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BECAUSE OF THE BASIC DIFFERENCES BETWEEN THE SPORTS, head protection in baseball has never been the worry that it is in football. Baseball pitchers now have an option to protect themselves against line drives, with an engineered padding that can be sewn into their caps. The product, called isoBLOX, provides frontal head protection from line drives reaching 90 mph, according to its manufacturer.

THE ORIGINAL SOCIAL MEDIA?

Advances in technology are enabling better designs for ham radios—a classic hobby that many radio enthusiasts call the original social media.

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

LENGTHENING THE LIFE OF LITHIUM-ION BATTERIES

An unprecedented increase in lithium-ion battery research has occurred in recent years, with the goals of improving performance, durability, and safety. To achieve these goals, fundamental understanding of the underlying degradation mechanisms that limit battery life is of critical importance.

VIDEO: NANOENGINEERING FOR ENERGY AND SUSTAINABILITY

Understanding physicochemical processes at the nanoscale can help in improving macroscale energy conversion and storage devices. Professor **Partha P. Mukherjee** of Texas A&M University discusses strategies for scaling up production of new devices.

NEXT MONTH ON ASME.ORG

SUGAR POWER

Researchers at Virginia Tech have created a sugar cell that can store 10 times as much energy as a lithium ion battery. The trick is the enzyme pathway—24 enzymes operate in succession to release 24 electrons—all that the sugar's got to offer.

ENERGY EDUCATION FOR THE MASSES

An engineering professor aims to spread the word about energy by adapting for a TV audience a popular college course he created for engineering students.

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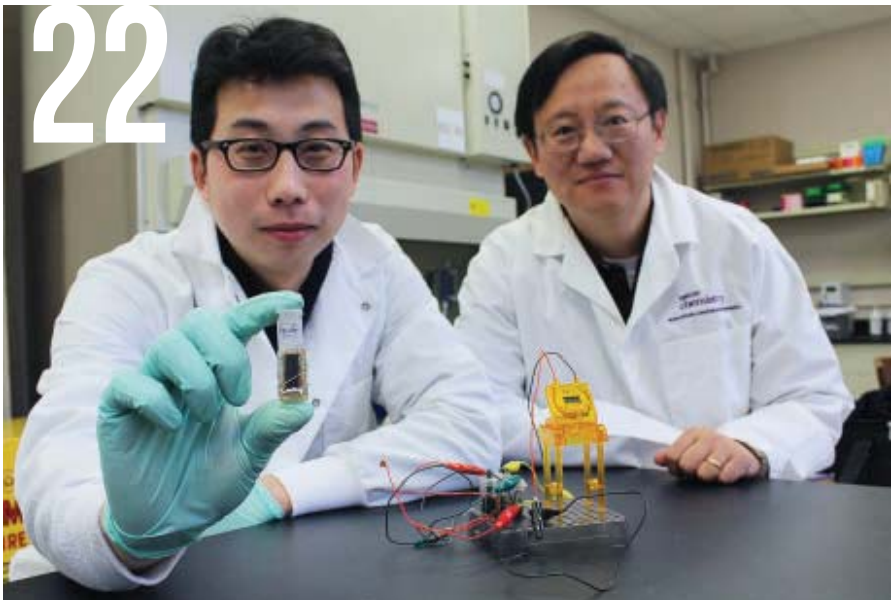
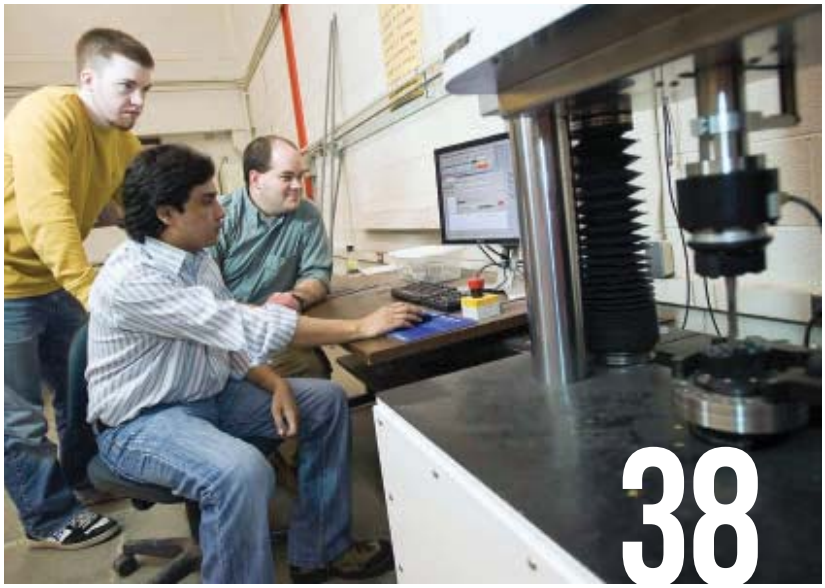
ASME
SETTING THE STANDARD





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

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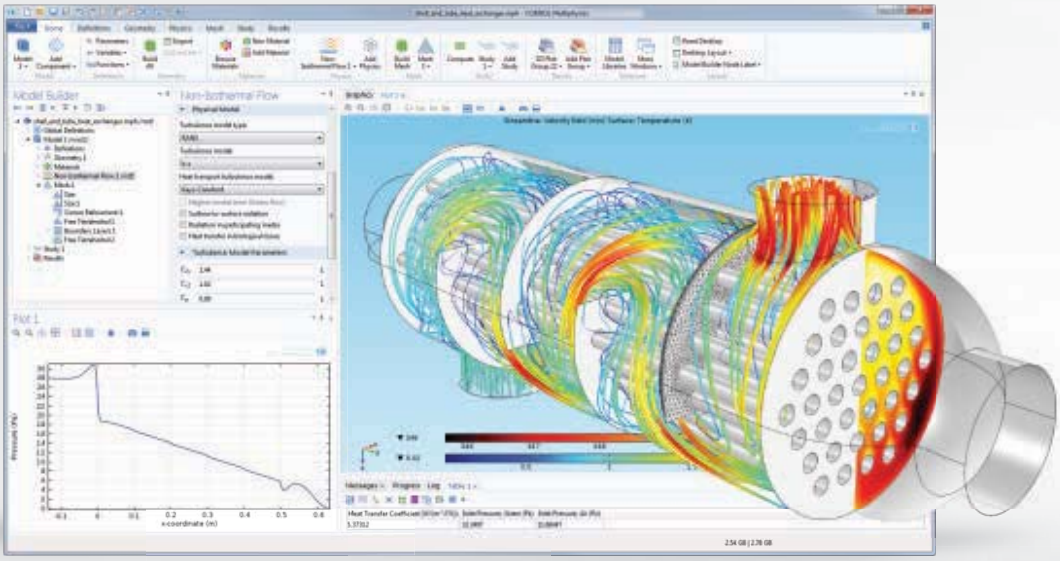
HEAT EXCHANGER: Model of an air-filled shell and tube heat exchanger with water flowing through the inner tubes. Simulation results reveal flow velocity, temperature distribution, and pressure within the vessel.



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John G. Falcioni
Editor-in-Chief

DECISION POINT ON STEM

There are times when it seems you can't turn around without hearing about STEM. But tracking the roots of the acronym, which refers to fields related to science, technology, engineering, and math wasn't easy. Wikipedia hints that STEM may have its origins with the National Science Foundation, and *The Winona Daily News*, in Minnesota, reported a few years ago that the term was indeed coined by the NSF—well sort of.

Back around 2001 former Winona State University president Judith Ramaley was director of NSF's Education and Human Resources Directorate and was developing curriculum to improve education in science, math, engineering, and technology. So the acronym for these disciplines became "SMET." But Ramaley didn't like the sound of it (and who could blame her?), so she changed it to STEM, and the rest is history. (Interesting enough, there's some dislike for the STEM moniker as well in some circles, including deep inside the White House, because of the potential confusion with "stem cell.")

The newspaper in Winona quoted Ramaley suggesting that in STEM, science and math serve as bookends for technology and engineering. Science and math are critical to a basic understanding of the universe, she said, and engineering and technology are means for people to interact with the universe.

For middle schoolers of my generation it was math and science; engineering was a nebulous career destination far into the future and technology was but a burgeoning amorphous term with no clear identity. The educational landscape has changed.

What hasn't changed is that, generally speaking, engineering students are good at solving problems. Clearly, as a society, we need as many individuals as possible with the types of skills to wrestle down the challenges that exist locally as well as globally. Thus the push toward an emphasis on STEM in K–12—and I would argue especially in middle school—makes sense. The point is not to force-feed STEM over subjects like history, art, and literature, but to even out the level of instruction and ensure that the teachers who are responsible for it have the right tools, and the right skills, motivation, and drive to motivate students.

Seeing firsthand the drive behind the work of engineers, especially the rigor of those who work on building solutions in developing countries, is hugely inspirational. The landscape of problems facing the proliferation of STEM education is complex because it's inherently difficult to fix problems comprising, in part, elements of human behavior.

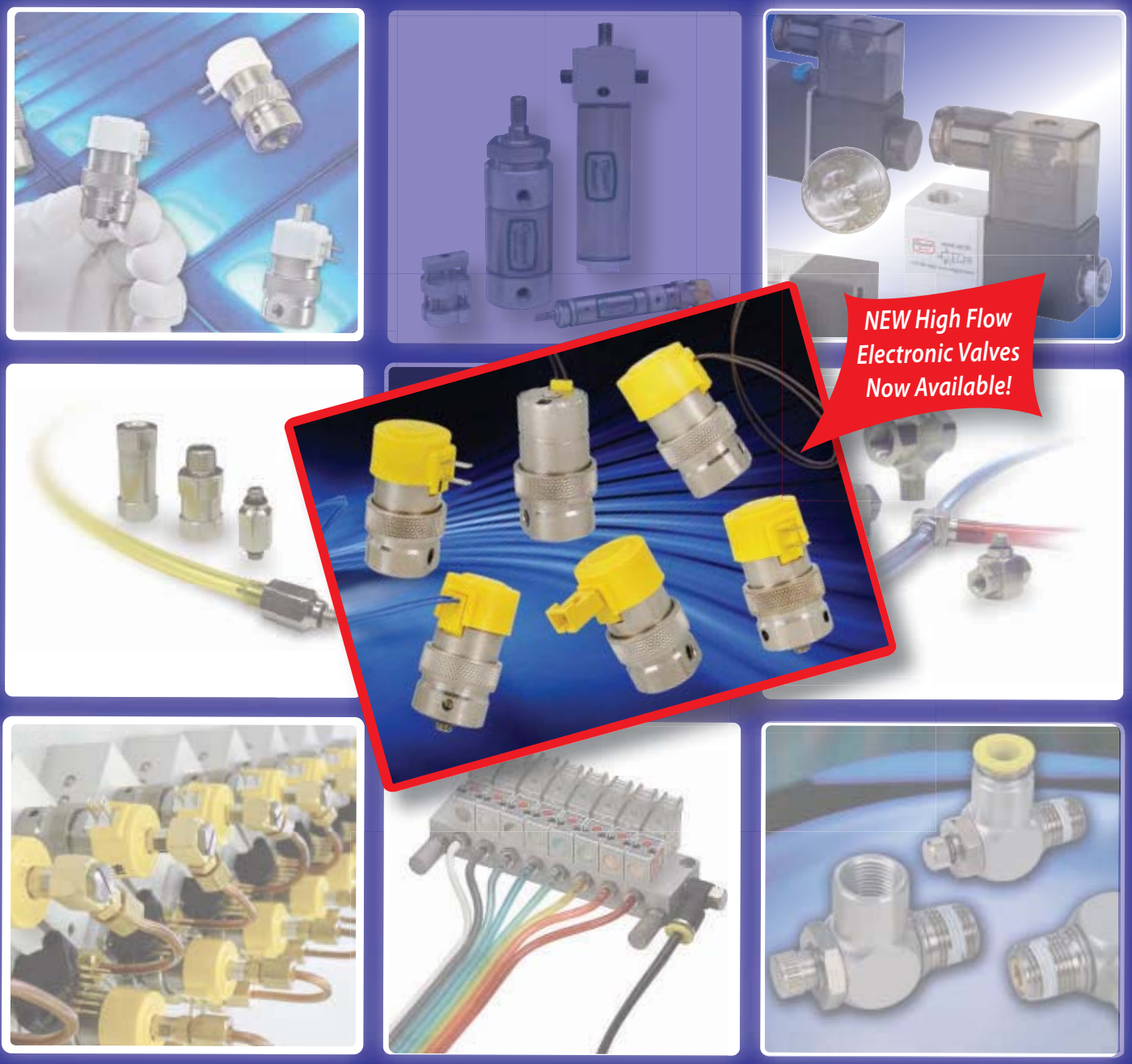
Some of these are the issues to be examined at this month's taping of the ASME Decision Point Dialogues (www.go.asme.org/dialogues), which will take place on the 23rd. This dialogue is being held prior to the opening of the U.S. News STEM Solutions Conference, in Washington, D.C. STEM Solutions precedes the USA Science and Engineering Festival. John Hockenberry, host of the National Public Radio program "The Takeaway," will moderate the ASME dialogue. The Decision Point Dialogues will be broadcast on ASME.org beginning in June.

From Winona, Minn., to both coasts of this country and beyond U.S. borders, the conversation over STEM is being heard. It's time for actions to speak louder than words. **ME**

ATTEND

To attend the taping of ASME'S Decision Point Dialogues on STEM, send me a note at

memag@asme.org



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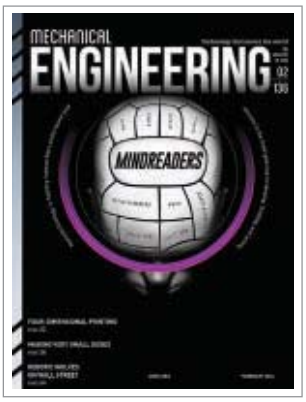


FEBRUARY 2014

Readers Kirsch and Clemens question Bill Nye's credentials on climate change.

« One reader connects the space race to new ways of working. Others object to an interview subject's comments on climate and Darwin.

BUILDING THE SYSTEMS AGE

To the Editor: I wish to comment on a statement James A. Vedda made in "The Next Space Age," featured in the January issue. He writes,"The Apollo program happened at an anomalous time during which geopolitical, technological, economic, and cultural factors came together in ways that we cannot expect to recur."

These factors are the environmental conditions which started what Total Quality Management calls the "Systems Age." In this new age of team-work, the collective efforts of multi-disciplinary professionals working in concert is essential to continuing development of the world.

Mr. Vedda's last sentence, "For humanity's future, the cost of not doing these things may be un-affordable," should be made clearer.

Ibrahim A. Ashie, *Conway, S.C.*

HOLLYWOOD AGENDA

To the Editor: I recently read your question and answer with Bill Nye, the science guy (February). It is disheartening to see that the ASME official publication gives an entertainer a platform to push his Hollywood agenda. While I appreciate what Mr. Nye does with teaching youth about the wonderment of science using basic elementary experiments, he oversteps his boundaries when it comes to climate change.

Mr. Nye is an engineer by trade, not a climate scientist. He has no formal training in the earth sciences beyond the requirements for his undergrad degree. He is an entertainer and uses his celebrity to warn us about the dangers of climate change.

There are many prominent true earth scientists who disagree with Mr. Nye, and as time goes on, many more are coming out of the woodwork. He asserts that the "force of industry" is trying to confuse the poor non-intellectuals about what is really happening. I could accuse him of siding with the "force of environmentalism."

COMMENT

IS THE INCUBATOR A STATE UNIVERSITY ROLE?

"Two Groups Argue for Federal Aid to R&D," in the January issue of *Mechanical Engineering* raises a number of issues about university incubators.

Let's begin with the most likely motive for this growing university interest in incubators, and that is reduced federal support for research. Given the rise of these university incubators, one might ask the question of why incubators, although some have existed, were not common in the past. The simple answer is that incubators are difficult to operate due to a number of thorny issues.

An incubator is likely to be made up of unsophisticated actors since it's focused on the entrepreneurial goal of bringing a product or service to market. A start-up may benefit by being bold and unfettered by standard corporate policies, but sloppiness can be dangerous when operating under the umbrella of a state university. It's different from a research professor, perhaps assisted by post doctorates or staff, managing a crew of graduate students doing research not directly related to a product launch.

The primary issue is whether a state-supported incubator is displacing private enterprise. Stated more simply: Is the state using public funds to pick winners and losers based on its own best interests? How could a university avoid such a conflict? It is too easy to imagine a university turning out top researchers only to compete with them for jobs after graduation, essentially "eating their young." In either case, the state would not be developing its economy but could be inhibiting its economy. Instead of a mission of providing a skilled workforce, its mission somehow morphed into business development.

Most universities enjoy special software and equipment contracts. Laboratory equipment is often provided at deep

One could assert that most earth scientists are touting man-made global warming to generate more funding, which indeed does happen. I have tried to look at what the real experts present as their proof and come to my own conclusions. There is no difference between Mr. Nye and Al Gore when it comes to experts on global warming. They both have zero credentials in this field.

With a master's in mechanical engineering, I admit I cannot begin to understand all of the parameters that go into climate cycles, but do understand through history it does cycle. The climate models fail miserably at almost all predictions including the 16-year pause of warming.

Now they are trying to "find" the warmth as they tout that global warming causes more heat waves, cold spells, droughts, floods, more hurricanes, less hurricanes, etc. I was once a believer in AGW but through reading both sides of the debate I have come to my own conclusion.

I don't work for "Big Oil" or whatever "force of industry" Mr. Nye refers to. Stay away from the twilights of Hollywood, ASME, and focus more on things that would interest mechanical engineers.

Matt Clemens, *Angola, Ind.*

NAY TO NYE

To the Editor: The Q&A with Bill Nye in the February issue is regrettable and embarrassing for your magazine.

Communicating the value of engineering and science to youth is commendable, but it is really all Bill Nye is qualified to do. His close-minded "science-is-settled" position on anthropogenic global warming and the predicted calamitous future impacts is indeed anti-scientific.

It was bad enough that you contributed to his political activism by identifying him as "a notable defender of .... climate change," but I was completely dumbfounded that you actually published his indictments against an entire industry.

M.J. Kirsch, *Baton Rouge*

FEEDBACK

Send us your letters and comments via hard copy or e-mail memag@asme.org (use 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.

EVOLUTION BEFORE DARWIN

To the Editor: I am surprised Nye said "... Darwin's discovery of evolution ..." because evolution was popular thousands of years ago (Anaximander). Even Darwin's grandfather wrote extensively of evolution.

Why do evolutionists usually lose debates? The science is against them.

David Martin, *Dover, N.H.*

discounts, if not for free. Typically the terms and conditions include prohibitions against commercial use (not to compete with the manufacturer's customers). Does the incubator police these issues? Imagine "on the ground" policing such as when a student carries equipment into a laboratory. The whole structure of providing low-cost academic equipment could collapse when contract abuse is eventually uncovered.

Since incubators are run by the state, isn't it likely that state politicians might use their structure for patronage or rewarding favors? Have you ever reviewed the biographies of middle managers in your own state? Whether this situation arises depends on the state leadership, but the incubator presents an opportunity.

IT IS REVOLUTIONARY INNOVATION THAT IS BEST SUITED TO UNIVERSITIES; NO PRODUCT IMMEDIATELY RESULTS, BUT LICENSING OF IDEAS MAY ENABLE MANUFACTURERS TO MAKE PRODUCTS.

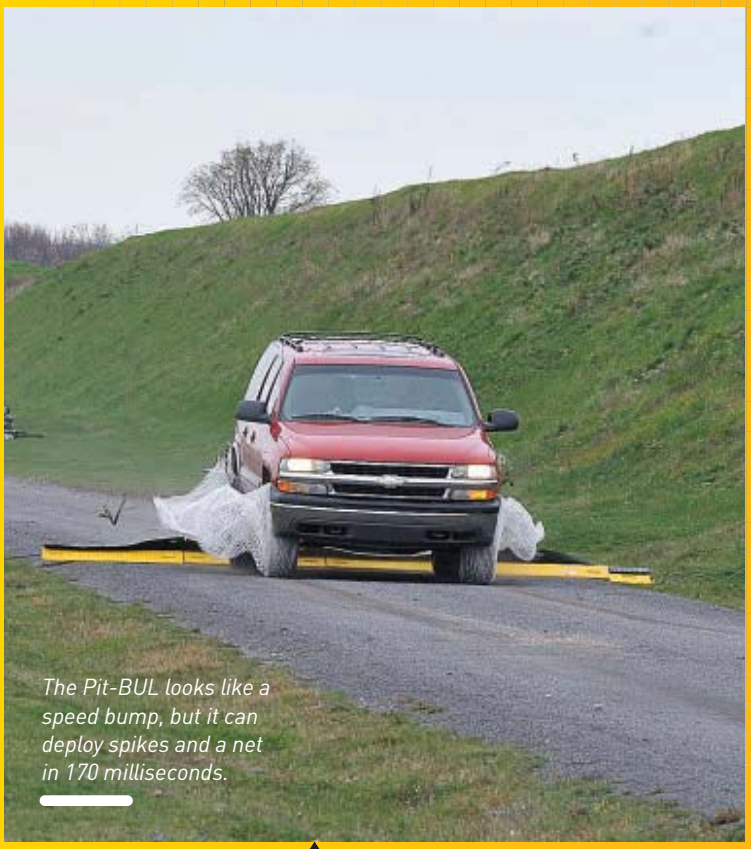
Where do these incubators operate? Likely they are located on university property. Are they being taxed at the same rate as other start-ups or are these incubators getting another break?

There is another motivation for incubators, an economic motive to create jobs. This seems a mismatch of the research-focused talents within a university. One set of leading management scholars categorizes innovation into three buckets: revolutionary (pure invention), architectural (development of new product categories), and incremental (simple product refreshes, process improvements, or distribution improvements). It is revolutionary innovation that is best suited to universities; no product immediately results, but licensing of ideas may enable manufacturers to make products. The other two categories best belong in businesses.

These concerns above all stem from the reduction in funding for university research. Therefore, I propose that our focus return to funding university research rather than continuing this path into the state-funded incubator. ME

DANIEL N. DONAHOE operates 1000 Kilometers PLLC, a professional engineering consulting services firm based in Bountiful, Utah.

CAUGHT IN A NET



The Pit-BUL looks like a speed bump, but it can deploy spikes and a net in 170 milliseconds.

You've driven over speed bumps before but never one like this. Meant to stop vehicles that slam through checkpoints without slowing, a net flies from this innocuous looking speed bump to surround and capture a car like something out of a Spiderman comic book.

QUICK FACTS

WHAT IT IS: A non-lethal device for stopping automobiles.

WHERE IT IS USED: At security checkpoints.

DEVELOPED FOR: The U.S. Army.

DEVELOPED BY: Pacific Scientific Energetic Materials Inc.

SET-UP TIME: 15 minutes.

ABOUT FIVE YEARS AGO, THE U.S. ARMY asked the folks at Pacific Scientific Energetic Materials Co. in Chandler, Ariz., to develop a device for use at checkpoints at Army bases mainly in the Middle East, said Bryan Stacey, senior business development manager at the company.

Design engineer Mynor Castro invented the Pit-Ballistic Undercarriage Lanyard, or the Pit-Bul, which masquerades as an innocuous speed bump but which can stop vehicles going up to 45 miles per hour, Castro said.

"The Army has guns at checkpoints but sometimes people don't speak the language so they don't know they're supposed to stop," Castro said. "They wanted something to give them a little more time to tell a good guy from a bad guy. This will slow the vehicle down to give them a few seconds to consider what to do next."

The system stops vehicles in 80 feet and also in a nonlethal manner, Stacey hastened to add.

Most systems include a sensor placed ten feet in front of the speed bump; should a vehicle cross the checkpoint without stopping, the system releases spikes that puncture the tires and also pull the net from a small pit within the middle of the bump. The system can also be manually deployed by a person standing up to 300 feet beyond the checkpoint, Castro said.

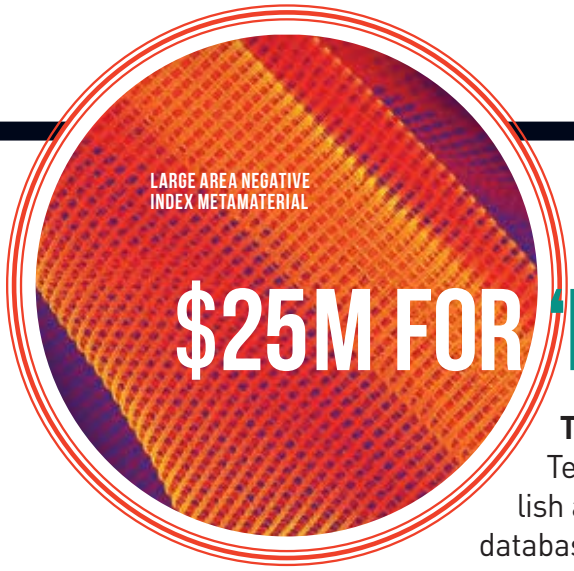
"When someone traveling at 40 miles per hour, you don't have time to react," he said. The system reacts in 170 milliseconds.

"If you put all your effort into blinking as fast as you can, that's 250 milliseconds," Castro added.

Pacific Scientific owns the intellectual property for the security system, which runs on rechargeable lithium ion batteries, and this year has begun selling it for installation at airports, casinos, power plants, and other secure locations, Stacey said.

The portable speed bump can be up and running within 15 minutes, he added. **ME**

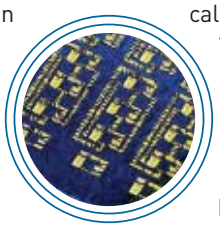
JEAN THILMANY


LARGE AREA NEGATIVE INDEX METAMATERIAL

$25M FOR 'MATERIALS BY DESIGN'

THE U.S. NATIONAL INSTITUTE OF STANDARDS AND Technology has awarded $25 million over five years to establish a center of excellence that will develop computational tools, databases, and techniques to support "Materials by Design."

According to NIST, Materials by Design combines physical theory, computer models, materials properties databases, and computation to guide the material design with specific properties for particular applications—for example, a tough, lightweight composite for auto bodies or a biocompatible cell scaffold. It aims to develop materials faster than trial-and-error methods.


STRETCHABLE SILICON INTEGRATED CIRCUIT

The program, called Center for Hierarchical Materials Design, is led by Northwestern University. Other members are the University of Chicago and Argonne National Laboratory.

As part of the program, the national lab has entered one partnership with each university: the Computation Institute with Chicago and the Northwestern-Argonne Institute of Science and Engineering.

Materials by Design is a goal of the Obama Administration's multi-agency drive called Materials Genome Initiative. The president asks federal agencies to support research that will accelerate the development of advanced materials.

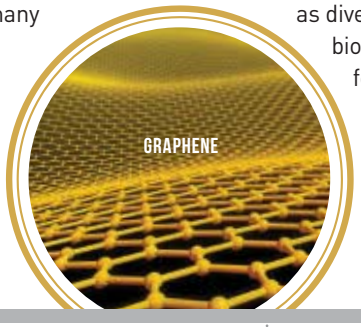
According NIST, Materials by Design techniques can potentially revolutionize the development of advanced materials, which in turn can form the bases of whole industries.

NIST estimates that as many as 20 years can lapse between the discovery of a new material and its first commercial use; the MGI aims to halve that.

The center has three co-directors: Peter W. Voorhees and Gregory B. Olson, professors at Northwestern, and Juan de Pablo, a professor at the University of Chicago.

The consortium plans to work with QuesTek Innovations, a materials design spin-off of Northwestern, co-founded by Olson; ASM International, a professional society of materials scientists; and Fayetteville State University in North Carolina. It also hopes to include industrial collaborators from across the nation.

The center plans to work on both inorganic and organic materials in fields as diverse as self-assembled biomaterials, smart materials for self-assembled circuit designs, organic photovoltaic materials, advanced ceramics, and metal alloys. ■


GRAPHENE

BILLS PROPOSE A FAB LAB NETWORK

BILLS IN THE HOUSE AND SENATE PROPOSE SETTING up a national network of fabrication laboratories in an effort to support the next generation of entrepreneurs and innovators.

Senators Dick Durbin (D-IL) and Kirsten Gillibrand (D-NY) introduced legislation last fall. A similar bill was introduced in the House in August by Rep. Bill Foster (D-IL).

Fab labs are small, community-based workshops that give the public—from students to small businesses—access to educational resources and manufacturing equipment.

Fab labs are independently owned and operated facilities that provide communities with the equipment, tools, and resources necessary to engage in the fabrication of objects.

Fab labs are also used by science, technology, education, and math educators to give students hands-on experiences with the principles and technology they are learning in classes.

The National Fab Lab Network Act, S. 1705, would grant a federal charter to the National Fab Lab Network. As a charter entity, the network would assist and support communities in the establishment of new fab labs and develop curriculum for STEM education and workforce training needs.

Foster's bill in the House, H.R.1289, is co-sponsored by Representatives Randy Hultgren (R-IL), Danny K. Davis (D-IL), Bobby Rush (D-IL), and Jan Schakowsky (D-IL).

The bills are available at thomas.loc.gov. They are found in a search by bill number. ■

TRACKING OCEAN POLLUTION

Analysis predicts where debris from the Tohoku tsunami will wash up on North American shores.

AFTER MORE THAN A DECADE OF STUDY AND RESEARCH, a mechanical engineering professor's work in early detection of where pollutants in the ocean will make landfall may be getting traction in the real world.

Thomas Peacock, an associate professor at the Massachusetts Institute of Technology in Cambridge, is active with researchers across the globe studying ocean dynamics and environmental flows. A key aspect of this work is how the movement of pollutants is controlled by invisible structures, called Lagrangian coherent structures. The ability to identify where pollutants, whether oil from a spill or debris from a tsunami, may damage a coastline can enable better and earlier disaster response.

The *Deepwater Horizon* oil spill and the Tohoku tsunami that hit the coast of Japan focused public attention on environmental issues, Peacock says, and highlighted how tough it is to predict where pollution goes in the ocean. "Any new techniques that could shed light on this would be of great use," he says.

That's exactly the focus of his work, which also draws on his background in dynamic systems theory. "It's an exciting field to be in, and there has been huge progress in the last four or five years," Peacock says. "It had been hard to make sense of because the flows are so complex."

Even though Leonardo da Vinci did a good job of drawing vortices in fluid motion that he saw in rivers 500 years ago, being able to say what they are and describe them mathematically has been tough, Peacock adds.

"WHAT'S SO EXCITING IS THESE METHODS THAT WE WRITE ABOUT IN SCIENTIFIC PAPERS ARE BECOMING THINGS THAT PEOPLE ARE USING IN THE EVERYDAY WORLD."

Recent methods of tracking ocean contaminants involved computer models estimating the likelihood a pollutant would travel a certain path. While more advanced than traditional methods, it doesn't offer insight into why things went to one location and not another. Lagrangian coherent structure analysis helps identify barriers to the flow, which, in turn, facilitates the analysis of where *continued on page 14»*

GLOBAL

BEIJING CURBS NEW CAR REGISTRATIONS

Beijing will step up its effort to fight air pollution by reducing the number of license plates it issues for passenger cars, according to a report in China Daily.

Since January 2011, the city has issued 240,000 new plates a year. This year, the city will restrict the number to 150,000. The newspaper said the new lower limit is expected to remain in effect through 2017.

The city distributes the plates through a lottery, and the new limit will increase already-steep odds. The newspaper calculated the likelihood of winning the license plate lottery at 90 to one, and that was in the contest for 240,000 plates.

The city meanwhile will increase the number of plates reserved for electric and other clean-energy vehicles, China Daily reported. There will 20,000 green plates this year, 30,000 next. The number will be 60,000 in 2016 and 2017.

The newspaper said that Beijing originally imposed the limit on plates to reduce traffic congestion, but now sees it as a means to fight air pollution.

According to the Chinese Academy of Sciences, automobile emissions account for more than 22 percent of Beijing's PM 2.5, the airborne particles less than 2.5 micrometers in diameter that are considered a substantial health risk. Coal burning accounts for less than 17 percent of the city's PM 2.5.

The municipal government last October established the Beijing Municipal Heavy Air Pollution Emergency Response Program, under which cars with odd- and even-numbered license plates will be allowed on roads only on alternating days when a red alert, the highest level air pollution warning, is in effect. ■

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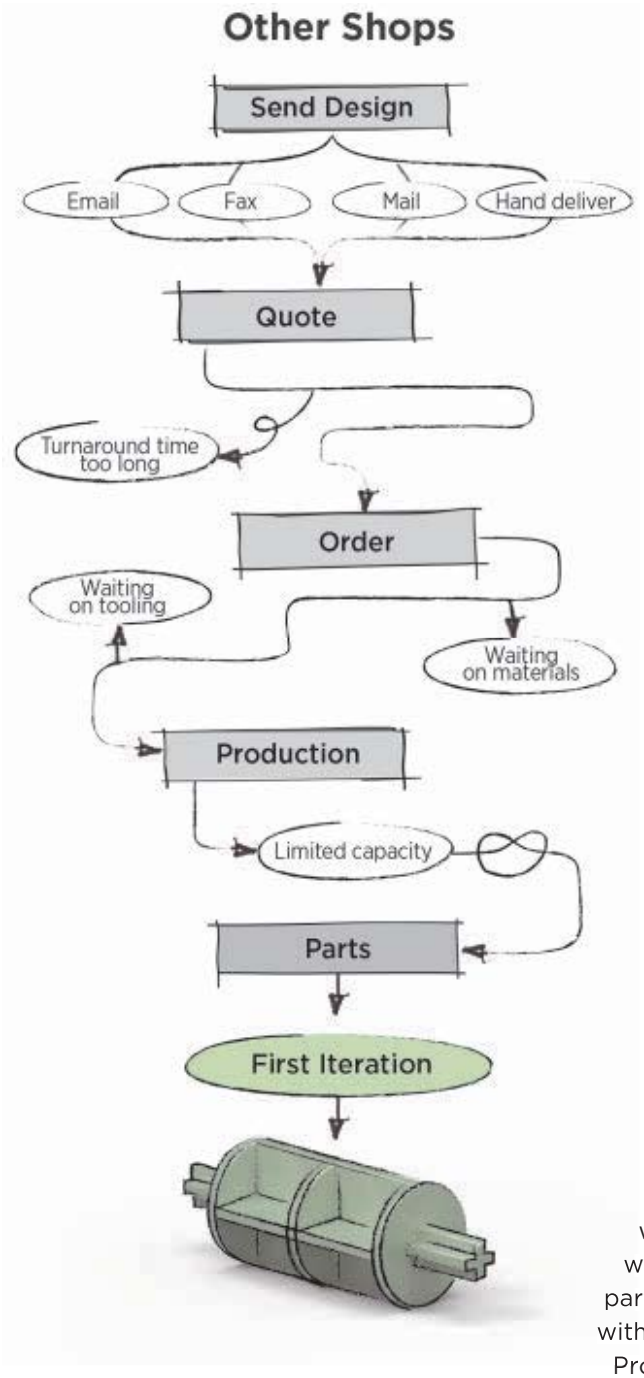

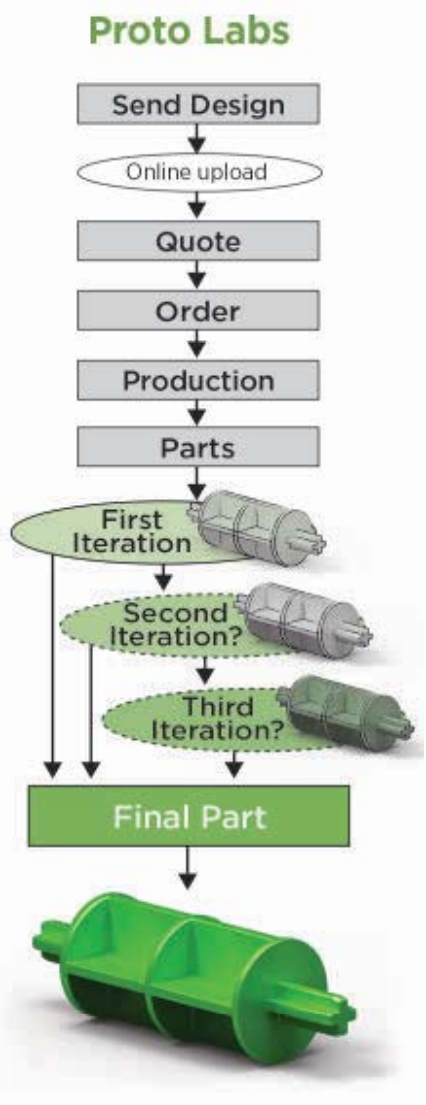

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COOKSTOVE MONITORING

The cooks in Nana Kenieba, a backcountry village in southern Mali, have well-designed, clean-burning stoves that they don't use often. Instead, they cook over the open fires that the stoves were supposed to replace.

Cookstoves have been supplied to more than 800 million people worldwide. The stoves are aimed at solving the crises of indoor air pollution, deforestation, and economic hardship linked to open cooking fires, but cookstoves go unused around the world.

There may be a design solution, but not one that can be discovered in a lab. How can stove developers learn about the practices of cooks in millions of open-fire kitchens? And how much, if at all, are the stoves reducing air pollution and fuel consumption?

New monitoring technologies may provide some answers.

Businesses and universities are incorporating low-cost cell phone technology and high-priced proprietary instruments into stove sensors and air quality testers. A $75 wireless device from technology company Nexleaf Analytics of Los Angeles latches to the stove and records when it's used.

The device sends its data wirelessly using a cheap built-in cell phone. If you know what the stove is burning, the company's analytic software can estimate the amount of fuel consumed, said Nithya Ramanathan, Nexleaf founder.

Nexleaf can also wirelessly measure black carbon emissions around the cooking station. Wood and coal smoke carries black carbon particles that are a major greenhouse-effect contributor and a risk factor for respiratory and other diseases.

"We're developing monitoring tech that works in the field. Wireless is an important piece of that," Ramanathan said. "It's very labor-intensive and difficult to visit houses and collect data. It's also very intrusive and can change people's cooking practices and lead to biases,"

Nexleaf Analytics' stove sensors are retrofits, but the company is now working to build sensors directly into stoves as they are manufactured. The goal will be to reduce costs with mass production and make sensing pervasive for large-scale data collection, she said. **ME**

A sensor with built-in cell phone tracks the use of cookstoves in distant places.

ENGINEERINGFORCHANGE.ORG

Accurate predictions of where pollution, like the oil spilled after the Deepwater Horizon *explosion, will permit better and earlier disaster response.*

continued from page 12 »

TRACKING OCEAN POLLUTION

particles are going to flow.

Peacock has had conversations with at least one major oil company about implementing the methods into oil spill strategies, and he is helping predict where debris from the 2011 Tohoku tsunami continues to hit the U.S. and Canadian west coast and is expected to continue for perhaps another five years.

"What's so exciting is these methods that we write about in scientific papers are becoming things that people are using in the everyday world," he says. "The main thing for me is the applicability to real-world problems ... that these methods are taken up and used alongside existing techniques."

The next milestone for Peacock will be the results of a project taking place early in 2014 in the South China Sea off the coast of Taiwan. Funded by the U.S. Department of Defense's Office of Naval Research, the study involves using data from high frequency radar measuring the ocean's

EPA EXAMINES RADIATION RULES

The U.S. Environmental Protection Agency is considering updating rules that limit how much radiation can be released from normally operating U.S. reactors and facilities that process uranium.

The agency published a notice in the Federal Register in February seeking comment on ways to update the standards, which limit radiation releases from normally operating reactors and facilities involved in the milling, conversion, fabrication, use and reprocessing of uranium fuel for generating commercial electrical power.

Comments are due by June 4.

The agency said updates may be necessary because a number of trends have emerged since the 1970s, when the existing rules were put into effect. The rules were based on technology and the understanding of radiation biology at the time. The agency pointed to improved dose and risk methods stemming from new calculation tools, as well as a growing interest in nuclear power stemming from concerns about climate change.

The EPA also wants to ensure that the standards reflect new nuclear technologies that could become available in the next three decades and any changes in on-site storage of spent nuclear fuel. The agency is also re-examining the need for more groundwater protections.

More information is available at www.epa.gov/radiation/laws/190/. ■

surface currents to predict where particular structures are and then sending a research vessel to verify those predictions.

According to Peacock, it is a step toward developing a monitoring system that can predict where things are going to go in the ocean. "In the case of search and rescue operations, it can be a matter of life and death," he says.

The techniques being developed have broad applications, not limited to ocean and geophysical flows. "Our lives are spent living in fluids," Peacock says. "Someone in industry could use this to understand mixing in combustion chambers; someone in a hospital to understand injecting fluid into something and how it will be transported. A professor at Berkeley is using these techniques to understand blood flow." Others are looking at how these structures affect all sorts of transports, from airplanes to autos.

"I would hope that the actual technique is something that will become a widely used tool throughout engineering working with fluid flows," Peacock says. ME

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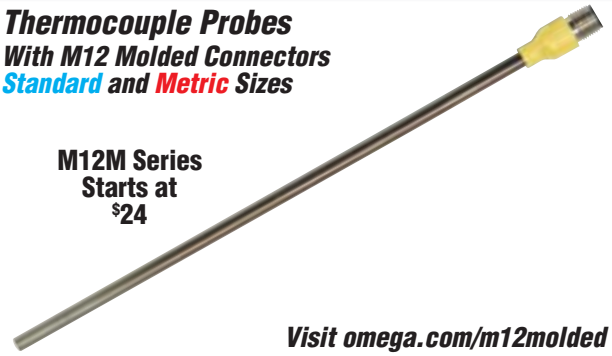

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BETTER TOOLS FOR ENERGY LITERACY

The old methods of teaching—using chalk and talk—**aren't giving citizens a deep enough understanding of complex energy issues.**

Just about every sector of society and the economy is affected by energy-related policies. But because scientific fundamentals as well as economics, politics, law, and culture underlie what energy can—or can't—do, the general public has a hard time engaging in the policy debates in a meaningful way. Too often, the public debate gets reduced to bumper sticker slogans such as "Drill, baby, drill," or "Don't frack the planet."

Improving energy literacy and overall STEM education should be one of the most critical priorities for the United States. As an energy educator, I believe we can use innovation to bridge the gap by supplementing traditional classroom instruction with engaging and dynamic outreach initiatives. Last year, I had the opportunity to practice what I preach by experimenting with new teaching technologies and methods across a variety of different media.

One way of doing this was via television. I hosted "Energy at the Movies," a nationally syndicated PBS television special that featured clips from different movies to teach the history and science of energy. Movies such as *Silkwood*, *Syriana*, and *Promised Land* contain useful imagery and scenes related to energy topics, and my role as the educator is to point out where Hollywood got the science right—or wrong. Early feedback on the special has been so positive, with telecast carriage exceeding 45 million homes, that an "Energy at the Movies" series is being developed.

One of the benefits of working with public television is the ability to reach a large audience of prospective minority STEM students. Given the U.S. Department of Energy's Minorities in Energy Initiative, expanding this approach could help address the needs of underrepresented groups.

I also taught a successful massive open online course, or MOOC, in the fall of 2013 titled Energy 101. Over 44,000 students from 173 countries enrolled. Nearly 5,000 students completed the course, resulting in a 13 percent completion rate, which is more than twice the rate for a typical MOOC.

MAKING DYNAMIC TEACHING MATERIALS AVAILABLE TO A NEW AUDIENCE HUNGRY FOR CONTENT CAN ENHANCE ENERGY LITERACY.

During my first virtual "office hours," I received questions from students on every continent (except Antarctica). In all, this MOOC expanded global reach for energy literacy and STEM education. The platform brought a college course to people who would not easily have access otherwise. In fact, a few high schools are using it.

These two experiments—the national television show and the global MOOC—offer a few lessons learned.

First, support and financial backing from the school—from the department chairs up to the university president—is needed before educators can experiment with multimedia teaching tools. Fortunately for me, the University of Texas at Austin and the Cockrell School of Engineering are both very supportive.

Creating educational content for the general population or for a global audience makes for better educators. Energy 101 is based on a graduate course retooled every few semesters at UT. However, video is forever, so close content scrutiny and a highly coherent lesson plan were vital for the MOOC's success. Also, because many MOOC students are outside the U.S., teaching a MOOC requires an international lens. All this focused my teaching, and forced me to reframe some of the arcane details of American energy policy in a way that could be accessible to everyone.

Overall, the MOOC was an effective experiment with energy literacy curriculum. However, until online assessment capabilities improve, the traditional classroom will continue to serve a critical function for not only distributing critical information but for assessing students' learning objectives.

Indeed, MOOCs are probably misnamed. They function less as courses and more as open textbooks—a massive open online textbook, if you will. Turning these online materials into high-quality, interactive textbooks is the right direction for the future. Making these dynamic teaching materials available to a new, global audience hungry for content is a powerful way to expand STEM education, and it can enhance energy literacy. Both of those outcomes would benefit society. 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.

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Q&A BAS LANSDORP

A PERMANENT HUMAN SETTLEMENT ON MARS BY 2024? That's the vision of Bas Lansdorp, the 37-year-old Dutch engineer and entrepreneur who co-founded the Dutch nonprofit Mars One with Arno Wielders three years ago. The company plans to send a crew of four people, departing every two years, to Mars starting in 2024. Colonists will not return to Earth. In December 2013, Mars One culled a list of applications from more than 200,000 to 1,058 with plans to continually narrow the pool. The company plans to launch its first unmanned mission in 2018. Initial cargo missions will include communication satellites, two rovers, and other equipment needed to prepare for human settlement. For a look at the people who applied to live on Mars, or to donate to the company, go to www.mars-one.com.

ME: Why a permanent settlement on Mars?

B.L: This planet is explored and Mars is the next place to go. It has all the elements we need to support long-term human life: water, carbon, nitrogen, and oxygen. It has an atmosphere that, although thin, protects settlers from radiation and other dangers. It has a decent amount of gravity and a day that is almost exactly as long as that of the Earth.

ME: How did you meet your founding members?

B.L: Arno and I met 12 years ago when I presented my thesis work at the Dutch Mars Society. We've been in touch since and decided to found Mars One in 2011 when we thought of a way to finance the mission to Mars.

ME: What's your background, both in terms of career and personal interests? Did your background lead you to establish Mars One?

B.L: I'm a mechanical engineer. I graduated in 2003 from University of Twente, Enschede, Netherlands. I use my engineering background mostly to support business decisions and in technical discussions with suppliers. Mars One is not an aerospace company. We purchase space hardware and don't build it. I have always been interested in technology and was always taking things apart when I was young.

ME: How are you funded? Has funding been hard to achieve?

B.L: I had a different company, Ampyx Power [a wind energy company], before Mars One and sold part of my shares in that company to start Mars One. Right now, Mars One has solid revenue streams from investments, partnership deals, and media deals. We've started a crowdfunding effort because we want this to be everyone's mission to Mars.

I like our option of being able to send a passport photo to Mars with a message for the first humans that arrive there. [This is a perk offered on Indiegogo.com to contributors of $1,250.]

ME: What will you be looking for in your pool of candidates?

B.L: The most important skill is the ability to function in a team. After departure from Earth orbit, they fly to Mars in seven months and then spend 26 months on the surface before the second crew joins them. That isolation will be their biggest challenge. All the other skills—engineering, to fix what breaks; medical, to help each other in emergencies; botanical, to grow their own food—we can teach anyone with a good brain.

ME: What excites you most about the project?

B.L: What excites me most is that technically, financially, and humanly, this is possible. There are hundred of hurdles on the way, but it is possible. Working on making it happen, taking steps in the right direction, believing that we can do it—that excites me tremendously.

ME: What's the biggest headache about the project?

B.L: Mars One's plan is quite different from that of space agencies. The lack of a return mission makes it much less complex. Many experts comment on our plan without knowing any details. That's very frustrating.

ME: So what do you do in your free time?

B.L: My what? Running Mars One is more than a full-time job. When I do find some time, I run or play the piano. ME

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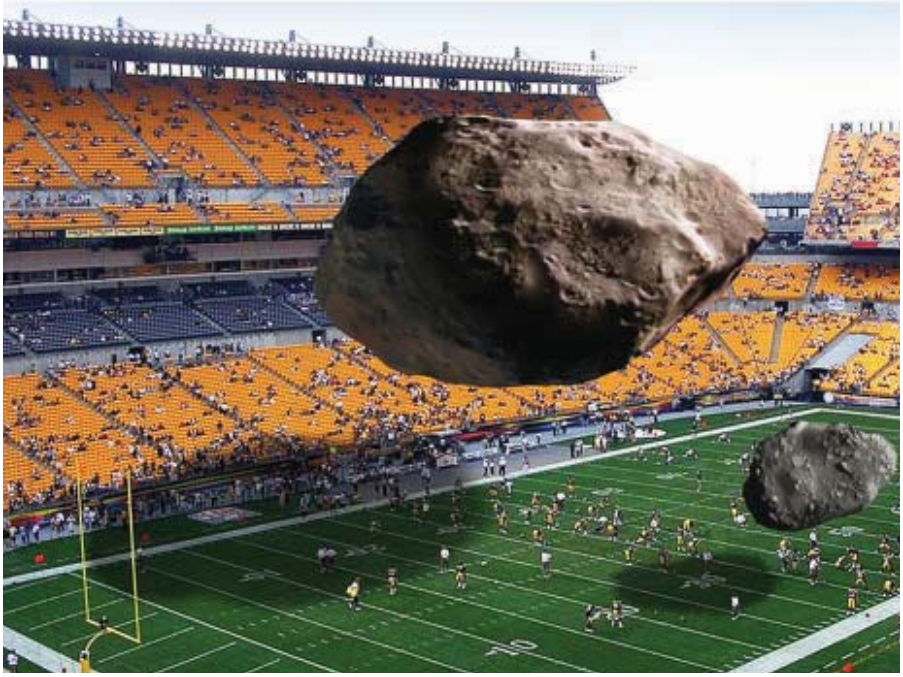
SAVING THE EARTH BY INCHES PER SECOND

In the movies, astronauts take care of dangerous asteroids with nuclear weapons. If we really need to move a small mountain, a gentle nudge might do just as well.



This artist's rendering compares asteroid 2012 DA14 (367943 Duende) and the Chelyabinsk bolide to Pittsburgh's Heinz Field. Courtesy: B612 Foundation/Michael Carroll.

WHEN A METEORITE EXPLODED OVER the Russian city of Chelyabinsk last year, injuring about 1,500 people, it brought to life what many planetary scientists had warned about for decades. Countless asteroids ply the solar system in the vicinity of Earth, and undoubtedly an asteroid large enough to be deadly is headed our way.

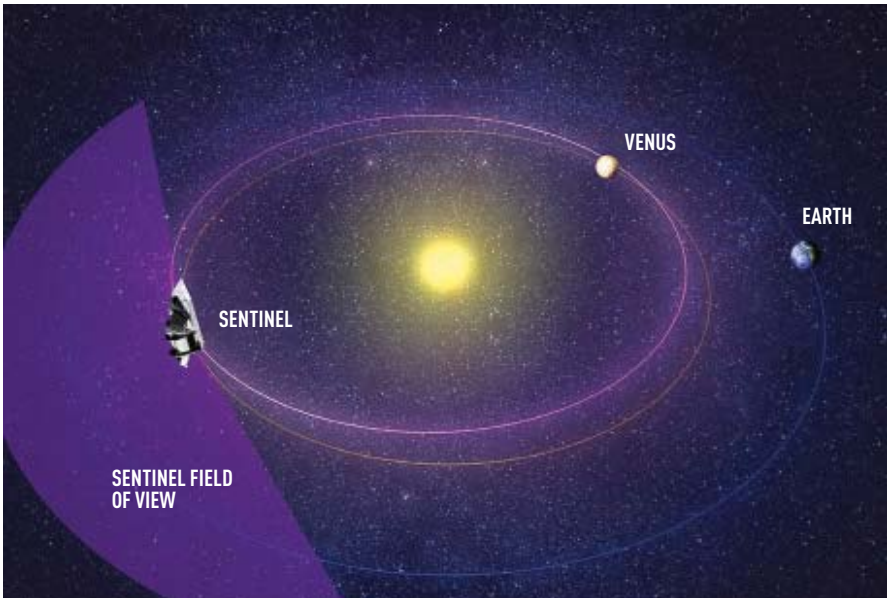
The only real question is: will we be able to turn it away before it strikes?According to Don Yeomans, manager of NASA's Near Earth Object program at the Jet Propulsion Laboratory in Pasadena, Calif., there are only three ways to increase our chances against an asteroid aimed at Earth: "Find it early; find it early; find it early."

A world-wide network exists to do just that, and the Minor Planet Center in Boston is its nerve center. "Astronomical surveys detect the objects," said Tim Spahr, the center's director. MPC collects the survey data, analyzes it and "turns it around quickly to see if there will be an impact in the near future—from a few weeks to six months," Spahr said.

Next, according to Yeomans, JPL's NEO program "takes the MPC's observations, improves and updates the orbital calculations, runs them out to around 100 years and does impact probability calculations for a particular date. We want to observe Earth impactors years in advance."

An incident on New Year's Day gives a sense of how quickly JPL and MPC can work. A small near-Earth asteroid was discovered by the Mount Lemmon Observatory in Arizona. The MPC and JPL were able to determine its orbit and verify that the asteroid was aimed at Earth, all before the object hit less than 24 hours later. Fortunately, the asteroid, designated 2014 AA,

The proposed Sentinel spacecraft would scan the inner solar system, looking for potentially hazardous asteroids.



was only the size of an SUV and burned up over the Atlantic without incident.

To provide a better warning, the non-profit B612 Foundation is promoting the construction of a space-based telescope named Sentinel. Most near-Earth objects are very dark, said Harold Reitsema, development lead for the Sentinel mission, but "glow very brightly in infrared." In a seven-month orbit around the Sun and using infrared detectors, Sentinel "can survey half the sky every month," Reitsema said.

If astronomers identify a dangerous object with a couple of decades' warning, engineers have some possible means for averting disaster.

One method is shooting it with a bullet. A kinetic impactor deflection involves hitting "an asteroid with a one-ton spacecraft going as fast as possible—perhaps 20,000 miles per hour," Reitsema said. That kinetic energy changes the asteroid's velocity by about 0.04 inch per second. "If you let it go for a few decades, that small amount of delta-vee makes the asteroid miss the Earth," Reitsema said.

If the kinetic impactor isn't enough, add a gravity tractor.

"Send the heaviest spacecraft possible near the asteroid and use the spacecraft's rockets to hover above it for more than a year," Reitsema said. "The gravitational attraction between the two changes the asteroid's velocity very slowly. Most of the delta-vee would come from the kinetic impactor, and then you can fine-tune the trajectory with the gravitational tractor."

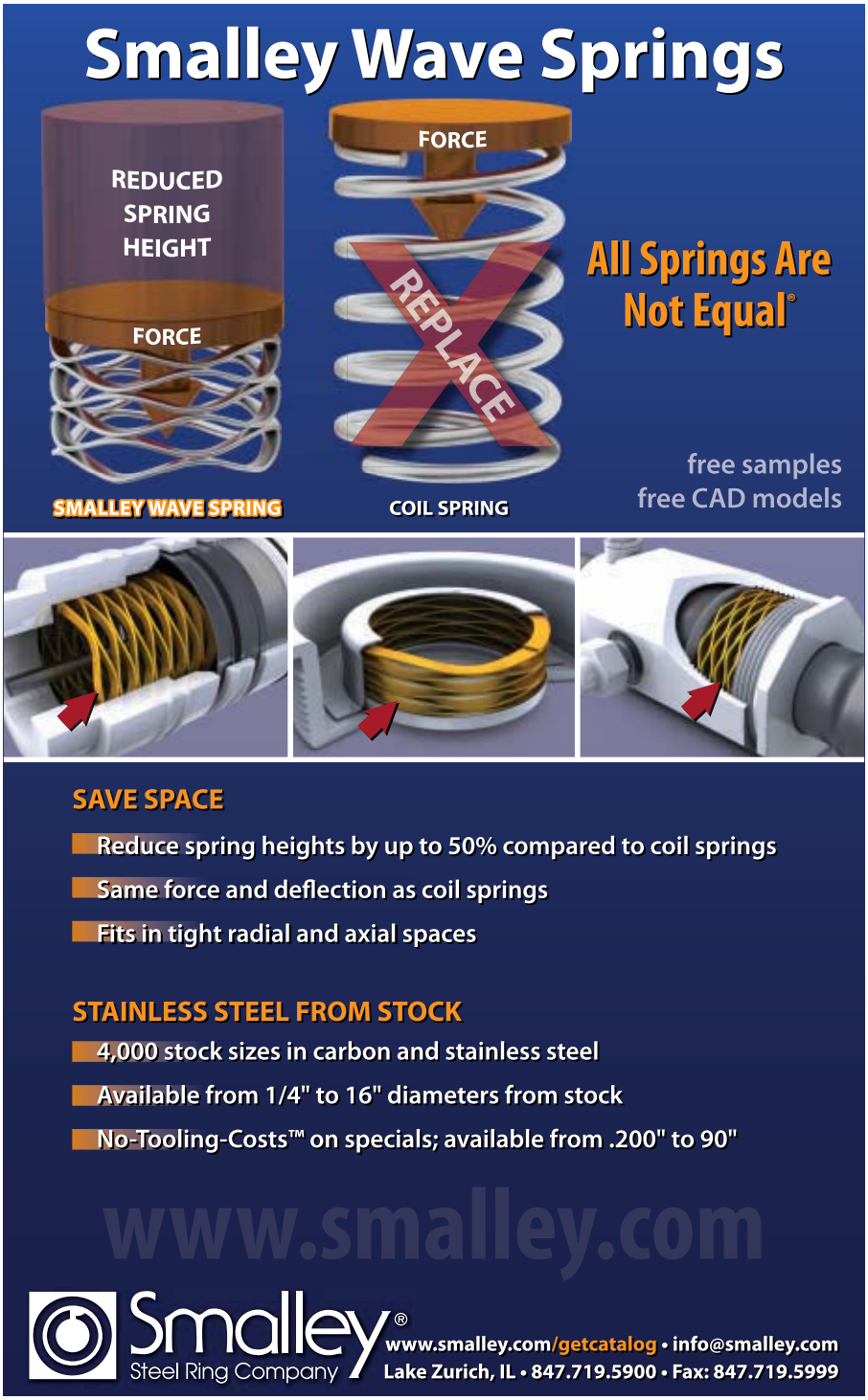
And if that fails, then bring out the nukes.

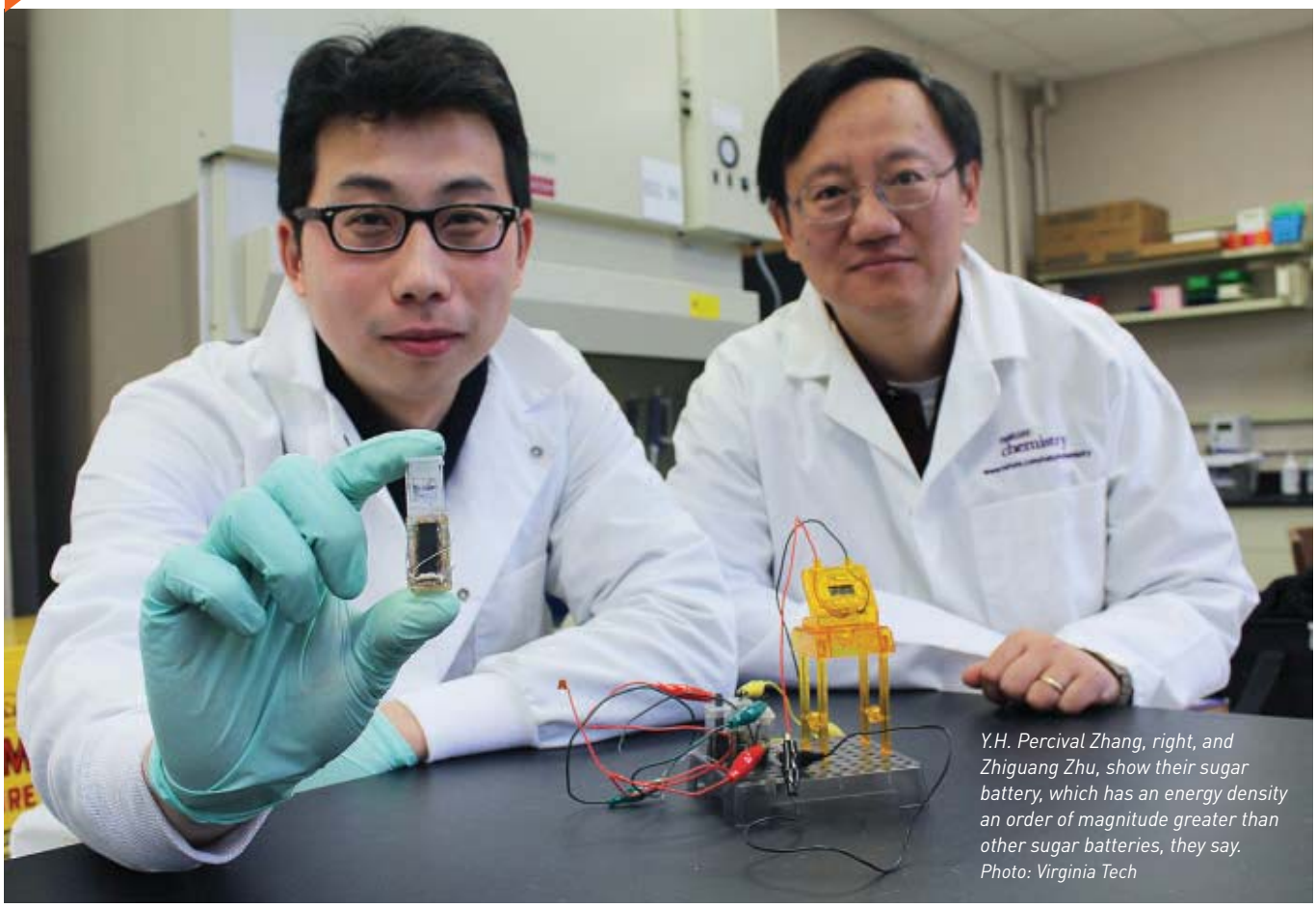
"Ideally, blowing up a neutron bomb above the surface will ablate it, which moves it," Yeomans said. "Or you could imbed the bomb into the object to blow it up into 33-foot to 50-foot fragments. They wouldn't make it past the atmosphere. There would be fireballs and air blasts, but no significant ground damage."

Another option is a hive of "laser-bees": sunlight would power lasers aimed at vaporizing sections of the asteroid's surface. "That would create a plume that acts like a rocket," Reitsema said.

So Earth has the technology, potentially. What it needs is time. According to Yeomans, using today's technology means we'd need a decade's head start to deflect an asteroid. The harder we look, the better off we'll be. ME

BRIDGET MINTZ TESTA is a contributing writer who lives in Houston.





Y.H. Percival Zhang, right, and Zhiguang Zhu, show their sugar battery, which has an energy density an order of magnitude greater than other sugar batteries, they say. Photo: Virginia Tech

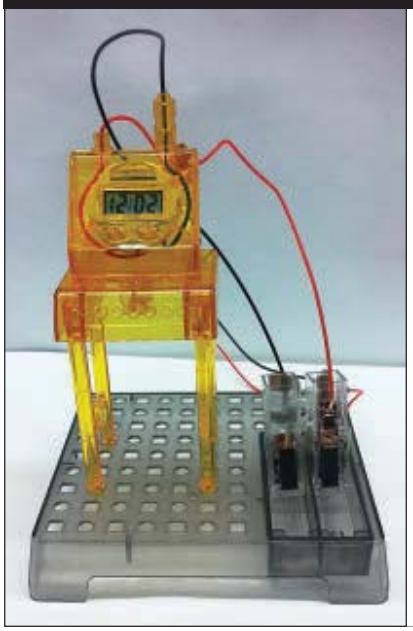
MADE GREENER

Two labs say they've found more environmentally friendly, sustainable ways to create the electrical batteries, cosmetics, plastics, and detergents we've come to depend on.

Researchers at the Biofuels and Carbohydrates Lab at Virginia Tech have developed a fuel cell that runs on sugar. As such, it's refillable and biodegradable, two things you can't say about the traditional batteries that lab director Percival Zhang hopes the sugar batteries will one day replace.

The Virginia Tech batteries are cheaper than today's batteries, too, Zhang said.

SWEET ELECTRICS



THE LAB Biofuels and Carbohydrates Laboratory, Virginia Polytechnic Institute and State University, Blacksburg; Y.H. Percival Zhang, director.

OBJECTIVE Sustainable technologies that, though based that on well-known methods, still look like crazy ideas, according to the lab's home page.

DEVELOPMENT A battery that runs on sugar.

Two Virginia Tech-developed sugar batteries are connected to power a digital clock. Photo: Virginia Tech

And the sugar is a sustainable compound. The lab creates sustainable technologies, he said.

"Sugar is a perfect energy storage compound in nature so it's only logical that we try to harness this natural power in an environmentally friendly way to produce a battery," he said.

While other sugar batteries have been developed, this one has an energy density an order of magnitude higher than the others, which means it can run longer than the others before it needs to be refueled, Zhang said.

Like all fuel cells, the sugar battery combines fuel—in this case, maltodextrin, a polysaccharide made by separating starch via a chemical process—with air. In this way, the electron charges stored in the sugar solution are slowly released, Zhang said.

The process generates electricity and water. The battery is also refillable and sugar can be added to it much like filling a printer cartridge with ink, Zhang said.

The fuel sugar solution is neither explosive nor flammable and has a higher energy storage density than hydrogen or direct methanol fuel cells, he said.

In as soon as three years, the lab's battery could be running some of the cell phones, tablets, video games, and the myriad other electronic gadgets that require power, Zhang said.

Researchers at the Dumesic lab have come up with a process to convert biomass-derived feedstock into linear alpha olefins (LAOs), chemical building blocks for many everyday products like plastics, beauty products, and detergents.

U.S. demand for LAOs in 2007 was 3.4 million metric tons, and that figure is still on the rise, said Dong Wang, a researcher in the lab.

Existing LAO production technologies use petrochemicals as a starting material but the lab's process doesn't, offering advantages for both efficiency and sustainability, he added.

This process uses Lewis-acid catalysts, such as gamma-alumina and tungstated alumina to produce linear alpha olefins in a reactor, Wang said.

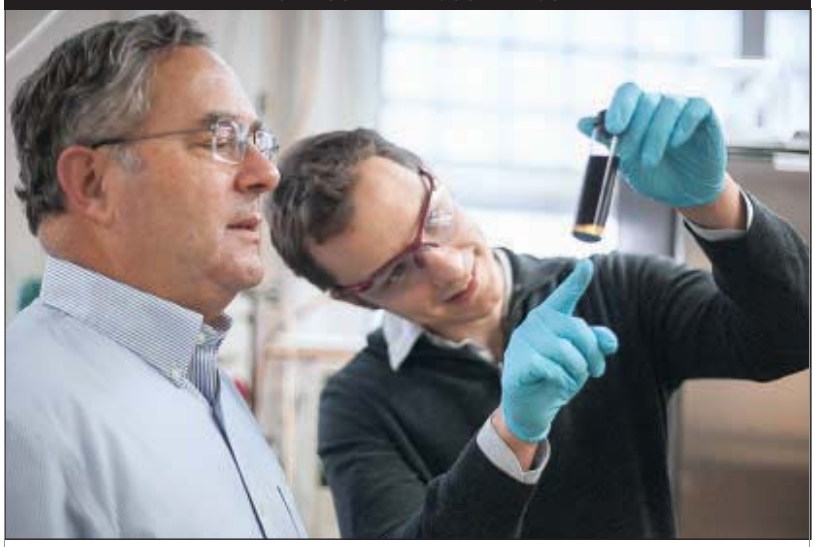
Another advantage of the process is its simplicity. It is a one-step reaction that can be run continuously in a single, small reactor, he said.

One unusual feature of this new process is that it causes reaction compounds to separate into layers, like an unshaken salad dressing bottle, making it easy for researchers to extract the final product, Wang said. In addition, the main catalyst used in the process is inexpensive and non-toxic.

"Market dynamics are changing all the time, so if I was a plant operator, I would want to install one of these reactor units in my plant so that when market demand for a certain type of LAO increases, I can start making that specific fraction," Wang said.

Before the process can be adopted by industry, further studies and economic analyses must be completed. The researchers are currently studying the process in more detail to better understand their catalysts' properties, said Sikander Hakim, a postdoctoral researcher on the project. ME

BIOMASS-MADE COSMETICS



James Dumesic, left, and Jeremy Luterbacher, a researcher in Dumesic's lab, with a vial of linear alpha olefins. The lab has devised a method to convert biomass into various LAOs, left.

Photos: Matthew Wisniewski/Wisconsin Energy Institute

THE LAB Dumesic Research Group, Madison, Wis.; Timothy Donohue, director.

OBJECTIVE Turning chemicals from grasses, wood, and crop residue into materials used to create environmentally friendly products.

DEVELOPMENT A process to convert feedstock into linear alpha olefins.

TECHNOLOGY FOR ORGANIC GARDENERS

John Bouey once worked as a wastewater treatment plant designer at firms like Brown & Caldwell. Then he made a career change into a field that is literally fertile ground for technical advancement and engineering.

The biofilter of a negative aeration system by Engineered Compost Systems at Alpha Ridge Landfill in Maryland.

Bouey, a licensed engineer, is president of Managed Organic Recycling in San Luis Obispo, Calif.

"My goal was to advance both recycling of water and recycling of biosolids," Bouey said.

His company builds composting systems in which microorganisms break down organic matter from yard wastes to food scraps to make soil amendments that organic gardeners, groundskeepers, and road crews can use. Many municipalities have developed composting facilities, and private composting businesses have also sprung up.

Several companies have evolved that specialize in designing turnkey compost systems complete with training. Besides Bouey's MOR, they include Engineered Compost Systems in Seattle; O2Compost

A positive aeration compost facility in Royersford, Pa., designed by O2Compost, has a blower supplying air to a pile.

in Snohomish, Wash; and W.L. Gore & Associates based in Newark, Del.

For years, conventional wisdom has held that compost must be turned over occasionally to keep air, heat, and moisture evenly distributed throughout the pile. Commercial operations typically arrange compost in long windrows, and huge windrow turning machines lumber along, churning the piles as they go.

Bouey's company builds systems to make the process more efficient than that. They use aerated static pile composting, which avoids the cost of windrow turning machines and reduces the odors that come from rotting organic waste.

In ASP composting, organic matter is arranged in piles about 80 feet long over pipes pierced with holes that deliver air forced by a blower. The air permeates upward though the pile, supplying oxygen for aerobic decomposition and removing excess moisture and heat.

Two common designs are forced draft and induced draft. Forced draft, also known as positive aeration, blows air into the compost. Induced draft, or negative aeration, draws air through the compost and discharges it to another pile known as a biofilter, which treats the air to eliminate odors.

According to Bouey, system design typically starts with sizing the pipes. One rule of thumb says the piping flow area should stay roughly the same throughout the system, and another says flow velocity in a pipe shouldn't exceed 50 feet per second. A typical blower may have an 8-inch inlet or outlet going to a 6-inch manifold pipe to 4-inch pile pipes.

Frequent choices for pipe material are PVC and polyethylene. The pipes can lie on the ground to be removed when a compost pile is broken down, or can be laid in concrete for a permanent system.

In an induced draft system, several blower outputs may pipe to a manifold, which feeds a biofilter, often through ductwork similar to that used in HVAC systems. A startup composting operation in Baltimore, for ex-

continued on page 26»

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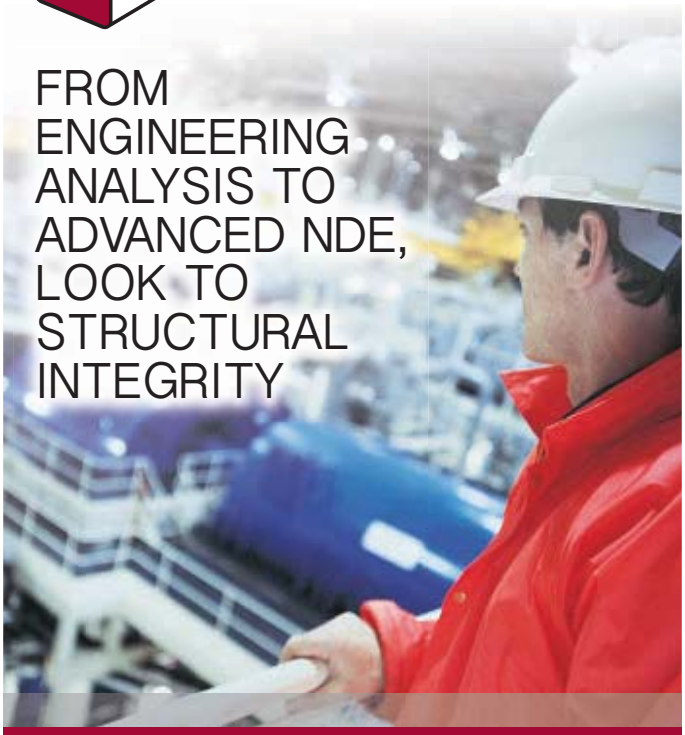

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continued from page 25»

TECHNOLOGY FOR ORGANIC GARDENERS

ample, had seven ASPs, each requiring 850 cfm of air, on each side of the main operating floor for a total of 14 blowers feeding a biofilter. An 18-inch duct from one bank of blowers ran above the operating floor to connect with the blowers on the other side and from there to the biofilter.

In calculating head loss in a piping system and sizing a blower, Bouey says, for a positive aeration system, "There are three head losses you have to consider. One is the manifold, then the orifices along the pipe, and then the compost mix itself." For a negative aeration system, losses for piping on the discharge side of the blower add to the total.

Pressure drop calculation is based on the Darcy-Weisbach formula, which factors in friction for the pipe material, length of pipe, flow velocity, and pipe diameter. A key point is that head loss varies exponentially with flow velocity; small increases in pipe size can sharply reduce the velocity and therefore the pressure loss and ultimately the size of blower required and the power to run it.

Aeration systems often use centrifugal blowers, and manufacturers publish performance curves that plot static pressure versus flow rate for use in selecting a blower.

Blowers can run at constant or variable speed. Most constant-speed systems have timers that turn the blower on and off, usually 20 minutes on and 40 minutes off per hour. Other systems have oxygen and temperature sensors in the pile as part of a feedback control strategy. W.L. Gore, for instance, uses an on/off system controlled by oxygen sensors.

Bouey designs systems with variable-frequency drives respond to temperature readings.

"We typically provide VFDs on all our blowers," he says. "It's an easy way to get a lot of flexibility." ME

TOM GIBSON is a consulting mechanical engineer specializing in green building and a freelance writer based in Milton, Pa.

The blower drives air circulating through the pilot composting facility at the Alpha Ridge Landfill in Howard County, Maryland.

CO_2 CAPTURE PROJECT MOVES FORWARD

The U.S. Department of Energy has approved $1 billion in financing for FutureGen 2.0, which will attempt to capture at least 90 percent of the carbon dioxide from a 168-megawatt coal generator near Meredosia in west-central Illinois.

An artist's rendering from the Department of Energy shows a concept for a FutureGen power plant.

FutureGen 2.0 is one of five DOE proposals to demonstrate capture technology at a commercial scale in the energy sector.

While the other proposals involve enhanced oil recovery, where carbon dioxide is used to pump oil out of a field, FutureGen 2.0 would sequester CO_2 in an underground saline aquifer. The project involves the redesign of an existing plant rather than construction of a brand new facility. Captured CO_2 at the Illinois plant would be transported along a 30-mile pipeline to a storage site in eastern Morgan County, where the gas would be injected approximately 4,000 feet below the surface.

The estimated cost of the initiative is $1.68 billion.

In October, the department concluded in a final environmental impact statement that FutureGen 2.0 would have "minor" impacts on groundwater, geology, land use, and air quality. The project received critical air and water permits from Illinois in December 2013. The project is scheduled to become operational in 2017.

The DOE action constitutes the last step in the National Environmental Policy Act process but does not guarantee the project's construction. The developers need to complete financial closing and obtain a handful of federal and state permits, including a CO_2 storage permit from U.S. EPA. ■

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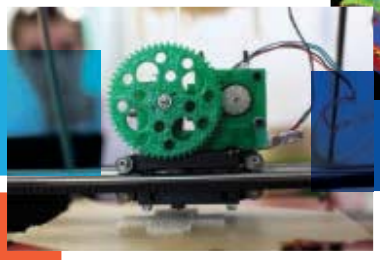

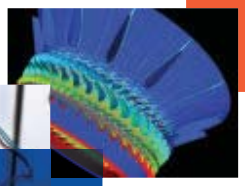

LOOKING BACK

Change and the need to keep up with it was already an obsession 50 years ago when this article was printed in April 1964.

MANAGING IN A CHANGING WORLD

BY LOUIS E. NEWMAN, ASME FELLOW; PRESIDENT, SMITHCRAFT CORP., CHELSEA, MASS.

The author of ASME's Henry Robinson Towne Lecture of 1964 considered character and moral suasion as key attributes of successful managers.

It seems that our modern manager must add another element to his well-recognized task of making human effort more productive. He must make both employees and the general public willingly accept his leadership and the system of which he is a vital part. He cannot do this by propaganda or communication alone, even though these techniques have a place in gaining recognition for worthwhile acts.

Our American management is strong in its technical phases of organizing, systemizing, measuring, and mechanizing. It is weak in its knowledge of the continuing developments in the behavioral sciences; weak in its inherited bias and prejudices having their roots in race, custom, nationality, and religion. In these areas of weaknesses we must strengthen ourselves and encourage the young men who follow us to broaden the base of their own knowledge and character.

The professions of medicine and law are keenly aware of the hurtful impact on their good and bad practitioners when one of their membership attracts public attention for unethical conduct. Through their national societies they can bring great pressure against these miscreants to avoid bringing discredit to their professions. We in management having nothing akin to disbarment for those among us who bring discredit to all managers.

So it seems to me that we must recognize our responsibility to each other by not only being men and women of high character but by doing what we can to be recognized for high ethical conduct. We can do this by setting standards that include not only how we accomplish our objectives but includes the objectives themselves. We must find ways to bring added pressure against those not serving the broad public interest. ME

Mustang in the Round: Ford executives introduced the car at a press conference during the 1964 World's Fair. It would prove to be Ford's hottest introduction since the Model A.

CLASSIC DEBUT

The 1965 Mustang, which became Ford Motor Co.'s most successful introduction since the Model A, was unveiled on April 17, 1964, at the New York World's Fair. Coming out five months before the start of the normal production year, fans dubbed it a 1964 ½ model. The initial design was built on the platform of a Ford Falcon, and to control the sticker price, which was $2,368 ($17,795 in 2014 dollars), many of the components came from the Falcon and Fairlane production lines.

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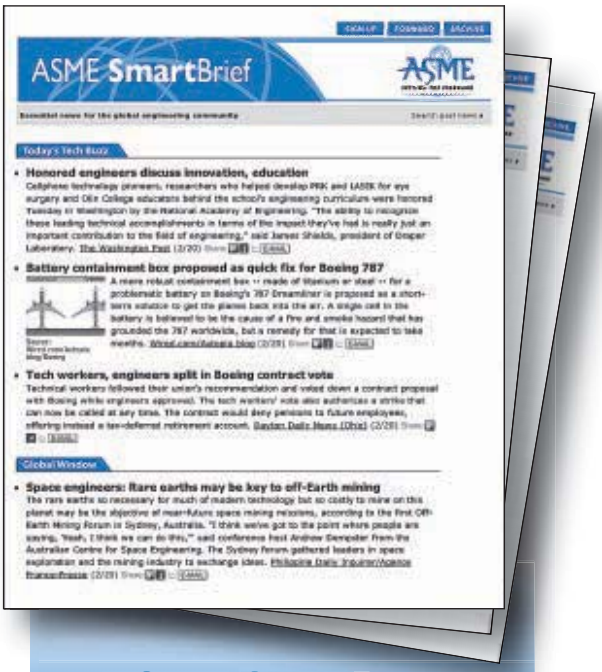
—Engineer



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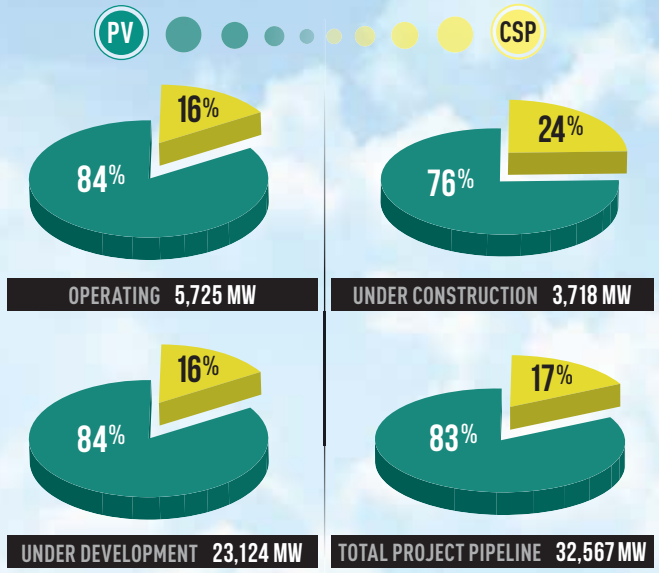
ASME SETTING THE STANDARD

BY THE NUMBERS: CONCENTRATED SOLAR POWER MAKES A COMEBACK

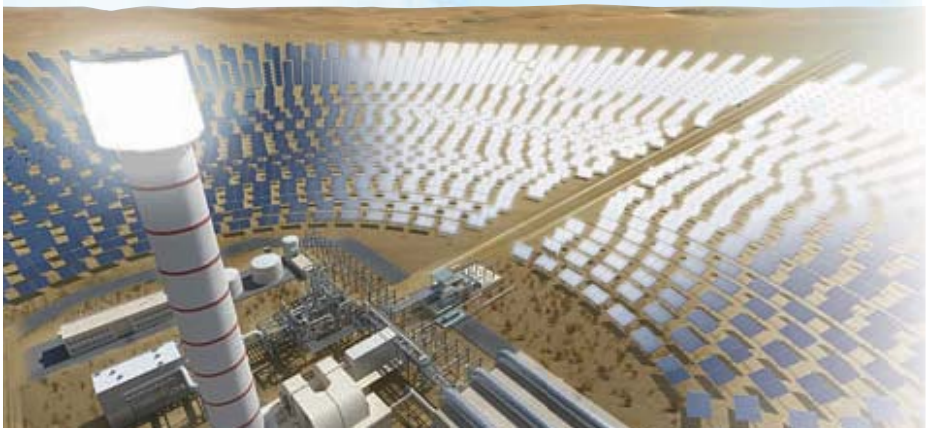
Concentrated solar power, an alternate energy technology overlooked for nearly two decades, is making a comeback, especially in the United States. After years of stagnation, U.S. CSP capacity jumped to 928 MW in February 2014, with 907 MW under construction and an additional 3,684 MW in development.

GRAPH 01 MAJOR SOLAR PROJECT CAPACITY BY TECHNOLOGY AND COMPLETION STATUS (MW)

SOURCE: *Solar Energy Industries Association*



GRAPH 1 According to the Solar Energy Industry Association, concentrated solar power accounts for a surprisingly large percentage of U.S. solar installations and projects in various stages of completion.



Concentrated solar power has a unique advantage among renewable systems, because it can store heat economically to generate electricity after sunset. CSP works by using mirrors or lenses to focus sunlight onto a heat transfer fluid. Some systems pipe the fluid along the focus of parabolic reflectors, then send it to heat exchangers to produce high-pressure steam for turbine generators. Other systems direct tens of thousands of mirrors at a central tower, or heliostat, heating the fluid to generate steam directly.

In either case, systems can either use that concentrated heat immediately to generate electricity or store it in molten salts or phase change materials, then tap it hours later, after sundown. Plants are able to operate longer and more reliably, and can use their expensive turbine generators more efficiently.

Several factors are driving the CSP revival, such as state mandates that utilities meet renewable energy goals. CSP will benefit from the California Public Utilities Commission's mandate that public utilities provide 1.3 GW of electrical storage by 2020.

Conventional power plants could add CSP to existing facilities, producing heat from sunlight during the day and from fossil fuel at night. In 2010, Florida Power & Light opened a 75 MW CSP plant next to a combined cycle natural gas power plant. The $476 million CSP unit is expected to save $178 million in fuel cost over its 30-year lifespan. The National Renewable Energy Laboratory estimates that 11 to 21 GW of fossil power plants receive enough sunlight to add CSP units.

CSP plants could also provide steam to inject in rock formations for tertiary oil recovery. BrightSource Energy has a 29 MW (thermal) demonstration project with Chevron, while GlassPoint Solar has smaller projects under way in California and Oman.

Costs remain a concern, but developers point to important gains made. Data from the U.S. Energy Information Agency recently projected the cost of building and operating an electric

TABLE 01

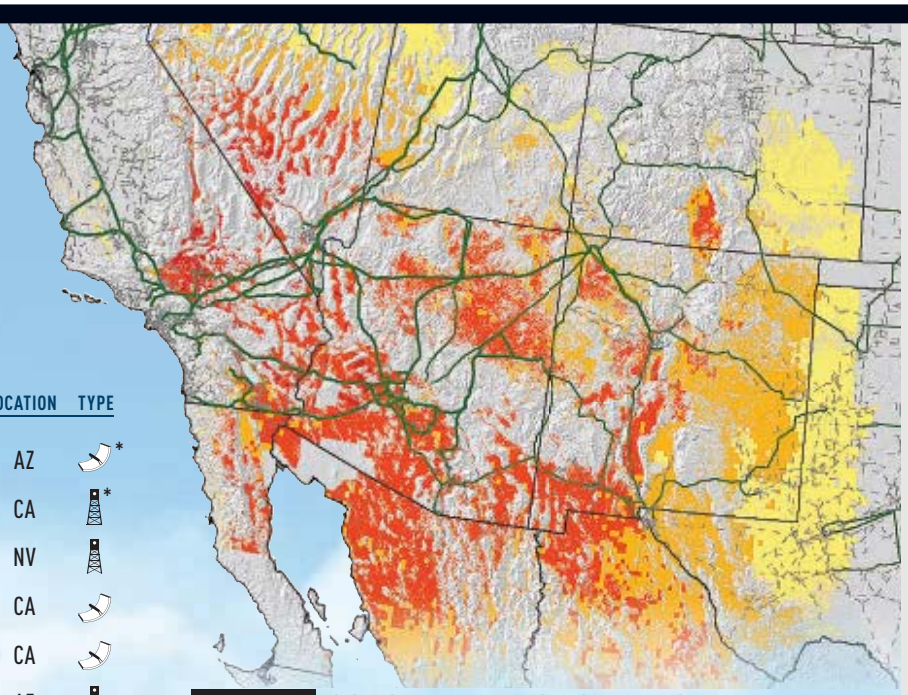
MAJOR CONCENTRATED SOLAR POWER PROJECTS IN THE UNITED STATES

SOURCE: *CSP Today, Solar Energy Industries Association*

NAME	GROSS CAPACITY	STATUS	LOCATION	TYPE
Solana Generating	280	OPERATING	AZ	*
Ivanpah Solar	392	OPERATING	CA	*
Crescent Dunes	110	CONSTRUCTION	NV	
Mojave Solar	280	CONSTRUCTION	CA	
Genesis Solar	250	CONSTRUCTION	CA	
Crossroads	150	DEVELOPMENT	AZ	
Quartzsite	100	DEVELOPMENT	AZ	
Rice	150	DEVELOPMENT	CA	
Saguache	200	DEVELOPMENT	CO	
Hyder Valley	375	PLANNING	AZ	
Palen	500	PLANNING	CA	
Sonoran West	540	PLANNING	CA	

* = parabolic trough = tower

TABLE 1 The capacity of concentrated solar power projects has grown rapidly from tens of megawatts to hundreds of megawatts. The economies of scale help to drive down costs.



GRAPH 02

CONCENTRATING SOLAR POWER PROSPECTS OF THE SOUTHWEST UNITED STATES

SOURCE: *CSP Today, Solar Energy Industries Association*

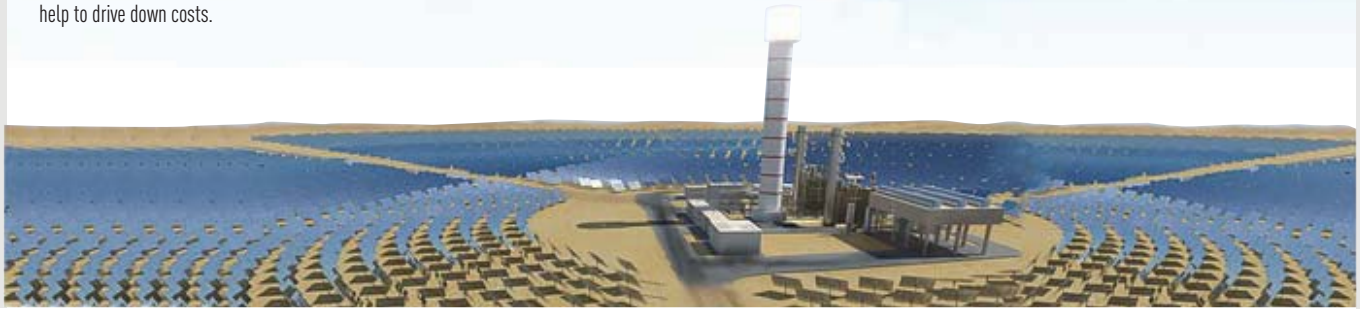
GRAPH 2 This map shows average insolation in buildable areas where the ground slopes at 3 percent or less. The southwestern United States and northern Mexico receive enough sunlight to support major CSP projects.

Direct normal solar radiation kWh/m²/day

- 8.0–8.2
- 8.0–7.5
- 7.5–7.0
- 7.0–6.5
- 6.5–6.0

TRANSMISSION LINES

- 735kV–999kV
- 500kV–734kV
- 345kV–499kV
- 230kV–344kV
- *BELOW* 230kV



generating plant over its duty life (total system levelized cost) for 2018. The total cost for natural gas was as low as 7 cents per kilowatt-hour, followed by coal at 10 cents and nuclear at 11 cents. Among the renewables, wind was 9 cents per kilowatt-hour, followed by photovoltaics at 14 cents, and CSP at 26 cents.

The industry claims that the newest CSP plants produce power for as little as 13 cents/kWh. Scale may be a reason: BrightSource's Ivanpah facility generates 392 MW of power using three heliostats surrounded by 170,000 mirrors. The company managed costs through design simulation and optimization, then built an automated plant to manufacture its mirrors on-site. It has benefitted from advances in design, materials, heat transfer fluids, and optical coatings.

The U.S. Department of Energy's SunShot initiative calls for reducing the cost of solar power to 6 cents/kWh by 2020. Given the cost reductions over the past few years, this goal might be reachable if subsidies for CSP continue. ME

ALAN S. BROWN

Engineering the Future Milan Dau, left, and Sadhika Prabhu, students in the Salk Middle School STEM magnet, work on a CAD program as part of their design curriculum.

THE BRIGHTLY FROSTED CUPCAKES SITTING ON THE TABLE SEEM OUT OF PLACE IN THIS HARD-WORKING JUNIOR HIGH THAT EMPHASIZES SCIENCE, TECHNOLOGY, ENGINEERING, AND MATH.

Shouldn't these kids be working at tilted tables with T-squares?

Or be parked in front of the latest CAD program?

Or attempting to make a three-dimensional print of their hand?

Nope. The cupcake making at Salk Middle School in Elk River, Minn., just outside Minneapolis, is actually a delicious chemistry lesson combined with a learn-to-bake class. Because what is dough of all kinds other than a chemical reaction?

Salk is a magnet school that ties all its curriculum, even physical education to STEM learning. It can be challenging, in a fun way, and eye-opening for the students, says Teri Ann Flatland, the curriculum integration coordinator. She also teaches seventh grade Engilsh.

HOLDING UP THE MIDDLE

NEW PROGRAMS KEEP STEM EDUCATION IN FOCUS FOR STUDENTS BETWEEN ELEMENTARY AND HIGH SCHOOL.

BY JEAN THILMANY

Take seventh grader Sadhika Prabhu. When she was in fourth grade at Weaver Lake Elementary in the Minneapolis suburb of Maple Grove, she was already thinking about middle school. As the daughter of a medical doctor and a computer engineer, she had always loved science, technology, engineering, and math classes, often referred to as STEM. The problem was—as it is for many students throughout the U.S.—carrying the STEM emphasis over into middle school can be difficult, as not many schools at that level emphasize that type of learning.

When it was time for sixth grade, Prabhu moved to Salk Middle School to take advantage of a recently inaugurated STEM magnet program.

Magnet schools are public schools that tie curriculum to a certain theme: in Salk's case science, technology, engineering, and math. The schools offer choice to a diverse population by drawing interested students from surrounding districts, Flatland said.

"If I wanted STEM to continue, I knew Salk was a good idea," Prabhu said. She rides the bus about one hour to get to school each day, but doesn't begrudge the journey.

Chemistry of cupcakes The Girls in Engineering, Math, and Science club at Salk learns about chemical reactions that take place during baking, above. Below, club members test what they've learned by baking cupcakes.

"I'M THINKING OF BECOMING A BIOMEDICAL ENGINEER SO I CAN MAKE INVENTIONS THAT HELP PEOPLE."

"I'm thinking of becoming a biomedical engineer so I can make inventions to help people," Prabhu said. If that doesn't happen, she says engineering is still likely in her future, as she really loves it.

Milan Dau is also in seventh grade. She's always been good at math and has plans to become a pharmacist to create medications to help people.

"My parents thought that a good junior high with a good magnet program would build the foundation for high school and college and help me with tests further down the road," she said.

Elk River, Minn., home to Salk Middle School, is about 30 miles up the Mississippi River from Minneapolis.

Science Fairgrounds All Salk students participate in the annual science fair, which can take on the appearance of a technical conference poster session.

ANSWERING A CALL

Salk is one of about 40 STEM programs in schools across Minnesota. The STEM initiatives are spreading nationwide, spurred by an increased call for science and math skills, and pressure to fill a future job market that is expected to be short of engineers and science-savvy workers.

But not many middle schools across the nation have embraced the STEM trend, and that can be hard for students who don't want to lose that focus between elementary and high school, Flatland said.

Salk kicked off its magnet program in the 2007 school year. That first year, only a cluster of students within the school took the STEM curriculum. It hadn't yet been opened up to the whole school, Flatland said.

Students from eight surrounding school districts could apply to be part of the STEM cluster and they were selected by lottery. Students within Salk's district still automatically attend the school, because it's one of their district middle schools.

In the 2010 school year, Salk opened its STEM program, and now all its students follow the STEM curriculum.

"The cluster was doing so well we wanted to open up the program-

After-school club Milan Dau, left, and Sadhika Prabhu work on their science fair project during a Girls in Engineering, Math, and Science meeting.

ming for everyone," Flatland said.

The first year saw a greater percentage of boys apply than girls, Flatland said. To remedy that, Flatland and her team started a club called Girls in Engineering, Math, and Science (GEMS), hired more female teachers, and began advertising to reach girls in the surrounding districts. Now the numbers are fairly balanced; the 859 student population is 51 percent boys and 49 percent girls, Flatland said.

Dau, Prabhu, and Flatland say Salk Middle School isn't some kind of anomaly where every activity centers around engineering or science.

"There's been lots of big changes at this school, but it's really still just a normal school with a yearbook and English classes and after-school clubs," Flatland said.

Of course, GEMS is one of those after-school clubs. A University of Minnesota food scientist recently came to a GEMS meeting to talk about genetics, including the DNA of a strawberry.

And, like most middle schools, you'll find students working on their science fair projects after school. At Salk, those projects can center on building robots, helmet safety, or dissolving pills.

CRUCIAL TIMING

According to Flatland, middle school is the perfect time to emphasize STEM, as students of that age are particularly eager and ready for science, technology, engineering, and math classes.

"All our projects are inquiry based, which is also how kids learn independent skills and learn to communicate," she said. "That's how critical learning happens in middle school. They identify questions, find answers, and collaborate. We tell them STEM professionals work just like this."

Salk calls upon the Project Lead the Way curriculum as its main curricular program. Project Lead the Way, based in Indianapolis, is a nonprofit organization that designs STEM education programs for elementary and secondary schools. The activity, project, and problem-based curriculum aligns classes along technology, engineering, design, robotics automation, and other STEM

Distinguished guest Minnesota Senator Al Franken meets students during a tour of Salk Middle School..

specialties, Flatland said.

The STEM curriculum touches all classes, no matter how far afield a subject may seem. It's a family life class that teaches cupcake making. Kids in phys ed class pay attention to how their bodies move as they run. Writing an essay in English class involves asking questions, doing research, proposing a hypothesis, testing and analyzing, and drawing a conclusion.

"The students are hearing that same decision-process language in all their classes. All the traditional classes integrate STEM," Flatland said.

Take her own experience. Flatland is a middle school English teacher by training. But she came to the school in 2007 prepared to teach English and help implement the new STEM curriculum.

"Some teachers think you can't do English and STEM at the same time, but I wanted to prove it could be done," she said. "For English, we research by reading nonfiction books related to science. Then, of course, the writing process aligns directly with the scientific decision-making process: brainstorming, writing, revising, and prototyping."

In Flatland's English classes, students identify a problem or idea to write about, make a prototype by writing a first draft, test it by reading it back through, and redesign it by editing.

Space Camp Every other year, students at Salk take a field trip that makes several stops and includes activities at the Space Center in Huntsville, Ala..

For a science fair project, students might see if they can walk and read at the same time. Dau is excited about the prospect of building and programming robots for the science fair next year. The programming is reserved for eighth graders, which makes it highly anticipated.

National Engineers Week, held the third full week of February, is a big deal at the school. "It's not lecturing. It's hands on and it mixes technology," Flatland said. Two years ago, the Solar Tiny House, created by the Minnesota Renewable Energy Society, spent a week at the school. Students toured the house to learn more about how solar power heats a home.

Students also have a hand in choosing the technology they use. They investigate options, with an eye on how software will improve learning. They're

SPECIAL PROGRAMMING

The number of U.S. STEM middle school magnets grows every year thanks in part to a curriculum from Project Lead the Way. Another explanation for growth in this sector is "because middle school is this funky level," said Scott Thomas, executive director of Magnet Schools of America, an advocacy organization in Washington, D.C.

STEM EDUCATION FROM KINDERGARTEN THROUGH HIGH SCHOOL ISN'T A TREND.

MSA sees great interest in the STEM middle school magnet, an age range often neglected by past programs. School leaders now realize STEM education shouldn't lag in those middle years, and that junior high curriculum needs a special focus, Thomas said.

"A lot of elementary STEM magnates are getting kids interested. And high school STEMs are more like career techs in that they specialize in health care or biotech or computer science. They split it up more," he said.

Fourteen years ago, Project Lead the Way Inc. of Indianapolis developed Gateway, a specialized STEM middle school curriculum. For the 2013-2014 school year, about 2,100 U.S. schools used the curriculum, made up of eight nine-week units. Schools that use the curriculum are required to implement the design and modeling and the automation and robotics units. They can then choose among other units, said Jennifer Cahill,

also looking at whether a computer program is just temporarily popular with kids or touted in education circles and isn't particularly useful, Flatland said.

"We talk about this stuff with kids, 'What is the benefits of this program over this one?' " she said. "So Google Docs can be used across the school with teachers and we can communicate with the family with it."

Annual field trips touch on many aspects of engineering and science, Flatland said. Space Camp, which happens every other year, alternates with a trip to Washington, D.C., to check out science and engineering marvels close up. In the nation's capital, students visit the Smithsonian National Air and Space Museum, the Smithsonian National Museum of Natural History, the Natural Museum of American History, and the Washington Monument. They are continuing research that began in the classroom on specific science and engineering subjects found in the museums and monuments.

This year Space Camp happens over a whirlwind five days in June and includes a stop at the Gateway Arch in St. Louis, then the Huntsville, Ala., Space Center, Mammoth Cave National Park in Kentucky, and the Shedd Aquarium in Chicago.

Exploring the capital Field trips to Washington include the science museums of the Smithsonian Institution and other sights. Here, teacher Ron Hustvedt and student Sam Kirscht take a pencil rubbing from the wall at the Vietnam Veterans Memorial.

Because the middle school kids are in their early teens and because the Salk magnet program is only a few years old, there is no information on how many students will go on to make a career within the STEM professions. Many students will try to enter Blaine High School, a STEM magnet in a nearby district. Entry to the program is also lottery based.

Prabhu and Dau both hope to go to Blaine High School and then on to college and their chosen careers. But meanwhile, they're distracted by something much more pressing, the colorful and sweet cupcakes they helped bake. ME

JEAN THILMANY is an associate editor of *Mechanical Engineering*.

senior director of media.

Students in junior high already involved in STEM subjects need additional exposure to math, science, and engineering before high school, said Cathy Kindem, coordinator of innovative educational programs in Minnesota's School District 196. Her district includes a STEM elementary, middle, and high school.

Gateway middle school units focus on engineering design, sustainable energy solutions, aeronautics, astronautics, and green architecture, said Cahill. All units tie into the high-school curriculum available through Project Lead the Way, she added.

Salk Middle School uses the Gateway units and incorporates STEM programming into the other subjects such as English and physical education, said Teri Ann Flatland, curriculum integration coordinator.

STEM education from kindergarten through high school isn't a trend, said Cahill. With that in mind, Project Lead the Way launched a kindergarten to fifth grade curriculum program, being tested in the 2013–2014 school year. It will be fully implemented in the upcoming year, when the curriculum will be available for students in kindergarten through high school.

"We believe it's critical for students as early as preschool and kindergarten to get involved in STEM education," Cahill said. Studies show students, especially girls, make decisions about STEM as early as third grade. "Unfortunately, those decisions are 'I'm not good at math,' or 'science isn't for me.'"

Students exposed early to a STEM curriculum often follow it through high school. The growth in middle school programs lets them do just that, Cahill said. ■

Project Lead the Way, which has developed STEM education programs for middle and high schools, has added a curriculum for kindergarten through fifth grade.

Online learning opens a path from the technical to the technological.

By Tom Gibson

About 15 years ago, Todd Torrence worked at Pratt & Whitney Space Propulsion in San Jose, Calif., as a technician, performing nondestructive testing on solid rocket motors and related components. He worked on such notable programs as the Minuteman missile, Space Shuttle booster separation motors, and global missile defense.

He caught the engineering bug.

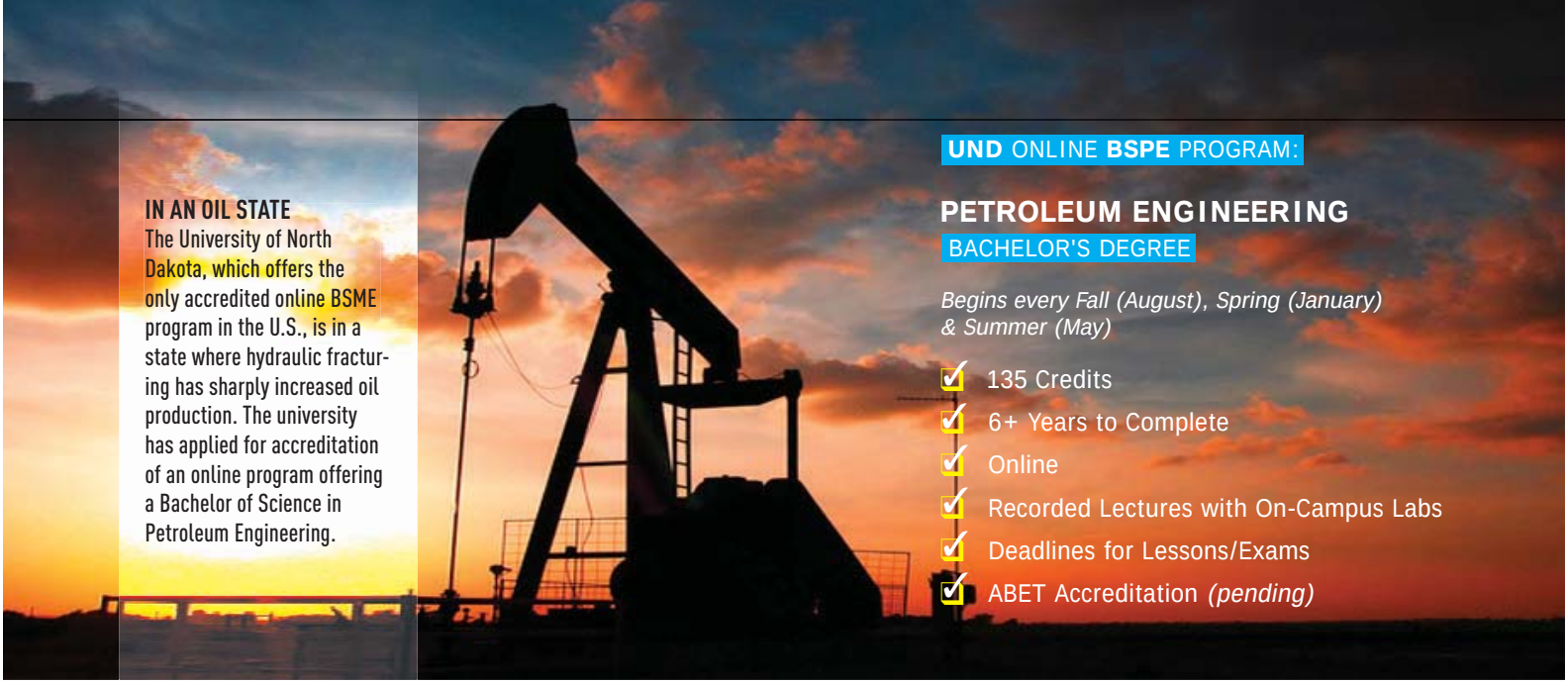
"I worked a lot with the engineers on failure investigations," Torrence recalls. "I learned what an engineer actually does, and that sounded pretty interesting to me. I liked the technical end, problem solving, and learning how things work."

Torrence had an associate degree in nondestructive evaluation from Moraine Valley, a community college near his home town of Chicago. He decided to pursue his mechanical engineering degree in 2002. He started taking classes in subjects such as statics at local community colleges, but then the San Jose facility closed, throwing him and many others out of work.

He decided to return to the Chicago area and applied for a job as an engineering technician at a Rockford, Ill., plant of Hamilton Sundstrand, a sister company to Pratt & Whitney, owned by United Technologies. At that point, he was in his 30s and had a couple of years of engineering school. "It was enough to get in on the bottom engineering rung at Hamilton Sundstrand," Torrence says.

Engineers in the Distance

distance learning



IN AN OIL STATE
The University of North Dakota, which offers the only accredited online BSME program in the U.S., is in a state where hydraulic fracturing has sharply increased oil production. The university has applied for accreditation of an online program offering a Bachelor of Science in Petroleum Engineering.

UND ONLINE **BSPE** PROGRAM:

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He wanted to continue pursuing a Bachelor of Science in Mechanical Engineering, but the courses were only available through traditional four-year schools, and their classes met during the day, when he needed to work.

"I went online and Googled 'online engineering bachelor degrees,' " Torrence says. "Really, the University of North Dakota was the only option I found that was an accredited school." He started there in 2006.

Torrence became part of a new trend in distance learning in which engineers increasingly take courses and complete degree programs online.

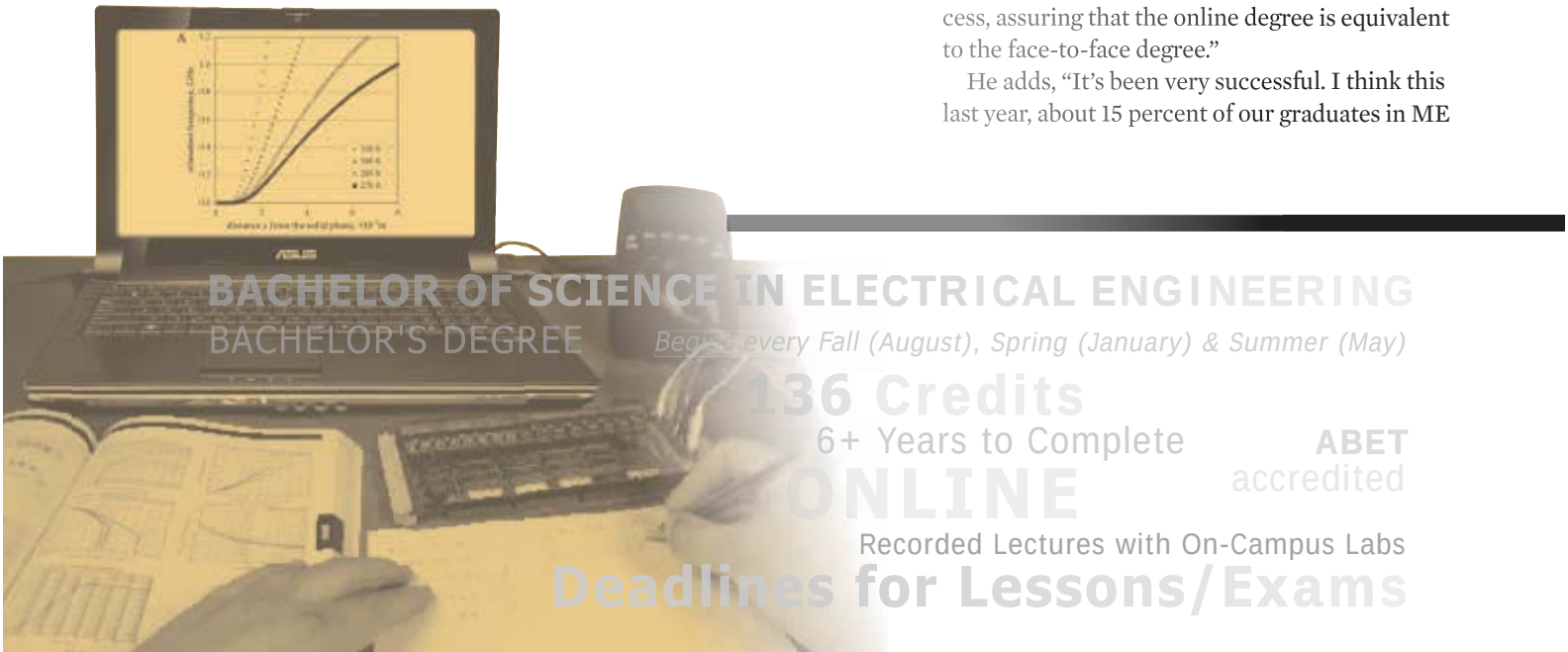
Leonard Bohman, associate dean of academic affairs in Michigan Tech University's College of Engineering, says, "I think it's growing, especially at the master's level because there is a demand for people to understand more complex engineering activities. Their employers see the need for them to get more education, and not all companies are within a reasonable commuting distance to a university that has an engineering program."

Indeed, many engineering colleges around the country offer online graduate-level programs, often in specialized areas. Michigan Tech offers M.S. and Ph.D. degrees in mechanical engineering, an M.S. in electrical engineering, graduate programs in hybrid electric drive vehicle engineering, and certificates in electric power engineering. At North Carolina State University, the College of Engineering's distance engineering division, known as Engineering Online, offers master's degrees in aerospace, chemical, civil, computer, electrical, environmental, industrial, mechanical, nuclear, and nano engineering, and integrated manufacturing systems, and materials science.

But the University of North Dakota offers the only accredited undergraduate mechanical engineering program in the country.

The UND online BSME program covers the same material as its on-campus counterpart. According to Matt Cavalli, assistant dean for outreach and recruiting in the College of Engineering and Mines, "That's part of the accreditation process, assuring that the online degree is equivalent to the face-to-face degree."

He adds, "It's been very successful. I think this last year, about 15 percent of our graduates in ME



BACHELOR OF SCIENCE IN ELECTRICAL ENGINEERING
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were distance students, and that percentage continues to increase." UND's Online and Distance Education division also offers bachelor's degrees in civil, chemical, electrical, and petroleum engineering as well as certificates and courses in a host of subjects.

A small number of other undergraduate distance engineering programs exist around the country. Arizona State University offers online Bachelor of Science in engineering degrees in electrical engineering, engineering management, and software engineering through its Ira A. Fulton Schools of Engineering.

North Carolina State has a 2+2 program where a student can go to a partnering university at the east and west ends of the state for the first two years of their undergraduate work. They attend classes in brick-and-mortar locations but view lectures delivered from the main campus in Raleigh through technologies such as streaming media and video conferencing. Then after two years, they can transfer to the main campus or continue on the distance format for two more years. In Asheville, the school offers a BSE with a concentration in mechatronics, and Havelock has a similar program in mechanical systems engineering.

So why so few undergraduate online degree programs? "The difficulty is providing labs," Bohman says. "For our graduate degree programs, most people are working, and they get the experience at their companies. We haven't found a way to give the hands-on experience online."

Actually, Michigan Tech once offered an undergrad BSE program through General Motors. It had more of a manufacturing flavor than a pure mechanical engineering degree, and it was geared toward GM people. Located in the Upper Peninsula about 500 miles away from the center of GM activity in Detroit, the school could handle the lab conundrum because it was dealing with students concentrated in a geographic area. The school conducted labs using facilities in the area and running programs on weekends or over a weeklong period. It used GM facilities and contracted with other universities.

Another challenge with undergrad online engineering programs is their sheer size and the time it takes to complete them, as compared with graduate programs. UND's BSME degree consists of 129 credits. Cavalli explains, "The time to graduation for a distance student is typically much longer than for an on-campus student because they're

https://www.google.com/search?q=online+undergraduate+engineering

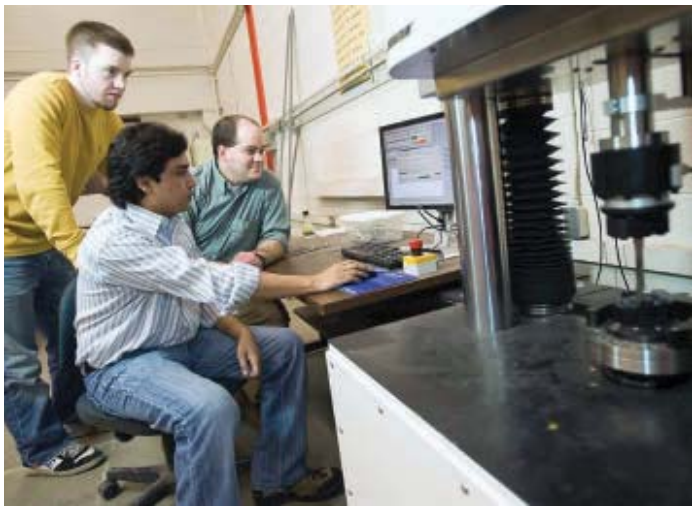
online undergraduate engineering degree

So why so few undergraduate online degree programs?

The difficulty is providing labs.

Most of those enrolled in graduate degree programs are employed, and get the experience at their companies.

Universities have not yet found a way to give the hands-on experience online.



LABS FOR ONLINE STUDENTS The University of North Dakota offers undergraduate labs to online students in the summer. According to Matt Cavalli (seated right), assistant dean for outreach and recruiting, that helps students manage time and expense, and it still provides "an equivalent hands-on experience compared to the on-campus students."

The University of North Dakota online BSME program covers the same material as its on-campus counterpart.

Part of the accreditation process is assuring that the online degree is equivalent to the face-to-face degree.

taking maybe two classes a semester on average as opposed to five to six classes for an on-campus student. And some of them will take a semester off because of job and family commitments."

For UND's online classes that have labs, the students typically come to campus for a week in the summer for each lab. Cavalli notes, "We think we've found a good balance between the time and expense for students to come to campus and making sure they get an equivalent hands-on experience compared to the on-campus students." Torrence made the trip to the University of North Dakota in Grand Forks three times and labels the experience as intense and stressful. "You're essentially doing everything students on campus did over the whole semester in a week," he says.

As for the classes, Torrence says he watched the same lectures as the students on campus. A camera in the classroom records the entire session. Students attending online can hear the questions that students ask, hear the teacher, and see what the instructor is presenting.

"I like that because if I didn't understand something, I could always go back and listen to the lecture online again," Torrence says. "We would do the same homework as required on campus. We took the same tests at essentially the same time. It was almost like being there. The only thing I think you miss is the interaction with the instructor during the class."

Although taking the undergrad online BSME route had its challenges, Torrence now reflects favorably on it. "It was great because I was able to work full time during the day, and I would get home and do all the classwork and homework and take tests," he says. It took until 2012 to get his BSME. "It was six years, but I probably could've done it in four."

Torrence typifies the breed of online engineering student that has evolved. They are older, more motivated, and well versed in time management.

Linda Krute, director of distance education

Students enrolled online watch the same lectures as the students on campus. A camera in the classroom records the entire session. Students attending online can hear the questions that students ask, hear the teacher, and see what the instructor is presenting.

programs for the College of Engineering at North Carolina State, says, "For working professionals that can't come to a college campus because of work, family responsibilities, or geographic constraints, the online programs are very valuable. For a young person coming out of high school, I still believe they need the on-campus experience of bonding with other students."

As another factor in the equation, it costs more to get an online engineering degree than it does the on-campus variety. According to Cavalli at UND, "There's an additional fee associated with the online courses for things like the technology and the additional support staff needed. Many students have support from their employers for the cost of the education. Particularly for students paying out of pocket, costs can be a significant issue."

However, on the plus side, some people argue that students learn unique skills through online programs that they might not get otherwise. Blake Haggerty, director of the technical support center and assistant director for instructional design at the New Jersey Institute of Technology, says, "It gives the students hands-on experience using the types of tools they're going to use in the workplace."

His colleague Gale Spak, associate vice president of continuing and distance education at NJIT, explains, "We're in an emerging, evolving global economy. Every engineering firm has global projects, and companies have offices around the world. If you're going to succeed in the company as an engineer, you work in teams and in different time zones. These are key attributes of online learning." She adds that employers look for these skills, and students have begun to request that it be noted on their transcript that they did their degree work online.

Beyond students, engineering schools benefit in several ways from offer-

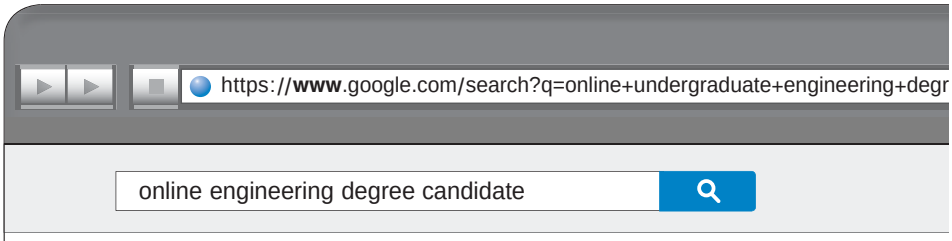
ing online programs as well. Cavalli says, "It allows us to educate a larger number of students than would fit in our classes or we have in our immediate geographic area. The majority of our on-campus students are from North Dakota and Minnesota. Our distance students are from all over the country and around the world, so we get different perspectives, and our on-campus students are exposed to those as well through career presentations and team collaborations. So it gives us some additional diversity, and it also gives us access to different employers and industries that might not have a presence in Grand Forks. In general, it expands our presence significantly beyond our geographic location."

Meanwhile, Todd Torrence reports, "Since I've gotten my degree, the company has pushed me into more design and development of new programs and products." At Hamilton Sundstrand, he works in the space systems enterprise focusing on turbomachinery, actuation, and thrust vector control for missile and space applications.

As an engineering technician, he mostly worked on existing products that had already been proven in the field and qualified. Currently, he's designing a fuel manifold for a torpedo engine and developing an electromechanical actuator for control of a rocket or missile, essentially starting from scratch.

Torrence says of his experience getting a BSME degree online: "I would definitely recommend it, especially for someone in my situation, where there's no other way to work full time and also get a four-year degree. Distance is the only way to do it. You just have to keep up on the lectures, watch the classes, do the homework, and put the work into it." ME

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

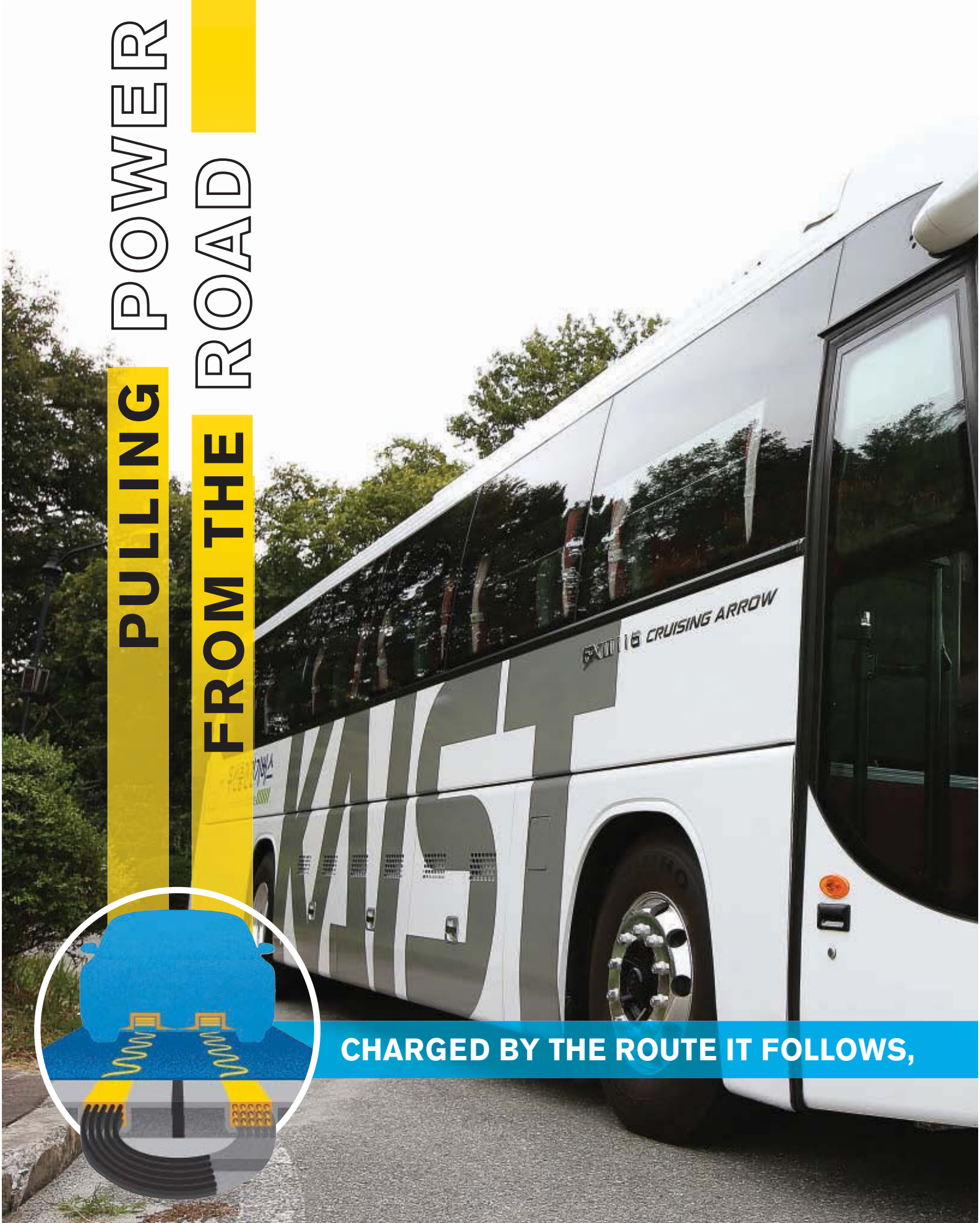


The typical online engineering student is older, more motivated, and skilled at time management.

A young person out of high school needs the on-campus experience of bonding with other students.

But for working professionals that can't come to a college campus because of work, family responsibilities, or geographic constraints, the online programs are very valuable.

PULLING POWER FROM THE ROAD



CHARGED BY THE ROUTE IT FOLLOWS,

when

an electric toothbrush recharges, it sits on a little pedestal. The pedestal is plugged in, but the brush isn't. An electromagnetic connection takes the place of a wired connection. So imagine the toothbrush is a bus, and it doesn't sit on a pedestal, but rides 10 inches above the road. A team in Korea has proved not only that the bus can recharge without wires, but unlike the toothbrush, the bus can carry passengers.

Two new buses were put to work last August on a 15-mile route in Gumi City, an industrial center 150 miles from Seoul. The buses are all-electric, not hybrid, and they do not need to plug in for a recharge. Instead, they periodically drive over cables buried in the roadway along their route.

The charging technology is called "shaped magnetic field in resonance," or SMFIR. It was developed by a team of engineers and technologists at the Korea Advanced Institute for Science and Technology. The work was funded by three South Korean government ministries to reduce air pollution and greenhouse gas emissions from vehicles in urban areas.

The concept is called on-line electric vehicles, and the heart of OLEV technology is the transfer of enough electricity across

WIRELESS RIDE An all-electric bus developed in Korea recharges its battery when it travels over electric coils buried at intervals along its route. After a tryout at Korea Advanced Institute of Science and Technology, where the system was designed, it has entered passenger service in Gumi City.

AN ELECTRIC BUS GETS A REAL WORLD TEST. BY JACK THORNTON

gaps of up to 10 inches to power a fully loaded bus. Specifically, underground cables transfer power from the electrical grid to drive motors and on-board batteries via pickups beneath the OLEV bus bodies. In Gumi City, the six sets of power cables total roughly 160 yards in length, a tiny fraction of the 15-mile bus route. The total length of the underground cables varies inversely with the size of the on-board battery; the smaller the battery, the more cable recharge sections.

The technology was installed by Dongwon OLEV, a licensee of the Korean institute. Dongwon, a South Korean industrial conglomerate, focuses on green technologies.

According to Nam Pyo Suh, an ASME Fellow and professor of mechanical engineering at the Massachusetts Institute of Technology who was part of the development team, the Gumi City buses cost the equivalent of $73,900 each. Infrastructure costs were $235,790 per kilometer of the bus route.

"Some published projections by skeptics make this technology seem too expensive," Suh said. "Their numbers weren't up to date."

On-line recharging of electrically powered vehicles was pioneered in 2009 on a 1.4-mile route at a large amusement park in Seoul. Since 2010, regular OLEV buses have been running on a 2.4-mile route at the Korean technology institute campus in Daejeon, where they replaced diesel-powered buses. The Gumi City installation is the largest trial to date.

The project that developed the SMFIR system was led by Dong-Ho Cho, a vice president of the Korea Advanced Institute and a professor of communications engineering. The project teams included about 100 people from academia and industry.

Shaped magnetic field in resonance transfers power to via magnetic fields that are generated by underground power cables. In wireless power transfers, the electrical field between the magnetic poles is shaped to reach a pickup unit underneath the vehicle. This shaping accommodates any differences in the gaps between the buses' pickups and the pavement, Suh said.

In Gumi City, power cables are needed beneath just one percent of the buses' routes. For the rest of the distance traveled, an on-board battery supplies power. Suh said that the batteries in the Gumi City buses are typically less than one-fifth the size of those needed in battery-powered electric buses, which helps minimize the OLEV's overall cost.

Lithium-ion batteries are a major reason why battery-powered electric vehicles cost twice as much as comparable vehicles powered solely by an internal combustion engine. Regenerative braking also recharges on-board batteries. Over 180 patent applications have been filed.

SMFIR transfers rely on electromagnetic field resonance rather than inductive coupling, Suh said. In SMFIR technology, the sending unit and the vehicle receiver resonate at 20,000 hertz. According to Suh, the frequency was chosen to maximize power transfer efficiency. Some kitchen appliances use similar frequencies.

CHARGING STATIONS Six recharging sections occupy 160 yards in a 15-mile bus route. The system can transfer energy at a rate of 100 kW, its designers say.

"MANY TRADITIONAL POWER ENGINEERS AND MOST ELECTRONICS ENGINEERS ASSERTED IT WOULD BE IMPOSSIBLE TO WIRELESSLY TRANSFER THAT MUCH POWER."

POWER FROM BELOW An electric coil, left, under the road surface generates a magnetic field that is converted to recharge a lithium-ion battery that powers the bus.

Conventional wireless power transfer has been limited to very low wattages for smartphones and similar portable electronics devices. The widely used Qi interoperability standard, developed by the Wireless Power Consortium, can transfer small amounts of electricity up to thirty feet.

Because of the potential dangers of electromagnetic radiation, engineers sought and won Korean government approvals on all aspects of OLEV operations, including power levels and system frequency.

"Months of testing at government laboratories preceded the installation of the underground power systems," said Suh. "Approvals of the relevant government agencies verify that power transfers will not interfere with medical devices such as heart pacemakers. As one of many Gumi City safety features, only an OLEV bus can activate power transfers."

SMFIR technology is a straightforward way of transferring large amounts of electrical power across gaps. According to Suh, the technology could replace the direct, continuous contact forms of power transfer— third rails and overhead power cables— used my mass transit systems worldwide. Third rails can cause severe shock and even electrocution, and can be disrupted by heavy snowfalls. Overhead power cables limit vehicle speed and are subject to electrical shorts during high winds.

Conventional wireless transfers can power a cellphone or a toothbrush for a few days. But phones and toothbrushes need minuscule fractions of the power needed by a bus carrying 40 or 50 people. According to Suh, "Many traditional power engineers and most electronics engineers asserted it

would be impossible to wirelessly transfer that much power."

The system can transfer energy at a rate of 100 kilowatts of electricity and will charge a battery whether the bus is moving or still.

According to Suh, "The underground power system is designed considering the number of stops the bus makes at bus stations to take and discharge passengers, the number of signal lights, slope of the road, etc. For example, at a bus station where they load passengers and discharge passengers, the bus may stay there one or two minutes. At signal lights, it may stay two or three minutes to wait for the light to change. The length of the underground power system is a function of the speed. If the speed increases, the length of the underground power system must be longer.

"We considered all these factors and designed the underground power supply system," Suh said. "We designed so that the electric charge of the battery on board of the vehicle comes back to its original state when it makes a complete round. That is, if the bus starts out with a 50 percent charge, it fluctuates about this 50 percent level over the course of its operation, but when the bus returns to the original starting station, the charge on the battery returns to the original level of 50 percent when the bus leaves the station. The bus drivers do not worry about the power supply, they simply and literally drive.

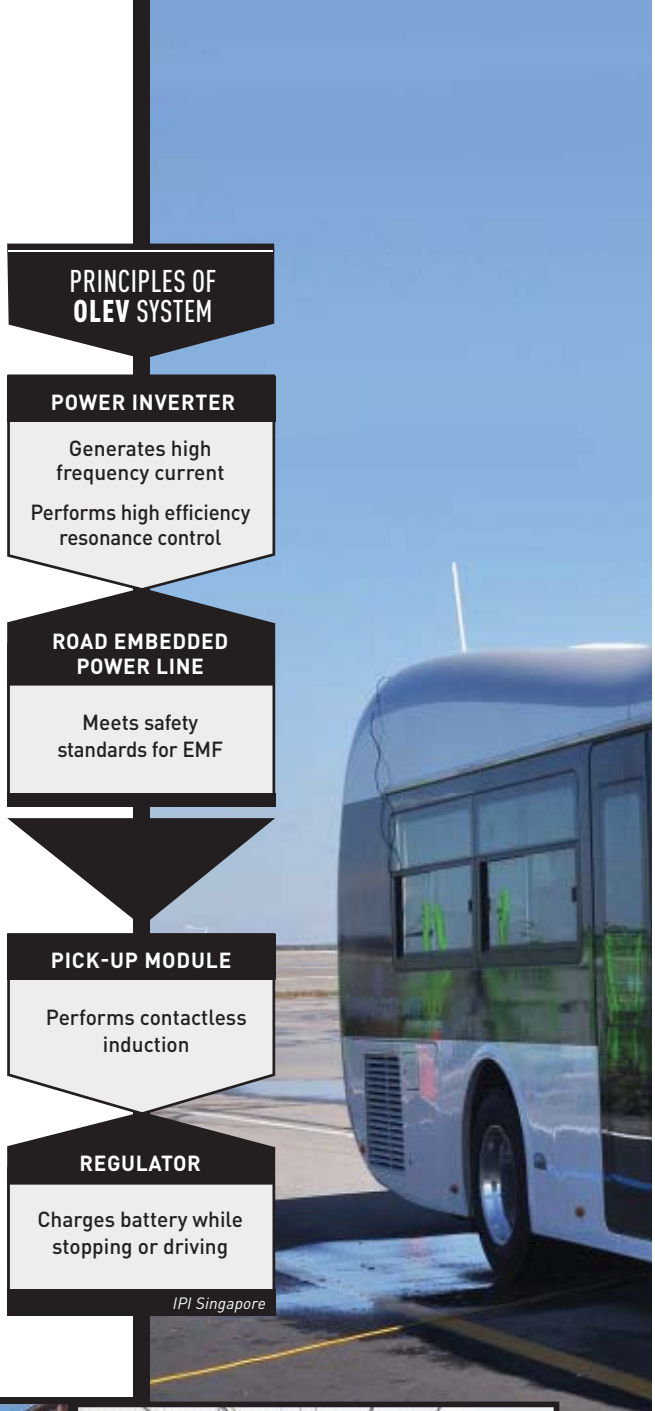
The energy transfer spans air gaps of up to seven inches between electrical contacts. "Many knowledgeable engineers said it would be impossible to transfer a significant amount of power across air gaps of more than two centimeters," Suh said. The system works more efficiently than its developers had expected. It transfers up to 85 percent of the available power; initial efficiency targets were 60 percent.

The Gumi City buses—initially two with 10 to be added by 2015—are of carbon-fiber engineered-composite construction. And because they weigh less than the steel or aluminum of mass transit workhorses, they consume less power.

The developers have their sights on international markets. A U.S. licensee, OLEV Technologies Inc. based in North Reading , Mass., is marketing the system in the United States.

There is competition, however. A research team at Utah State University and a company called WAVE Inc. are pursuing SMFIR technology independently of the Korean institute and Dongwon; they have a prototype known as the Aggie bus.

"Trains, trams and taxis are the next obvious SMFIR candidates and, eventually, passenger cars," Suh said. "If about ten percent of the roadways have underground power supplies, passenger cars in major cities can use SMFIR technology without fuel pumps or charging stations."



IPI Singapore

EXPANDING SCOPE The OLEV system has been tested in passenger service in a city and, near left, at a park near Seoul. An electronic panel displays the state of charge, battery pickup rate, and other key information about the vehicle. A licensee is marketing the system in the United States.

He calculates that if all South Korean urban transportation used SMFIR, the nation would need four more 1,000-megawatt nuclear power plants to supply the electricity. South Korea's existing nuclear power plants (23 reactors total) provide for nearly half of the nation's electrical consumption; South Korea has almost no fossil-fuel resources of its own.

"Transportation of all sorts is a big contributor to the world's many environmental problems," Suh said. "The world will be so much better with SMFIR vehicles and we will have the possibility of minimizing the global warming." ME

JACK THORNTON, a contributing writer to the magazine, is based in Santa Fe, N.M.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GLOBAL GAS Turbine NEWS
Volume 53, No. 6 • April 2014
ATLANTA, GA, USA — ASME INTERNATIONAL GAS TURBINE INSTITUTE

ASME Turbo Expo 2014 in Düsseldorf, Germany

Technology reduces life cycle cost

In this issue

JOIN MORE THAN 2500 PROFESSIONALS from over 50 countries for ASME Turbo Expo 2014 – a premier 5-day technical conference and a 3-day, premium exhibition of turbine products and services supported by leading companies in the industry, such as GE, ANSYS, CD-adapco, and Pratt & Whitney. This year Turbo Expo is being held June 16-20 at the CCD Congress Center – Düsseldorf, Germany. Register today at www.turboexpo.org. Early registration discount ends May 9. Also, in celebration of our early Sunday registration hours at Turbo Expo, there will be a Registration Feier. Come join us on Sunday, June 15th at the CCD Congress Center as we enjoy German music, pretzels and beer from 12:00 - 3:00 pm. Registration will close at 6:00 pm and reopen on Monday, June 16th at 7:00 am.

Why you should go to Düsseldorf

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- *Targeted Leads*
- *Focused Training*
- *High ROI*
- *Cutting-Edge Technology*
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- *Practical Application*

Keynote Speakers Announced

Three leading figures in the industry, Dr. Wolfgang Konrad of Siemens AG, Dr. Karsten Mühlenfeld of Rolls-Royce Deutschland, and Charles Soothill of Alstom Switzerland, will speak in the opening keynote session on June 16.

...Continued on p. 55

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A VIEW FROM THE CHAIR

By Karen Thole, Chair, ASME IGTI Board

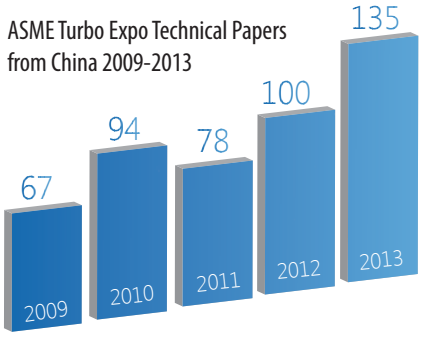
China's Plan for Gas Turbine Research and Development.

Gas turbine research and development is being given a strong push in China with the goal of launching companies into the gas turbine market. For commercial aviation, Aviation Industry Corporation of China (AVIC) Commercial Engine Co., Ltd. is developing China's first indigenous large commercial jet engine. For power generation gas turbine development, three large Chinese power generation companies have teamed up with international partners – Dongfang Electric with Mitsubishi Heavy Industries; Harbin Electric with General Electric Power and Water; and Shanghai Electric with Siemens Energy. Furthermore, AVIC Energy is collaborating with various Chinese research groups to develop a 115-MW utility gas turbine. This push is being backed by the Chinese government who has pledged to support the research and development by investing more than US$17B in the coming years. An appreciable amount of these funds will be awarded to the universities allowing them to build up the needed expertise and infrastructure. Universities such as Tsinghua University, Chinese Academy of Sciences, Beijing University of Aeronautics and Astronautics, Shanghai Jiao Tong University, and Xian Jiao Tong University are quickly responding to such opportunities.

Over the past few years, we have seen an increase in the number of papers submitted to Turbo Expo by China. In 2013, for example, there was a 101% increase in the papers presented from China relative to 2009. Also, Chinese groups are active participants in the Asian Congress on Gas Turbines which was last held in Shanghai in August, 2012 and will be held in Seoul in August 2014. Numerous other conferences and forums have taken place in China in the past few years on gas turbine research and development, including the recent Gas Turbine World China Summit, which was held in Shanghai in October 2013 and the planned China Gas Turbine Focus 2014, which will take place the week following Turbo Expo also in Shanghai.

Shanghai Jiao Tong University is one such university that was quick to set up a center of excellence in gas turbine technology responding to the opportunities to further develop their research in gas turbines. One of the kick-off activities in setting up the center was to hold an inaugural 2014 International Symposium on Gas Turbine Technology. The Symposium involved two academic partners including Penn State and the University of Stuttgart. Also attending were the three large power generation companies including Dongfang Electric, Harbin Electric, and Shanghai Electric. Pictured below are the speaker representatives at the Symposium. Over 80 academics and industry participants attended the two-day Symposium held in the School of Mechanical Engineering at Shanghai Jiao Tong University. These companies clearly indicated a desire and intent to develop their own gas turbines through collaborations with the universities.

With the strong financial support and increasingly large number of talented engineers being educated in China, we can expect that there will soon be new Chinese companies entering the gas turbine market. ❖



Karen Thole
Board Chair

Born in Europe, the Gas Turbine Launched a Global Industry 75 Years Ago

Septimus van der Linden, President BRULIN Associates LLC

"It is appropriate that ASME Turbo Expo 2014 is held in Europe, specifically Düsseldorf, Germany. Whether by coincidence or not, it is a great occasion for the gas turbine industry to reflect on its humble beginnings 75 years ago."

Several significant events for both the industrial and aviation gas turbine industry occurred as the dark clouds of WWII gathered.

The first utility gas turbine to generate electricity was developed by Brown Boveri and installed in the town of Neuchâtel, Switzerland 75 years ago. On July 7th, 1939, it was full power tested at 4 MW in Baden, Switzerland. Key to this engineering breakthrough was the successful demonstration of an efficient axial compressor developed by Claude Seippel of BBC. Turbo-compressors were the early forerunners of several applications, specifically the Houdry process in refineries. Some years later, development of the axial compressor brought success to the aviation gas turbines that crowd the skies today.

Interestingly, the first gas turbine flight also took place in 1939. On August 27th, a Heinkel He 178 aircraft, powered by a Turbojet using Hans von Ohain's radial compressor design, made its maiden flight from Rostock-Marienehe, Germany. Whittle's turbojet design had been turned down in 1930. Three years later, Hans von Ohain, a German engineering student with no knowledge of Whittle's work, wrote a paper proposing a strikingly similar jet engine. The first British jet plane, the Gloster, took off in 1941. The German Messerschmitt MW-262 "Deadly Swallow" was the first jet fighter aircraft, claiming 542 Allied kills in WW II.

In terms of energy conversion, the gas turbine is relatively new from a historic perspective, being only 75 years young this year. However, the potential of the gas turbine was presented in a technical paper in February, 1939, by Dr. Adolf Meyer, former Director of BBC Brown Boveri, at a meeting of the Institution of Mechanical Engineers in London. It was titled, "The Combustion Gas Turbine: Its History, Development and Prospects." Dr. Meyer concluded that the subject of combustion turbines "...is a promising one, full of interesting possibilities." The author believed these prospects were based on raising the turbine inlet temperature in the near future to 648°C (1,200°F) from 538°C (1,000°F), raising the cycle efficiency (of the Neuchatel machine) from 18% to 23%, representing an improvement of 28%. This possibility was not only realized through further combustion turbine development but exceeded, viz. increasing turbine inlet temperature of 1,010°C -– 1,121°C (1,850°F -2,050°F) and, in modern utility sized units, with 1,260°C (2,300°F) to 1,500°C (2,732°F) firing temp and beyond. In his prescient conclusion, Dr. Meyer foresaw further cycle developments and improvements for the gas turbine as a motive power source for steam driven locomotives and ships, as well as alternatives for wind tunnel drives, blast furnace plants and, finally, a challenge to conventional steam power plants. There, the combustion turbine would be utilized with the recovery of exhaust heat to produce steam for the steam turbine in a combined gas turbine steam plant that would be more economical due to higher efficiencies and lower cost per kilowatt installed. The modern Combined Cycle Plant achieves better than 60 % efficiency and possibilities of 65 % are foreseen as cycle improvements will improve incrementally.

The 4 MW gas turbine municipal power station at Neuchatel, Switzerland, is the 26th International Historic Mechanical Engineering Landmark to be designated and the 8th to be designated outside of the United States. Others are located in England (3), France, West Germany, Australia and China. After 62 years of service, the Neuchatel unit was retired, then relocated and rededicated by the ASME International Historic Mechanical Engineering Landmark Committee in Birr, Switzerland, as a museum exhibit in 2007.

...Continued on p. 55

AS THE TURBINE TURNS...

By Dr. Lee S. Langston, Professor Emeritus of Mechanical Engineering, University of Connecticut

Jet Engine Fuel Burn Reduction Through Boundary Layer Ingestion

Airframe and engine designers strive to achieve "clean" inlet flow conditions for jet engines.

In their frontal engine location, fans and compressors work best with a uniform flow, free of significant total pressure losses. The famous S-shaped inlet duct for the middle engine of Boeing's tri-jet 727 required a lot of engineering attention to minimize inlet distortion for happy engine operation.

However, airline fuel costs have become such a major driving factor, the need for clean inlet flow conditions is being re-evaluated. Using a concept called "boundary layer ingestion" (BLI), airliner designs featuring close-coupled, rear-mounted turbofans are being considered, with a fuselage sculpted to sweep a large part of the fuselage boundary layer into engine inlets for reduced fuel consumption. (Recall that Ludwig Prandtl's boundary layer consists of viscously retarded fluid flow near and in contact with a solid surface, that is a source of aircraft frictional drag.)

With an engine array fuselage-centered, rather than splayed out on wings, reduced rudder control is needed in the event of a single engine outage. This reduces the size of a BLI tail assembly, saving weight and reducing drag.

Just how could the ingestion of the slackened and distorted flow of a boundary layer reduce engine fuel consumption? Given a flight speed of u_0, the average air velocity entering a BLI engine would be $u_1 < u_0$ where the magnitude of u_1 would depend on the extent of the ingested boundary layer. Following a simplified model by Plas [1], consider an idealized one-dimensional flow entering a BLI jet engine at u_1, and leaving the engine nozzle at u_2. The thrust force, T, created by the engine is:

$$T = \dot{m}\,(u_2 - u_1) = \dot{m}\,\Delta u \qquad (1)$$

Figure 1 MIT's Mark Drela (right) and Alejandra Uranga prepare the D8 model for NASA wind tunnel testing. (Aviation Week and Space Technology)

given by the momentum equation in the axial direction for the engine as the control volume. The mass flow of air through the engine is $\dot{m}$ and we have neglected the small effect of fuel flow.

The mechanical power, P, produced by the engine flow is equal to the rate of change of its kinetic energy, given by:

$$P = \frac{\dot{m}}{2}\left(u_2^2 - u_1^2\right) = T\left(\frac{u_1 + u_2}{2}\right) = T\left(u_1 + \frac{\Delta u}{2}\right) \qquad (2)$$

If we assume the BLI engine will have a the same mass flow, $\dot{m}$, and a thrust force, T, as the conventional engine, Δu in (2) will be a constant. A decrease in the average velocity u_1 entering the engine will thus result in a decrease in power P — and consequently the promise of reduced engine fuel consumption.

In a paper on wake ingestion, Smith [2] points out it has been long known in the field of marine propulsion, that ingestion of craft wakes (surface ships, torpedoes or submarines) in a propeller can reduce the propulsive power needed. He points out that Albert Betz [3] (a student of Prandtl) explains that with wake ingestion the power expended can actually be less than the product of the forward speed and craft drag.

Recently, an Aviation Week and Space Technology article [4] highlights research going on at Massachusetts Institute of Technology (MIT), NASA, Aurora Flight Sciences, Pratt & Whitney and United Technologies Research Center to evaluate BLI.

...Continued on p. 58

Gas Turbine 75th Anniversary

...Continued from p. 53

Originally designated in 1988, the Gas Turbine was still in operation. It remained in service until 2002 when it was retired. In 2005, ALSTOM, a successor company to Brown Boveri—the original manufacturer—decided to preserve and restore the landmark. ALSTOM acquired the landmark from the owner, Service Industriels de la Ville de Neuchâtel, relocated it to its factory in Birr, Switzerland, restored it and put in on public display in a building especially built to house and preserve the landmark. Re-dedicated 2007

When Brown Boveri was launched in 1891, over 100 years ago, its two founding engineers were Charles E.L. Brown, an English electrical engineer and inventor, and J. Walter D. Boveri, a Bavarian mechanical engineer and an astute businessman. This unique formula would prove to become a dominant force in the success of power generating equipment and set the stage for the modern Global Gas Turbine Industry to be represented by the delegates attending ASME Turbo Expo 2014 in Dusseldorf, Germany, June 16-20, 2014. ❖

ASME IGTI Awards & Keynote

...Continued from p. 51

Monday, June 16, 2014 • 10:15 a.m. – 12:15 p.m.

The program opens with ASME IGTI's annual awards program to honor individuals who have made significant contributions to advance turbine technology and industry. Following the awards program, prominent experts from the turbomachinery industry will address the important keynote theme: *Technology Reduces Life Cycle Cost.*

The life cycle cost of gas turbines, whether for use on land, at sea or in the air, has a direct impact on the profitability of the power plant's operation. The life cycle cost is the sum of all of the recurring costs, such as maintenance, and one-time costs including the cost of acquisition, over the full life span of a gas turbine. Neither category can be ignored in today's economic climate. In aviation, for example, the maintenance costs are typically twice the acquisition cost. Furthermore, with the introduction of total care agreements in all of their forms, such as fly-by-the-hour, original equipment manufacturers now directly experience the impact of items such as in-service maintenance costs. In the keynote session, three leaders of aviation and land based gas turbine OEMs will examine the changes that are occurring in the industry as well as discuss current development needs and the conflicts that can arise in meeting the goal of life cycle cost reduction. ❖

Now in its 59th year, ASME Turbo Expo is recognized as the must attend event for turbomachinery professionals.

Exposition and Sponsorship Opportunities

ASME Turbo Expo delegates represent an impressive array of segments from throughout the turbomachinery community with major influence on developing trends and products. This is your chance to attract new clients, visit with current ones, learn more about the changing needs of the international turbomachinery industry - and ultimately, increase your sales.
Exposition space is available. Contact us today to secure your location on the show floor.

ASME Turbo Expo 2014 Sponsorship Opportunities

Platinum €20,000 Gold €15,000 Silver €10,000 Bronze €5,000

Other sponsorship opportunities are available to meet your budget. Featuring a variety of sponsorship opportunities designed to maximize your company's visibility, the ASME Turbo Expo sponsorship program provides even more ways to stand out from the crowd and make the most of your budget. Plan now to join over 2,500 turbomachinery colleagues from around the world at ASME Turbo Expo, ASME's premier turbine technical conference and exposition, set for June 16-20, 2014, in Düsseldorf, at the CCD Congress Center Düsseldorf ❖

For more information about ASME Turbo Expo, please visit:
http://www.asmeconferences.org/TE2014//

TURBO EXPO
Turbomachinery Technical Conference and Exposition
Presented by ASME International Gas Turbine Institute

Keynote Speakers

Dr. Wolfgang Konrad
Chief Technical Officer
Siemens AG

Charles Soothill
SVP Technology
Alstom Switzerland

Dr. Karsten Mühlenfeld
Director Engineering
Rolls-Royce Deutschland

New Student Poster Session!

ASME International Gas Turbine Institute is announcing the first ever Student Poster Session to take place at ASME Turbo Expo 2014. Undergraduate and graduate/PhD students are invited to participate by submiting a poster for display during Turbo Expo. €500 checks will be awarded to the best poster in the undergraduate student and graduate/PhD student categories. All posters have been reviewed and approved through an abstract submission process.

This poster session is intended to give students opportunities to present work outside of the paper sessions. Therefore, the poster content cannot be work that is in a paper. The abstract deadline for the poster session was March 1st, 2014. For questions regarding the Student Poster Session, contact the Student Advisory Committee (sac.igti@gmail.com).

**Posters are not part of the official conference proceedings.*

Student Mixer

June 18, 2014 • 6:45 – 8:00 p.m.

A special and very popular event for rising engineers! Enjoy complimentary refreshments and network with fellow engineers, including a variety of turbomachinery industry personnel, as well as members of ASME IGTI's Committees.

Student News

ASME IGTI, Atlanta, GA

The Student Advisory Committee (SAC) is gearing up for ASME Turbo Expo 2014 in Düsseldorf, Germany. Last year, the SAC had the task of planning, organizing, and promoting the first ever student committee to operate in conjunction with ASME Turbo Expo. The SAC's hard work from late 2012 through the summer of 2013 paid off at ASME Turbo Expo 2013 in terms of numbers, exposure, and feedback. The 2013 Student Mixer achieved an all-time record attendance, the committee welcomed over 40 student members, and a successful tutorial was held at the inaugural committee meeting. This year the SAC has the task of planning their first international meeting. With the bar having been set high last year in San Antonio, the SAC is focused on creating an even better experience for the students in 2014. Many challenges await the SAC before ASME Turbo Expo 2014, but students and onlookers can be assured that the leaders of the committee are dedicated and eager to produce the most rewarding meeting possible.

The Student Advisory Committee consists of Jacob Snyder (Vice Chair), John McClintic (Secretary), who were both elected at the student committee meeting in San Antonio. Reid Berdanier (Chair) and Amy Mensch (Past Chair), who are two board members from last year, have the advantage of experiencing the process of organizing the student activities at ASME Turbo Expo 2013 in San Antonio. Together, the officers manage the committee, plan the student events, and represent the students before the ASME IGTI Board. The SAC encourages students to participate in the ASME IGTI Student Advisory Committee and will be advertising more details about ASME Turbo Expo 2014 soon. ASME Turbo Expo hosts well over 300 graduate and undergraduate students who present research findings, attend tutorials, visit the exhibition, and network with professionals. ❖

Visit go.asme.org/IGTI for upcoming announcements and official ASME IGTI Student News.

Pre-Conference Workshops

Gas Turbine Component Life Prediction and Life Cycle Management

Saturday, June 14, 2014

This intensive one day workshop offered by Life Prediction Technologies Inc. (LPTi) is designed primarily for mechanical and industrial engineers engaged in the design, operation, maintenance and overhaul of gas turbine engines and other types of turbomachinery. The focus will be on factors affecting the deterioration of engine components and on ways of ensuring the continued safe operation of life-limited components. The modes and rates of damage accumulation, and hence life, are intimately related to operating conditions of engine speed, temperature, and gaseous environment as well as the materials used in component fabrication. The course will enable the attendees to become better acquainted with the life prediction procedures and latest developments in the life cycle management of aging engines.

Earn 7 Professional Development Hours (PDH's) and receive a certificate of completion!

Instructor: Ashok Koul, Ph.D, P.Eng., FASM, Life Prediction Technologies ,Inc.

NEW! Primer on Gas Turbine Power Augmentation

Saturday, June 14, 2014

A comprehensive overview covering analytical, experimental, and practical aspects of the available gas turbine power augmentation technologies including a systematic approach of selecting a suitable power augmentation technology for a given application is provided. Importance of CFD analysis in case of specific technology is included. Case studies of actual implementation of discussed power augmentation technologies and lessons learned from these applications are included in the course. A significance of techno-economic evaluation and weather data analysis while selecting a suitable augmentation technology is discussed using a practical case. Gas turbine manufacturer's activities related to power augmentation technology are discussed.

Earn 7 Professional Development Hours (PDH's) and receive a certificate of completion!

Instructors: Dr. Rakesh Bhargava, Innovative Turbomachinery Technologies Corp.; Dr. Mustapha Chaker, Bechtel Corporation

Wind Turbine Blade: Design, Certification and Simulation

Saturday, June 14, 2014

This workshop will address Wind Turbine Blade Design: Practices, Challenges and Future Developments; Wind Turbine Blade Certification: Walk-through of the IEC 61400 certification process; and Wind Turbine Blade Design and Simulation: Overview of blade design tools and introduction to aeroelastic load simulations and design loads for wind turbine certification. After completing the course, the participants should gain insight and improved knowledge about theoretical approaches employed in aerodynamic design of wind turbine blades;

...Continued on next page

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ASME TURBO EXPO 2014 Pre-Conference Workshops

The 2014 Pre-Conference Workshops will take place from June 14-15 at the CCD Congress Center Düsseldorf.

knowledge about current state of the art in design codes; appreciation of design & operation challenges of current wind turbine aerodynamic designs; and knowledge about the state of research in wind turbine aerodynamic design. Each registered participant will receive, *Wind Turbine Technology: Fundamental Concepts in Wind Turbine Engineering, Second Edition*, a $199 value.

Earn 7 Professional Development Hours (PDH's) and receive a certificate of completion!

Instructors: Dr. George Pechlivanoglou & Dr. Guido Weinzierl, SMART BLADE GmbH

Introduction to Optimization Methods and Tools for Multidisciplinary Design in Turbomachiney

Saturday & Sunday, June 14 & 15, 2014

Modern innovative designs with higher loads and more compact configurations increasingly call for a concurrent design procedure to take into account interactions among multi-components and multi-disciplines at the same time. Innovative optimization methods are now rapidly moving from research labs to industrial real and virtual platforms and intend to provide novel and innovative design solutions in a reduced time to market. This workshop intends to provide the basic concepts and tools behind this technology. After completing the course the participants should have a global understanding of different optimization techniques; understand the adjoint method and differential evolution techniques through industrial relevant applications; understand the technical and non-technical barriers to a routine use of optimization techniques and appreciate why these techniques are important; and identify pitfalls and have notions on how to efficiently parameterize various turbomachinery components through many examples.

Earn 14 Professional Development Hours (PDH's) and receive a certificate of completion!

Instructors: Professor L. He, Oxford University; Dr Shahrokh Shahpa, Rolls-Royce; Dr. Tom Verstraete, Von Karman Institute for Fluid Dynamics

Gas Turbine Aerothermodynamics and Performance Calculations

Saturday & Sunday, June 14 & 15, 2014

This interactive course provides review and reinforcement of relevant thermodynamic and aerodynamic concepts as applied to gas turbine engines, and introduces performance calculation methods of both aircraft engine and power generation gas turbines. The course emphasizes fundamentals which will be helpful for the practicing engineer but is not designed to review industrial practices which are usually proprietary. The acquired knowledge and problem solving opportunity will enhance the participants' ability to excel in various assignments in gas turbine design, development, and application. Participants will work out typical problems in the class during recitation sessions facilitated by the instructor. The course material has been evaluated by the Department of Mechanical and Aerospace Engineering of North Carolina State University. After completing the course the participants should be able to apply aerothermodynamic concepts to the analysis of gas turbine engines; analyze turbomachinery velocity diagrams and relate those to thermodynamic parameters; appreciate the usefulness of the degree of reaction and the radial equilibrium equation; comprehend the discipline of operability and combustor characteristics; analyze cycle analysis problems in class on integrating the component performances to get the overall engine performance. Problems include both aircraft engine and shaft power cycles. With this approach the participants will be able to comprehend: the method of sizing the critical flow path areas at the design point; method of satisfying conservation laws to achieve cycle balance at off-design; technique of the multivariable solver used in cycle models; making models match test data; and the analysis of various engine cycles in the power generation field including hybrid cycles. Special Notation: Participants are required to bring a scientific calculator/ laptop to the class.

Earn 14 Professional Development Hours (PDH's) and receive a certificate of completion!

Instructor: Syed J. Khalid, Chief, Multidisciplinary Functional Integration, Parametric Solutions Inc.

NEW! Metal Temperature Measurement in Turbomachinery

Sunday, June 15, 2014 (please note that this is a ½ day course)

This course is targeted to engineers who have a vested interest in understanding the range of technologies available for temperature measurements in turbomachinery leading to analytical model verification and the relative costs and benefits. Discussions will include temperature measurement in the harsh turbine engine environment with a specific focus on the advantages and challenges of practical applications of a successful but relatively new technology – crystal temperature sensors. Objectives include a general overview of available technologies for metal temperature measurement in real engine conditions, practical considerations for the selection of particular methods, understanding of crystal temperature sensor technology and its applications, shared learning – real life benefits and challenges – based on 10 years of field experience with crystal temperature sensor applications, gap matrix for temperature measurement in turbomachinery based on current needs and coming developments, and potential development directions for crystal temperature sensor technology to meet future challenges.

Earn 3.5 Professional Development Hours (PDH's) and receive a certificate of completion!

Instructors: Anastasia Thomas & Lev Ginzbursky , LG Tech-Link

Gas Turbine Coating Technologies and Applications

Sunday, June 15, 2014

Gas turbines rely on various coatings to improve the functionality and durability of components. In fact many modern gas turbines could not safely operate without the application of specialized coatings. Coating materials, deposition processes, characterization and serviceability will be discussed. Several cases studies will be presented to show the design and analysis in action.

Part 1: Coating concepts and classification

Coating types and functions
Erosion resistant coatings
Sealing enhancement coatings
Wear protection coatings
Oxidation and corrosion resistant coatings
Heat resistant coatings

Part 2: Surface degradation and coating performance

Surface damage mechanisms
Coating performance
Life prediction methods and criteria

Part 3: Application technology

Paints
Conversion coatings
Diffusion coatings (aluminide or modified aluminide coatings)
Thermal spray
Physical vapor deposition
Coating removal and replacement
Quality control and assessment

Earn 7 Professional Development Hours (PDH's) and receive a certificate of completion!

Instructors: Doug Nagy, Liburdi Turbine Services; Xiao Huang, Carleton University

Introduction to Industrial Gas Turbine Operation & Maintenance

Sunday, June 15, 2014

This workshop will familiarize people from all aspects of the academic, manufacturing and after market segments of the gas turbine business on an introductory level. The objective of this training workshop is to improve the student's understanding of problems in class on integrating the component performances to get the overall engine performance. Problems include the starting & operation of gas turbines and the lifetime effects on maintenance & parts replacement.

Earn 7 Professional Development Hours (PDH's) and receive a certificate of completion!

Instructor: Ron Natole, Natole Turbine Enterprises (NTE)

...More Pre-Conference Workshops listed on next page

As the Turbine Turns...

...Continued from p. 54

Late last year, tests were carried out at the NASA 14' x 22' wind tunnel at Langley Research Center, VA. by the BLI team (the first three of the above organizations). Their D8 configuration test model shown in Fig. 1, was designed by Prof. Mark Drela. It departs from the traditional cylindrical tube and wing shape, to provide more fuselage lift with a roughly elliptical cross section. (Current literature frequently refers to it as a "double bubble" shape. As an early bubble experimentalist, I would comment its cross section is similar to a single non-spherical large bubble rising in a liquid, flattened on the bottom and with more curvature on the top.)

The D8 design is aimed at the huge single-aisle, narrow body market, now dominated by the Boeing 737 and Airbus 320 families. Both Boeing and Airbus are projecting [5] this as a two trillion dollar (US) market for the next 20 years, accounting for more than 23,000 airplane deliveries. (Because of its greater fuselage width, the D8 design with twin aisles would modify the market designation.)

The project's principal investigator is MIT's Prof. Edward Greitzer who is also a past chair of the IGTI Board of Directors. Two goals of the test are to validate the BLI benefit and characterize the flow into aft-mounted propulsors. Both BLI and conventionally podded propulsors were tested, using electrically driven fans. The BLI aerodynamic benefit is determined by comparing the mechanical power produced by the fans in each configuration at cruise conditions, defined as zero net force on the model as determined by the wind tunnel force balance. Preliminary data shows promising power savings of 5 to 8 percent for the aerodynamic effects of the D8 integrated configuration [4], with an estimated 18 percent gain including aircraft systems benefits [6].

A near-future goal of the BLI studies is to determine if modern engine front-mounted fans can be designed to operate efficiently and stably under BLI inlet conditions. Stay tuned - I'm sure there will be more to come on the promise of BLI.

1. Plas, Angelique, 2006, "Performance of a Boundary Layer Ingesting Propulsion System", Masters Thesis, MIT, Dept. of Aeronautics and Astronautics, pp. 22-23.

2. Smith, Leroy H, Jr., 1993, "Wake ingestion Propulsion Benefit", AIAA *Journal of Propulsion and Power,* Vol. 9, Jan.-Feb., pp. 74-82.

3. Betz, Albert, 1966, *Introduction to the Theory of Flow Machines*, Pergamon Press, pp. 215-220.

4. Norris, Guy and Warwick, Graham, 2013, "Flush with Potential", *Aviation Week & Space Technology*, Sept. 30, pp. 40-42.

5. Langston, Lee S., 2012, "The Coming Single-Aisle, Narrow-Body Aircraft Bonanza", *Global Gas Turbine News*, February, pp. 53-54.

6. Greitzer, Edward M., 2014, private communication, January 26.

Lee Langston is former editor of the ASME *Journal of Engineering for Gas Turbines and Power* and has served on the ASME IGTI Board as both Chair and Treasurer.

ASME TURBO EXPO 2014 Pre-Conference Workshops

...Continued from preceding page

Nonisentropic Compressible Flows in Gas Turbine Design

Sunday, June 15, 2014

Nonisentropic compressible flows are ubiquitous in gas turbines: in their inlet systems, compressors, combustors, turbines, and the exhaust systems. They are, however, generally counter-intuitive. For example, it defies common sense that the wall friction accelerates a subsonic compressible flow in a constant-area duct with or without heating. This workshop will provide comprehensive review and reinforcement of the key concepts of one-dimensional compressible flows with area change, friction, heat transfer, and rotation. These nonisentropic flows form the basis for the physics-based design of various gas turbine components, particularly in their preliminary/conceptual design phases. After completing the course the participants will develop insight into the basic theory and concepts of isentropic and nonisentropic compressible flows, including the coupled effects of friction, heat transfer, and rotation; will develop a strong foundation in the physics-based design of various gas turbine components; will be more knowledgeable in developing physics-based compressible flow models and applying accurate boundary conditions; will be more knowledgeable in correctly interpreting results of their compressible flow design analyses; will develop skills to hand-calculate compressible flow results to perform sanity-checks of predictions by design tools as well as validate these tools during their development; and will improve their engineering productivity with reduced design cycle time.

Earn 7 Professional Development Hours (PDH's) and receive a certificate of completion!

Instructor: Dr. Bijay (BJ) K. Sultanian, PE, MBA, Siemens

A Primer on Cogeneration/CHP Technologies

Sunday, June 15, 2014

Learn the basics of Cogeneration/CHP (Combined Heat and Power) technologies including various practical considerations and rules of thumb relating to the key topics listed below on technologies currently used and also under development for enhanced performance. Cogeneration/CHP technologies are gaining renewed attention globally as a means of effective utilization of available energy resources.

- Basics of Cogeneration/CHP including important terminologies used
- Currently used Cogeneration/CHP technologies with their advantages and limitations
- Introduction to gas turbines, HRSGs, steam turbines and auxiliaries
- Practical aspects of key components of a Cogeneration /CHP system
- Factors affecting performance of a Cogeneration/CHP system and techno-economic evaluation
- Importance of design, performance, operational, and maintenance issues of HRSG system
- Practical aspects of non-gas turbine based Cogeneration/CHP systems
- Emissions related issues and environmental regulations
- Operational and maintenance considerations
- Case studies of actual systems with applications of discussed analysis methods

Earn 7 Professional Development Hours (PDH's) and receive a certificate of completion!

Instructors: Dr. Rakesh Bhargava, Innovative Turbomachinery Technology Corp,; Cyrus Meher-Homji, P.E., Bechtel Corporation; Manfred Klein, MA Klein & Associates; Steve Ingistov, P.E., Watson Cogeneration Facility

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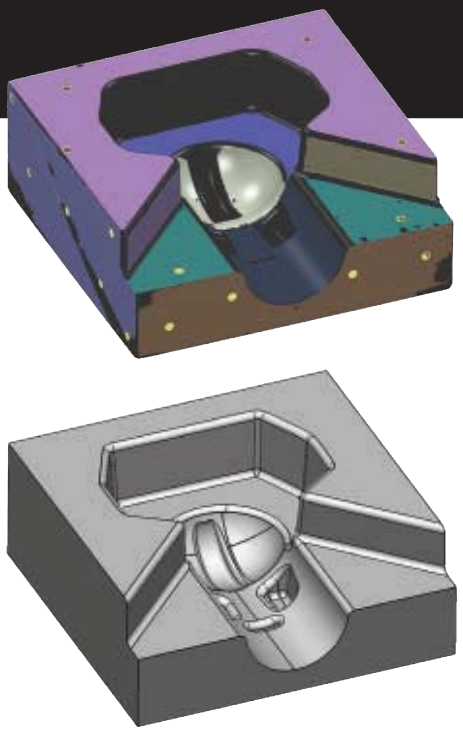
For more information about ASME-IGTI Courses, please visit: http://www.asmeconferences.org/TE2014//

TOOLING DESIGN

DELCAM, SALT LAKE CITY.

POWERSHAPE PRO 2014 RELEASE 2 FOR THE DESIGN OF PRODUCTS and tooling includes tools to make re-engineering complex parts from scanned data faster than was possible in past versions. New automated tools for re-engineering offer a way to segment a mesh of scanned data into primitive regions, such as planes, spheres, cones, and cylinders as well as into revolved or extruded surfaces. Primitive surfaces or solids can then be fitted automatically to those regions. The user has control over fit tolerance when creating the geometry and over the types of primitives to be identified.



PowerShapeE Pro includes automated tools for converting scan data into CAD models. Image: Delcam

ONLINE TESTS AND GRADES

MAPLESOFT, WATERLOO, ONTARIO.

The maker of technical education and research tools has teamed with Desire2Learn of Kitchener, Ontario, a maker of a computerized learning platform, to create Maple T.A. Connector. Desire2Learn users can now use Maple T.A. Connector to create tests and assignments and to assess student responses and performance. Results from Maple T.A. assignments are automatically added to D2L's grade book. All results are kept in a single location.

SEARCH ENGINE FOR DRAWINGS

DOCUPOINT, LOS ALTOS, CALIF.

The latest version of DrawingSearcher, an AutoCAD search engine for CAD drawings, allows users to search across multiple platforms and file types—including the most common types of AutoCAD files. Users can search and access their entire AutoCAD drawing archive based on keywords, search terms, or other parameters. The update, version 2014, includes more file types and is also now supported on most mobile device platforms such as iPad, Android, iPhone, Kindle, and Surface.

PLASTIC PART ANALYSIS

SOLIDWORKS, WALTHAM, MASS.

SolidWorks Plastics Advanced is used to optimize and analyze plastic part designs, including single-cavity, multi-cavity, and family-mold layouts. Users can design injection mold feed systems that include sprues, runners, and gates, and then optimize them for runner size and gate location, and balance the runner systems of family molds. The application can be used to design and analyze injection mold cooling line layouts and predict molded part warpage. This allows users to optimize cooling system design.

SIGNAL INTEGRITY ISSUES

ANSYS, CANONSBURG, PA.

The SIwave is three separate products used to design and optimize high-speed electronic devices. The three products within the newly updated suite—Siwave-DC, SIwave-PI, and SIwave—identify potential power and signal integrity problems within designs. SIwave-DC is for dc analysis of low-voltage, high-current printed circuit boards, and integrated circuit packages. It helps assess the end-to-end voltage margins for reliable power delivery. SIwave-PI includes all SIwave-DC features and adds alternating current analysis to model power delivery networks and noise propagation on printed circuit boards. SIwave combines all SIwave-DC and SIwave-PI functionality and adds a time-domain circuit simulation engine for end-to-end signal integrity design and compliance.

REVIEW WITHOUT CAD

LATTICE TECHNOLOGY INC., SAN FRANCISCO.

Technical communication and digital mockup software for manufacturing, XVL Studio, has been upgraded to version 12.1, improving productivity and collaboration capabilities over past versions. The application is used to create technical illustrations and interactive 3-D illustrations for purposes such as conducting design reviews outside of a CAD environment. The release includes new markup tools for this process. The application now supports the 3-D PDF format, with both import and export capabilities. Because this 3-D PDF format is available free, users can share interactive 3-D with anyone. The upgrade also automates collision avoidance in assembly and disassembly path creation. Using the update snapshot tool, a user can capture and annotate a specific view and send it to another user.

3-D SHARING ON ANDROID

MAKERBOT, BROOKLYN, N.Y.

The Thingiverse app is now available as an Android app. Those who download it can search on Thingiverse, a 3-D design community for sharing and printing 3-D models. They can look at featured 3-D designs and noteworthy items that have been selected by the Thingiverse community. When viewing 3-D designs, the user can scroll through slideshows of details. They can "like" designs and share them directly from the app to social networks or e-mail them. Thingiverse says it currently has more than 160,000 members and more than 200,000 downloadable digital designs of free 3-D models. ME

SUBMISSIONS

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

SPRING 2014

Spring 2014 Training Courses for Engineers and Technical Professionals

April 2014 – San Francisco, California USA

PD595	Developing a 10-Year Pump Inservice Testing Program	14-15 Apr
PD690	Economics of Pipe Sizing and Pump Selection	14-15 Apr
PD077	Failure Prevention, Repair and Life Extension of Piping, Vessels and Tanks	14-16 Apr
PD146	Flow Induced Vibration with Applications to Failure Analysis	14-16 Apr
PD190	BPV Code, Section IX: Welding, Brazing and Fusing Qualifications	14-16 Apr
PD442	BPV Code, Section VIII, Division 1: Design and Fabrication of Pressure Vessels	14-16 Apr
PD467	Project Management for Engineers and Technical Professionals	14-16 Apr
PD014	B31.3 Process Piping Design	14-17 Apr
PD622	BPV Code: Plant Equipment Requirements	14-17 Apr
PD672	BPV Code, Section XI, Division 1: Inservice Inspection 10-Year Program Updates for Nuclear Power Plant Components	14-17 Apr
PD691	Fluid Mechanics, Piping Design, Fluid Transients, and Dynamics	14-17 Apr
PD443	BPV Code, Section VIII, Division 1 Combo Course	14-18 Apr
PD581	B31.3 Process Piping Design, Materials, Fabrication, Examination and Testing Combo Course	14-18 Apr
PD629	Project Management Combo Course	14-18 Apr
PD665	BPV Code, Section I: Power Boilers	14-18 Apr
PD686	Layout of Piping Systems and Process Equipment and the Utilization of 3D Modeling	14-18 Apr
PD596	Developing a 10-Year Valve Inservice Testing Program	16-18 Apr
PD313	Fundamentals of Fastening Systems	17-18 Apr
PD441	Inspection, Repairs & Alterations of Pressure Equipment	17-18 Apr
PD449	Mechanical Tolerancing for Six Sigma	17-18 Apr
PD496	Preparing for the Project Management Professional Certification Exam	17-18 Apr
PD624	Two-Phase Flow and Heat Transfer	17-18 Apr
PD457	B31.3 Process Piping Materials, Fabrication, Examination and Testing	18 Apr

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April-May 2014 – Minneapolis, Minnesota USA

PD107	Elevator Maintenance Evaluation	28-29 Apr
PD445	B31 Piping Fabrication and Examination	28-29 Apr
PD570	Geometric Tolerancing Fundamentals 1	28-29 Apr
PD583	Pressure Relief Devices: Design, Sizing, Construction, Inspection and Maintenance	28-29 Apr
PD692	Communication Essentials for Engineers	28-29 Apr
PD231	Shock and Vibration Analysis	28-30 Apr
PD359	Practical Welding Technology	28-30 Apr
PD506	Research and Development Management	28-30 Apr
PD513	TRIZ: The Theory of Inventive Problem Solving	28-30 Apr
PD633	Overview of Codes and Standards for Nuclear Power Plant Construction	28-30 Apr
PD171	Pump and Valve Selection for Optimum System Performance	28 Apr-1 May
PD184	BPV Code Section III, Division 1: Rules for Construction of Nuclear Facility Components	28 Apr-1 May
PD603	GD & T Combo Course	28 Apr-1 May
PD561	Geometric Dimensioning and Tolerancing Advanced Applications with Stacks and Analysis	30 Apr-1 May
PD621	Grade 91 and Other Creep Strength Enhanced Ferritic Steels	30 Apr-2 May
PD456	Tools and Methods of Finite Element Analysis	1-2 May
PD531	Leadership and Organizational Management	1-2 May
PD606	NQA-1 Requirements for Computer Software Used in Nuclear Facilities	1-2 May
PD634	Comparison of Global Quality Assurance and Management System Standards Used for Nuclear Applications	1-2 May

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May 2014 – Las Vegas, Nevada USA

PD387	Understanding Chiller Performance, Operation and Economics	5 May
PD100	Introduction to Elevators and Escalators	5-6 May
PD539	Bolted Joints and Gasket Behavior	5-6 May
PD077	Failure Prevention, Repair and Life Extension of Piping, Vessels and Tanks	5-7 May
PD370	B31.8 Gas Transmission and Distribution Piping Systems	5-7 May
PD597	Risk-Informed Inservice Testing	5-7 May
PD619	Risk & Reliability Strategies for Optimizing Performance	5-7 May
PD701	Root Cause Analysis	5-7 May
PD672	Process Safety for the Mechanical Engineer	5-7 May
PD631	Manufacturing, Fabrication and Examination Responsibilities in Codes, Standards and Regulations for Nuclear Power Plant Construction	5-7 May
PD394	Seismic Design & Retrofit of Equipment & Piping	5-8 May
PD620	Core Engineering Management	5-8 May
PD632	Design in Codes, Standards and Regulations for Nuclear Power Plant Construction	5-8 May
PD657	HVAC Systems & Chiller Performance Combo Course	5-8 May
PD675	ASME NQA-1 Lead Auditor Training	5-8 May
PD013	B31.1 Power Piping Code	5-9 May
PD192	BPV Code, Section XI: Inservice Inspection of Nuclear Power Plant Components	5-9 May
PD432	Turbo Machinery Dynamics: Design & Operation	5-9 May
PD601	Bolting Combo Course	5-9 May
PD602	Elevator and Escalator Combo Course	5-9 May
PD027	Heating, Ventilating and Air-Conditioning Systems: Sizing and Design	6-8 May
PD386	Design of Bolted Flange Joints	7 May
PD102	How to Perform Elevator Inspections Using ASME A17.2	7-9 May
PD593	FRP Piping Fabrication & Installation Processes	8 May
PD577	Bolted Joint Assembly Principles Per PCC-1-2013	8-9 May
PD591	Developing Conflict Resolution Best Practices	8-9 May

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ROLLED STEEL MOTORS

WEG ELECTRIC CORP., DULUTH, GA.

A new line of rolled steel motors has been newly designed and rated from 0.25 to 25 hp. The motors come in both high efficiency (EPAct) and NEMA Premium models and are available in frame sizes NEMA 56 to 254/6T. All motors in this line can be specified as foot mount, C-face, or footless configuration with TEFC and ODP enclosure as standard and TEAO and TENV as options.

PANEL SCREWS

PENN ENGINEERING, DANBORO, PA.

PEM C.A.P.S. captive access panel screws integrate a captive screw in a spring-loaded assembly to attach panels, covers, drawers, or racks without loss of ready access inside. Their integrated screw eliminates handling, installation, and service problems typically resulting from loose hardware and reduces the overall parts count. The PC/ABS color knobs can be specified for various uses, such as designating access levels, referencing instructions, or simply enhancing the appearance of an assembly.

ENLARGED 3-D PRINTING

EOS OF NORTH AMERICA INC., NOVI, MICH.

The EOS M 400 3-D printer is based on a modular concept. A key innovation of the EOS M 400 is the volume of the building chamber, which measures 400 x 400 x 400 mm so that larger components can now be produced. The first extension to the basic model, with its corresponding processes, will initially be offered with the EOS aluminum $AlSi_{10}Mg$ and EOS nickel alloy IN718 materials and is thereby particularly suited for use in the automotive and aerospace sectors.

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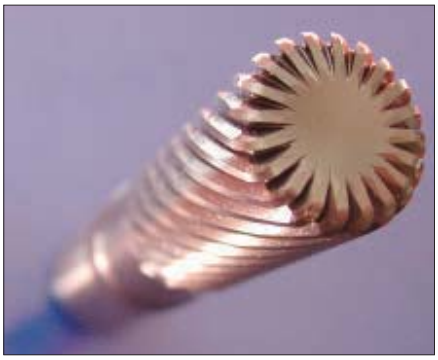
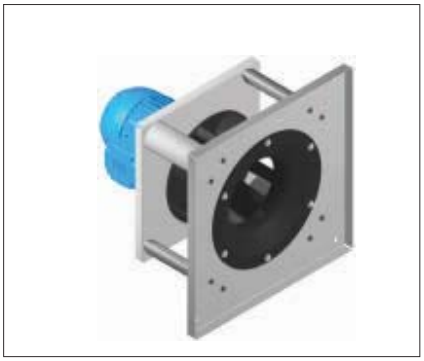


HIGH-RATE END MILL

5ME, DETROIT.

The 20-flute Cyclo Cut Max-Flute end mill can remove titanium at rates up to 12 cubic inches a minute with only 45 ft.-lb. of torque and 12 hp. Max-Flute tools use shallow, radial widths of cut, a design that transfers less heat to the cutting tool. This allows higher surface speeds for roughing titanium, Inconel, and other high-temperature alloys. The company was formed last year from the non-machinery units of the former MAG IAS.



PLUG FAN

CONTINENTAL FAN MANUFACTURING INC., BUFFALO, N.Y.

TEK plug fans feature backward curved airfoil wheels made by combining precision injection molding techniques with high-strength plastics to produce a wheel that the manufacturer says is stronger than steel, yet half its weight. The fans are suited for OEM applications where an easy-to-install plenum air circulator is required. They also incorporate an integral mounting panel that allows for air circulation in the plenum.

DATA TRANSMITTERS

OMEGA ENGINEERING INC., STAMFORD, CONN.

The DMD4008 series of transmitters accepts a resistance input from potentiometer, slidewire, linear position, displacement, or rotational devices, and provides an optically isolated dc voltage or current output that is linearly related to the potentiometer position. The DMD4008 is a quick setup for hundreds of I/O ranges, features external switches and table for range selection, has removable plugs for fast installation with a functional output test button and selectable sink/source for current output.

SMART CAMERA SYSTEM

ABB ROBOTICS, AUBURN HILLS, MICH.

Integrated Vision is a smart camera system intended to simplify vision-guided robotics applications. The system uses imaging technology developed by Cognex Corp., including a patented algorithm called PatMax for advanced part location. Protocols built into the camera communicate directly with a robot. Using 2-D vision guidance, the system can be used to track products, improve quality, troubleshoot challenging lines and processes, and expand a company's use of robotic automation.

OPERATOR INTERFACE

GE INTELLIGENT PLATFORMS, CHARLOTTESVILLE, VA.

QuickPanel+ integrates process control, view, and an option to run an embedded data historian with touchscreen technology. According to GE, it is the first product in a line of operator interface solutions designed specifically to take advantage of the Industrial Internet. QuickPanel+ is a general-purpose operator interface capable of connecting to a variety of industrial PLCs and PACs. It has a browser and multimedia support and can make training videos or documentation readily available to the operator.

SHAFT COLLARS

AMACOIL INC., ASTON, PA.

Shaft collars hold reels, spools, and other objects in place on shafts. Objects are held firmly between two pintles, one of which has a clamping force control. The clamping control permits adjustment of the holding force from 90 to 1,124 pounds. A conical point mounted to each pintle is the mechanism for engaging the object with the shaft. The points are specially machined so that start-up and braking moments are transmitted from the shaft to the load.

ROBOTIC TOOL CHANGER

AUTOMATION DIRECT, APEX, N.C.

The QC-001 micro robotic tool changer is suitable for high-speed spider or parallel-link robots enhancing their ability to switch end-effectors automatically. The tool changer allows for multiple assembly, dispensing, sorting, and material handling operations to be performed by one robot.

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ASME Pipeline Training Week At-a-Glance

Technical Track	Monday April 14	Tuesday April 15	Wednesday April 16	Thursday April 17	Friday April 18
Bolting	Bolted Joint Assembly Principles Per PCC-1-2013 (PD577) David Lay (2 Days)				
Piping and Pipelines	Pipeline Pressure Testing (IPTI203) Larry C. Decker (1 Day)	Composite Repair Solutions for Pipeline Anomalies (IPTI202) Chris Alexander (1 Day)	B31.8 Gas Transmission and Distribution Piping Systems (PD370) Mike Rosenfeld (2.5 Days)		
	Integrity Management (IPTI210) Tom Bubenik (1 Day)	Defect Assessment (IPTI280) Tom Bubenik (2 Days)		In-line Inspections for Pipelines (PD706) Martin Phillips (2 Days)	
	Onshore Design and Construction (IPTI265) Shashi Menon (3 Days)			ASME B31.4 Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquids (PD391) Carolyn Kolovich (2 Days)	
Welding			Practical Welding Technology (PD359) Al Moore (3 days)		

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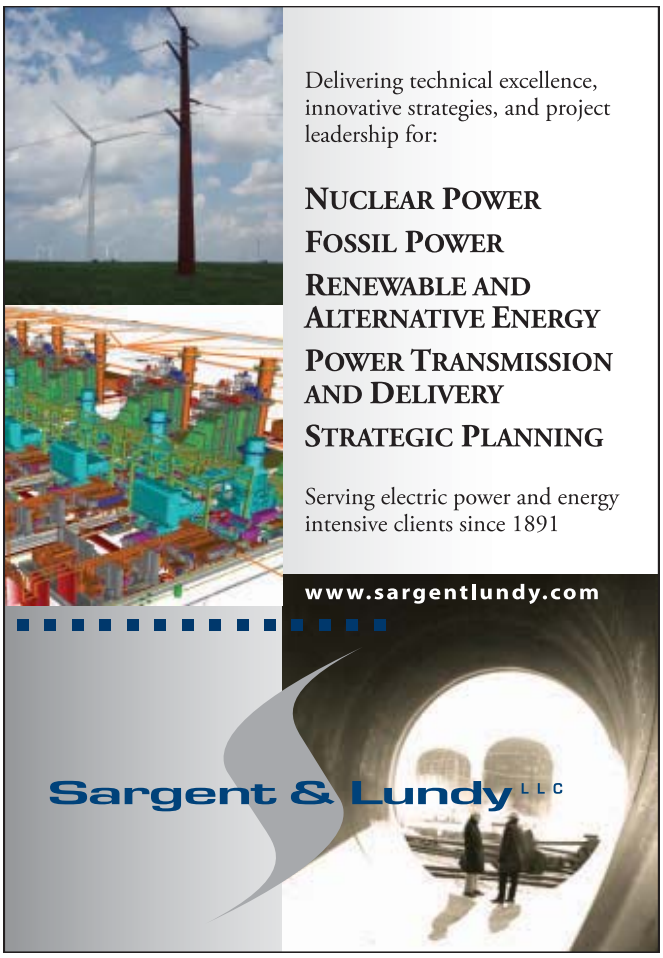
FOOD-FRIENDLY SILICONE

DOW CORNING, MIDLAND, MICH.

The Dow Corning 3074 Intermediate, which has been used in the architectural, marine, and industrial fields, is now available for food-contact applications. This versatile, solventless liquid silicone resin is designed to blend easily with organic or other silicone resins to improve the processability and performance of coating systems. It provides high-temperature resistance, durability, and weatherability for a broad range of coating formulations, and minimizes the release of volatile organic compounds.



PROBE MICROPHONE

PCB PIEZOTRONICS INC., DEPEW, N.Y.

A new probe microphone is for R&D engineers who need to measure sound pressure in confined areas. The probe tip diameter measures 0.05 inch (1.3 mm) which enables manufacturers of products ranging from telephones to musical instruments to make measurements in small and confined areas that cannot be accessed using traditional microphones. The small probe tip also allows near field measurements with minimal disturbance of the sound field.

MEMS ACCELEROMETER

SILICON DESIGNS, KIRKLAND, WASH.

The single-axis SDI Model 2220 is a higher-performance version of the company's Model 2210, combining an integrated low-noise, nitrogen-damped, fully calibrated MEMS variable capacitance accelerometer chip with high-drive, low-impedance buffering, each contained in an epoxy-sealed rugged anodized aluminum housing that mounts via two M3 screws. The design is suitable for measuring acceleration within industrial and commercial environments, where low mass (10 g) and small size (1 by 0.5 by 0.44 inch) help to minimize mass loading effects.

PIEZOELECTRIC LINEAR ACCELEROMETER

MEASUREMENT SPECIALTIES, HAMPTON, VA.

Model 8101 is a compact accelerometer for general purpose vibration measurement. The plug-and-play piezoelectric linear accelerometer is available in two dynamic ranges, ±40 g and ±160 g, and in two configurations for measurement on either the x-axis or z-axis. The Model 8101 features stable piezoceramic crystals in shear mode with low base strain sensitivity and a flat frequency response across a 6,000 Hz bandwidth.

EXPLOSION PROOF TRANSFORMER

LARSON ELECTRONICS LLC, KEMP, TEXAS.

The EPL-TX-320-2XLV-DC explosion-proof transformer is designed to convert standard 120-277 V ac to 12/24 V dc current in hazardous locations. The transformer also acts as a power distribution system through the inclusion of two 20 amp Class 1 and 2, Division 1 and 2 receptacles designed to accept twist lock explosion-proof plugs. This transformer is ideal for maintenance and turnaround operations and includes 25 feet of heavy duty 16/3 SOOW cord ending in a 250V, 20 amp explosion proof male plug for safe connections.

COMPACT LIGHT MEASUREMENT

HEXAGON METROLOGY, NORTH KINGSTOWN, R.I.

The WLS qFLASH is a non-contact stereo vision system used to quickly capture 3-D measurements on the shop floor. The portable unit can be handheld or mounted on a mobile pedestal. The system creates reports and digitizes acquired data on the spot for analysis or direct CAD comparison.

SUBMISSIONS

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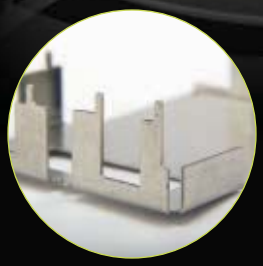

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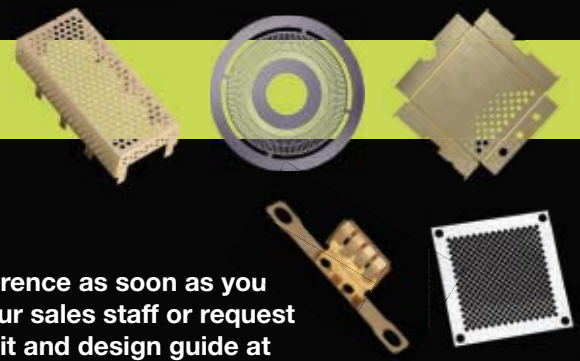

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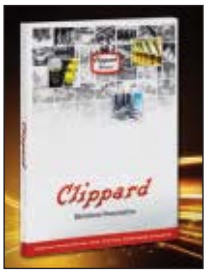

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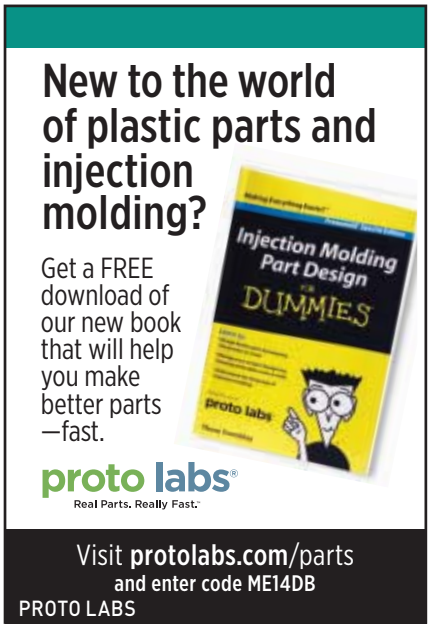

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A Master of Science degree, or a PhD in Mechanical, Aerospace, or Structural Engineering, or a related field, is required. Must possess extensive experience in mechanical test engineering planning and execution in shock, vibration, and modal test environments, as well as in evaluating dynamic testing results, data analysis, and assessing and reporting performance. Extensive knowledge in the use of some typical engineering software for data acquisition, analysis, and display is essential. Must have extensive experience in selecting instruments and establishing signal conditioning parameters. Demonstrated ability to analyze data on various consumer products required. Experience in the engineering design and analysis of components where concepts are turned into realistic parts in three dimensional modeling software, and analyzed using Computer Aided Engineering (CAE) tools such as Finite Element Analysis (FEA) method software, are required.

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The successful candidates will be responsible to teach undergraduate and graduate Mechanical Engineering courses; advise and mentor students; and develop an externally funded research program. The department is particularly interested in candidates with industry experience in petroleum, energy or manufacturing or those that have an interest in teaching in the newly developed Materials Science PhD program. Starting date will be August, 2014. Applicants must have a PhD in Mechanical Engineering, or a related Engineering discipline. Applicants must have excellent verbal and written communication skills.

The General Engineering Program at Montana Tech is ABET accredited, has approximately 300 students and offers BS and MS degrees with options in Civil Engineering, Mechanical Engineering and Welding Engineering.

Montana Tech is located in the city of Butte, in the scenic and mountainous region of southwest Montana. The area is surrounded with opportunity for outdoor activities, such as camping, fishing, hunting, hiking, biking, skiing, etc. Butte is a regional center for cultural, community, and sporting events, and Butte's long standing mining history boasts a unique National Historic District.

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MCMEEKING AWARDED PRAGER MEDAL

ASME FELLOW ROBERT MCMEEKING, professor of engineering at the University of California, Santa Barbara, has been awarded the 2014 William Prager Medal from the Society of Engineering Science for his research contributions in solid mechanics.

McMeeking was cited "for contributions underpinning finite deformation computational mechanics and the constitutive characterization of advanced structural and functional materials, including fracture and deformation of ceramics, composite materials, ferroelectrics, and the mechanics of adhesion and cells."

The Tony Evans Professor of Structural Materials and a professor of mechanical engineering, McMeeking taught at Stanford University and at the University of Illinois at Urbana-Champaign before joining the UCSB faculty in 1985. He was chair of the UCSB department of mechanical and environmental engineering from 1992 to 1995, and again from 1999 to 2003.

CHRISTIANSEN WINS KASTOR AWARD

JACK CHRISTIANSEN, DIRECTOR OF THE Petroleum Technology Initiative in the University of Houston's College of Technology, has been named winner of ASME's Ross Kastor Educator's Award. The award recognizes dedication to improving engineering and science awareness for students and the enhancement of education for future industry leaders.

Christiansen joined the university's staff after a 35-year career in the oil and gas industry. Christiansen worked as a geophysicist and geologist before entering management with Texaco and later, Chevron Corp.

In 2007, Christiansen became founding director of the Petroleum Technology Initiative, offering classes, field trips, professional events and other activities for students. It also offers programs and courses for industry. The initiative also offers an intensive international petroleum executive training program.

HPVC EXPANDS TO INDIA

MORE THAN 400 STUDENTS AND 36 TEAMS representing more than 30 universities competed in January in an ASME Human Powered Vehicle Challenge at the Indian Institute of Technology in Delhi. It was the first time an ASME HPVC event had been held in India.

The HPVC India event consisted of a design evaluation, followed by a double-elimination drag race speed competition and a two-and-a-half-hour endurance event. HPVC India was co-hosted by Delhi Technological University.

At the end of the three-day competition, *Pedocker*, the entry from the Indian School of Mines in Dhanbad, emerged as the overall winner. The team placed second in the speed event, third in the endurance event, and fourth in the design category.

Rajarambapu Institute of Technology's entry, *ArcK*, took second place overall, placing first in the endurance event, third in speed, and sixth in design. Jamia Millia Islamia's *Flare*, the winner of speed event, finished third overall.

Michael Moorhead, chair of the Human Powered Vehicle Challenge Committee and associate professor of mechanical engineering at Rose-Hulman Institute of Technology in Terre Haute, Ind., characterized the inaugural HPVC India as a "wildy successful" event that far exceeded his expectations.

Michael Moorhead (orange jacket) addresses the competitors.

"When we originally started we thought we'd call it a success if it had 10 or 12 teams that participated, because we never know what an international event is going to look like," said Moorhead, who attended the com-

MANY DISCIPLINES FEATURED AT NEMB CONGRESS

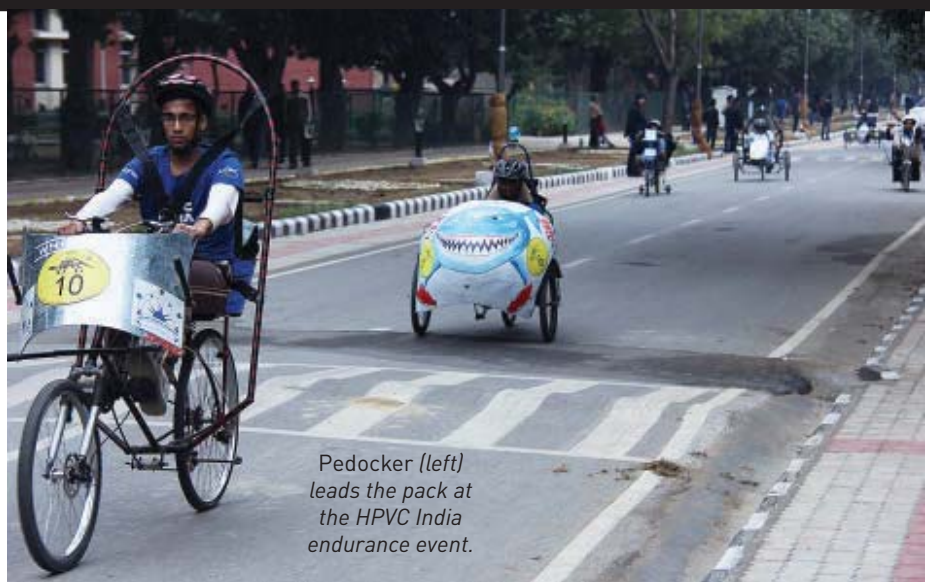
ARUN MAJUMDAR, VICE PRESIDENT OF energy at Google and professor at Stanford University, stressed the importance of multidisciplinary collaboration in the laboratory and office during the 2014 Global Congress on NanoEngineering for Medicine and Biology in February. Majumdar spoke during one of the plenary sessions.

"If you want to break down silos, mix disciplines up," Majumdar said. "Proximity matters, and you can't overestimate the impact of contact."

Majumdar also offered advice to young engineers and students in the audience: "When people say 'Your idea won't work,' consider if it violates laws of nature, and if it doesn't, question that assumption."

This year's Global Congress on Nano-Engineering for Medicine and Biology was held in San Francisco. It drew around 300 participants from around the globe, and included 45 technical sessions, 40 keynote and featured speakers, as well as seven plenary talks and five tutorials. For the first time in the program's three-year history, webcasts of six plenary talks and two of the tutorials were transmitted live from the conference.

Technical sessions covered nanotechnology topics ranging from diagnostics to toxicology. Tutorials included a primer on tissue engineering and an overview of the design and applications of microfluidic tools. Plenary talks included presentations by Mina Bissell of Lawrence Berkeley National Laboratory, Stephen Quake of Stanford University, John Rogers of the University of Illinois at Urbana Champaign, Mehmet Toner of the Harvard Medical School and Massachusetts



Pedocker *(left) leads the pack at the HPVC India endurance event.*

petition with six students from his college's human powered vehicle team.

"So when we had such great participation, that was the first indicator of success for us. But then getting through the weekend and actually executing the event just as well as we do in the U.S. was just fantastic. It was just much better than I ever would have expected it to be."

According to Moorhead, the HPVC Committee has been interested in establishing an event in India for several years. "Historically there have been a few teams from India that have tried to come to the United States for the U.S.-based HPVC events, and it's always a real challenge," he said. "We've been saying for years that we'd like to have an event in India, but we needed to find a cooperative host. That happened this year with IIT Delhi."

The competition in India was the first HPVC event to take place this year. In April, HPVC East will be held in Orlando, Fla., and HPVC West will take place in San Jose, Calif. An HPVC Latin America event is also planned for Mexico City in October.

For more on the HPVC program, go to www.asme.org/events/competitions/human-powered-vehicle-challenge-(hpvc). Visit www.hpvcindia.in/results.html for more on the HPVC India Event. **ME**

(Left to right) Rashid Bashir, Arun Majumdar, and John C. Bischof at NEMB 2014.

General Hospital, and Jennifer West from Duke University.

Paul Alivisatos of University of California, Berkeley, and Lawrence Berkeley National Laboratory opened the congress with his talk, "Studies of Colloidal Nanocrystals and Biological Micromolecules in Liquids Using the Transmission Electron Microscope."

At the special NEMB poster session, 18 finalists selected from more than 80 participants proceeded to a so-called lightning round presentation, where doctoral students garnered National Science Foundation-supported awards. Nasim Taheri from Rice University and Nikita Taparia of the University of Washington tied for first place in the competition. Sean Lubner from UC Berkeley and Ehsan Sadeghipour of Stanford University tied for second.

Archived versions of the tutorial and plenary sessions that were webcast from the conference—including the poster session lightning round—are available at the NEMB 2014 web page, at www.asmeconferences.org/NEMB2014/index.cfm

NEMB 2015 will be held next April in Minneapolis. For further details, contact Christine Reilley, ASME program manager, at reilleyc@asme.org. **ME**

DECISION POINT DIALOGUES TO FOCUS ON STEM

A LIVE TAPING OF THE SECOND installment of the *ASME Decision Point Dialogues* thought leadership series—which will focus on science, technology, engineering and math (STEM) education—is scheduled April 23, in Washington, D.C.

Emmy- and Peabody-Award-winning journalist John Hockenberry, host of the National Public Radio program *The Takeaway*, will moderate the program and take panelists through a Socratic dialogue—the *Dialogues*' signature concept—on some of the most challenging and critical areas related to STEM. The program will be broadcast on ASME.org beginning in June.

Hockenberry will raise questions touching on the impact of standardized testing on STEM K-12 education, specifically on the middle school years, and on whether goals to increase the number of STEM graduates matches with career opportunities available. He will also delve into a discussion on teaching methodologies, on the role of STEM in relation to other areas in the humanities and arts, and on how STEM is taught around the globe.

Building off the first program, "Will Engineers Be True Global Problem Solvers?" which was held in New York City, the goal of this year's program is to help advance the agenda and enhance STEM education and workforce development.

The live taping of *ASME Decision Point Dialogues* will be the pre-conference event prior to the opening of the *U.S. News* STEM Solutions Conference, a national gathering of leaders from business, education and government convening to advance the agenda for national change in STEM education policy. The *U.S. News* conference precedes this year's USA Science and Engineering Festival on April 26 and 27, a gathering of students of all ages. All the events are scheduled for the Walter E. Washington Convention Center.

To attend the live taping of the *ASME Decision Point Dialogues* program, contact memag@asme.org.

The Handley Page O/400 bomber of WWI had a wing-span of 55 feet.

WWI BOMBER WINGS FOUND IN GARAGE

IT STARTED WITH AN EMAIL. LAST APRIL, AL MCLEAN, senior curator at the Royal Air Force Museum in Cosford, U.K, wrote asking Ewan Cameron to review some attached photos. "What do you make of these?" he asked Cameron, who was a curator at a satellite site of the museum, in Stafford.

The photos showed a garage roof held up by something that didn't look like conventional lumber. Cameron saw that the roof supports looked like hollow box wing spars which came into use during the First World War.

He also noted that they were enormous. If they were indeed wing spars, then the size of the plane was exceptional for the time.

"With 25-foot-long spars you know you are looking at an aircraft with a minimum wing span of 50 feet. With the addition of a center section and wingtips, that would jump up at least 55 feet. There are few aircrafts which have this method of construction and a span that big. My initial candidate was the Handley Page O/400," said Cameron.

When he compared the garage roof supports to illustrations in a copy of a Handley Page parts manual, it seemed likely he was looking at the remains of a number of O/400 lower wing sections.

The O/400 was a biplane bomber manufactured by Handley Page Aircraft Co. between 1915 and 1922. Cameron knew that the museum would be eager to acquire the fragments since no other examples of an O/400 exist.

Cameron was reasonably confident about the identification of the wings, but he needed to be sure by getting a better look at the parts. He wanted to examine them for some kind of identification.

That opportunity came in October 2013, when a team from Cosford went to Connah's Quay, Wales, to demolish the garage and deliver the wings to the museum. Once they arrived at its Reserve Collection in Stafford, Cameron went looking for any identifying part, or drawing numbers.

Wing spars of the Handley Page bomber were found holding up a garage roof in Connah's Bay, Wales. The 95-year-old timbers are said to be in "astonishingly good condition."

It was no easy task—the wood was blackened by nearly a century's worth of dust, grime, and soot. A light eventually picked up the faint outline of a number on one of the box struts. It corresponded to one of the numbers in the parts manual.

According to Cameron, there were a total of four port mainplanes for four aircraft. The wings may never actually have been fitted to an aircraft. "While a manufacturer may be contracted to make 50 complete aircraft, they will usually also be contracted to manufacture a large number of spare parts."

McLean said, "The biggest challenge of getting the wing pieces out of the garage was the sloping roof that had to be dismantled from above. The cladding, consisting of roofing felt, galvanized corrugated iron sheeting, and timber, was removed. Non-essential structures were dismantled until the wing sections were in a situation where they could separate from the structure. For 95-year-old timber sections, they are in astonishingly good condition. Some of the metal brackets had fared less well, although many are still identifiable from the aircraft drawings."

The wing parts are currently in storage, available for research purposes. Cameron claims aviation historians and model makers may be interested in studying the wing parts, while other groups have expressed interest in recreating an O/400. ME

JAMES PERO

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