowering People Network and its approach to creating appropriate and accessible technological solutions for people in developing countries is now archived and available for viewing.

"Simple but Intelligent Solutions for People with Health Restrictions" featured speakers from the Network. Presenters included **Mathilde Iweins** from OneDollarGlasses; **Tish Scolnik**, CEO and co-founder of GRIT, a social enterprise that created the Leveraged Freedom Chair; and **Caroline Weimann** who has been working in the area of basic needs and social entrepreneurship at the Siemens Stiftung since April 2012.

To view this and other webinars in the Engineering for Change series, go to http://www.engineeringforchange-webinars.org/.

ASME ANNUAL REPORT POSTED ONLINE

The Society's Annual Report for 2013-2014, produced by ASME Public Information and Creative Services, is now available on ASME.org. A PDF version of the 54-page publication, which provides an overview of ASME's activities over the past fiscal year, can be downloaded by visiting the Annual Reports archive on the ASME website at: https://www.asme.org/about-asme/who-we-are/governance/annual-reports-from-asme-and-asme-foundation.

RAIL DIG UNEARTHS BLACK DEATH SKELETONS

Image: Crossrail Ltd.

Workers examining the burial ground in the Farringdon area of Central London. The graves date back to the medieval Black Death Plague.

LONDON IS ONE OF THOSE PLACES WHERE IT'S HARD TO DIG WITHOUT TURNING UP a lost piece of history. It has 2,000 years of history behind it. The Crossrail project is a case in point.

Crossrail is Europe's largest railway and infrastructure construction project, with work mainly under way in central London.

The plan is to build a 118-kilometer railway line to provide high-frequency passenger service linking parts of Berkshire and Buckinghamshire, via central London, to Essex and southeast London, starting in the year 2018. The central part of the line is a tunnel through the middle of London.

Work on the project began in 2009 after several decades of proposals.

In March 2013, Crossrail engineers began excavating a 5.5-meter wide shaft at Charterhouse Square as part of a plan to stabilize buildings adjacent to the tunneling work. About 2.5 meters down, they uncovered 25 skeletons laid out in neat rows, along with pottery dating back to the mid-14 Century.

Later investigation has determined that they died during the Great Plague.

The plague was arguably one of the most devastating pandemics in human history, sweeping across Europe and killing millions of people between 1347 and 1353. A French chronicler, Jean de Joinville, wrote that "a third of the world died."

The disease is caused by an enterobacterium, *Yersinia pestis,* which is transmitted by fleas. The fleas can be carried by rats, and that is believed to be how the disease spread so rapidly in the Middle Ages.

According to BBC News, there are records of a mass grave—or "plague pit"—just beyond the boundaries of the City of London, approximately where Charterhouse Square sits today.

Archeologists using underground radar scans have picked up signals of many more graves near this area. It was determined from analysis of the pottery that the burial ground was used in at least two distinct periods—during the plague of 1340s and '50s, and during a later outbreak in the 1430s.

Further excavations to unearth more skeletons may provide archaeologists with clues about where the people came from and what their lives were like.

Researchers are now using radio carbon dating to pinpoint which historical plague outbreak the so called "Charterhouse 25" could have fallen victim to.

Given all these findings, a lot can be learned from those people who died more than 600 years ago. They suffered from a combination of poor diet and hard work, and so the overstressed condition of much of the population may explain why *Y. pestis* was such a devastating plague.

In a sign that contemporary London's cosmopolitan nature is nothing new, 40 percent of the skeletons tested belonged to people who grew up away from the city, possibly as far north as Scotland.

By sequencing the ancient bacterial DNA, researchers are hoping to understand how the plague has evolved and spread over the centuries. Scientists are hoping to confirm whether the 14th century strain was the ancestor of all plague today.

In addition to the plague skeletons, the excavations have also unearthed Roman skulls washed down a lost river, a Bronze Age transport route. They have also uncovered the largest piece of amber ever found in the U.K.

All the archeology didn't delay the construction schedule. In a place like London, you have to add time for history before you can start building the future. ME

JAMES PERO

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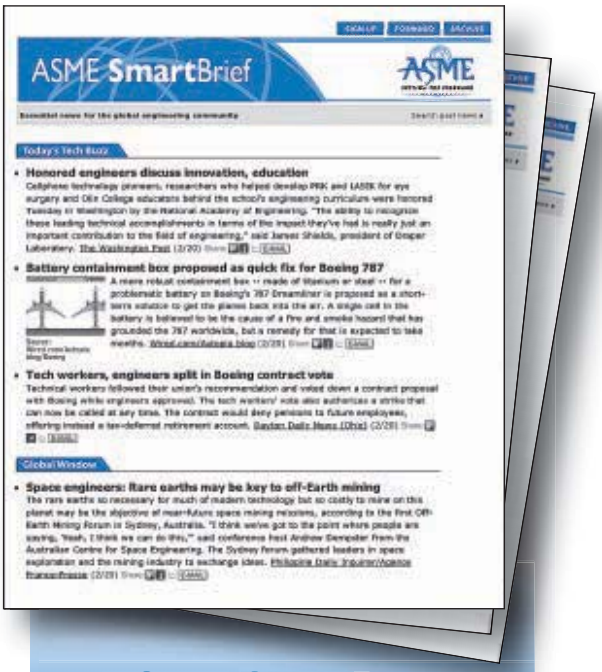

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ASME SETTING THE STANDARD

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