



## INDUSTRIAL ENGINEER

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### Front Line

News, trends & tactics in the October 2013 issue of *Industrial Engineer*

#### With solar cells, thin could be in

**Pittsburgh researchers work to optimize photonic crystal production**

Combining optimization techniques with electrodynamic simulations could yield a new type of thinner, more efficient, low-cost solar cell, according to researchers at the University of Pittsburgh.

Professor of industrial engineering Paul W. Leu and his colleague, electrical and computer engineering professor Kevin P. Chen, have received a \$107,498 Early-concept Grant for Exploratory Research from the National Science Foundation to develop the new process.

"We have this new methodology, this new manufacturing process by which we can make very small three-dimensional photonic crystals, three-dimensional nanostructures, over fairly large areas," Leu said. "We're trying to use these structures to trap light so that you can have very high efficiencies."

Like atomic crystals that have certain defined electronic properties, photonic crystals have optical properties that allow them to control how light interacts with them, Leu said. The plan is to learn how to produce more efficient solar cells that use less material in the manufacturing process. The nanostructures are so small that one solar cell would contain about 1 trillion units of the photonic crystal.

"We use electrodynamic simulations, which allows us to quickly with predicted accuracy evaluate different photonic crystal structures," Leu said. "So we want to integrate optimization methods with simulations so that we can very quickly determine what are promising or optimal structures."

"From the experimental standpoint, our goal is to fabricate a 3-D silicon photonic crystal as a proof of concept," Leu said. "And we're integrating these electrodynamic simulations with inverse design techniques to see what processes we should use to fabricate the desired structure."

One of the National Academy of Engineering's grand challenges of the 21st century is making solar power more economical and competitive with fossil fuels. Solar power is the best energy source for remote locations like space, deserts, forest watch towers and rural villages, Leu said. It is competitive with energy produced and distributed through the U.S. energy grid in the Southwest U.S. and, because of higher electricity prices, in parts of the Northeast. The industry is expanding rapidly and new rooftop panels and solar farms are being installed at an exponentially increasing rate.

Electricity that costs less than \$1 per peak watt starts becoming competitive with the grid, Leu said, although costs vary by location. Although that is the eventual goal, Leu said the photonic crystal research is too new to estimate future costs of production and distribution. The Pittsburgh professors hope to turn the exploratory grant into a full proposal where they dig



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down into the fundamentals, examining the structures' process and property relationships.

### Army seeks gas from trash

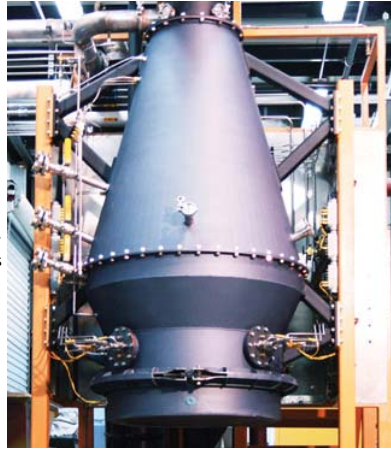
#### **Modified blast furnace can accept any kind of waste stream**

The U.S. Department of Defense is betting \$3 million that what is essentially a modified blast furnace will produce electricity from waste and fuel for vehicles and generators at a California military base.

*The New York Times* reported that Sierra Energy has been testing its FastOxPathfinder for several years. Inside the waste gasifier, which is the size of a shower stall, a chemical reaction heats any kind of trash to extreme temperatures without combustion. The output includes hydrogen and carbon monoxide, called syngas for synthetic gas, which can be burned to generate electricity or made into ethanol or diesel fuel, according to the newspaper.

The idea was passed down from two former industrial engineers from the now bankrupt Kaiser Steel, the newspaper reported in an Aug. 17 story. The two engineers came up with a way to inject oxygen and steam into blast furnaces to reduce emissions and increase the energy content of flue gas. Steel companies weren't interested. The engineers retired, but the grandson of one patented the idea, which is being commercialized by Sierra Energy. It should be in operation later this year at Fort Hunter Liggett, a training base in Monterey County, Calif.

So far, Defense Department tests have shown that in four hours, the FastOxPathfinder turns one ton of waste into 1,580 kilowatt-hours of electricity, which could power an average home for a month and a half, along with 42 gallons of fuel. Emissions are one-third less than power generation from coal. That gasifier can handle only 12 tons a day, but blast furnaces can handle 2,000 tons a day.



### Dispatching with math

#### **Research could help more long-haul drivers keep on trucking**

Oregon State University engineers could help create a truck transportation routing system more appealing to long-haul truckers, who are leaving the industry in droves.

More long-haul, full-truckload drivers quit every year than there are trucks of that type on the road.

#### **QUOTE, UNQUOTE: Parts in space**

"3-D manufacturing offers opportunities to optimize the fit, form and delivery systems of materials that will enable our space missions while directly benefiting businesses here on Earth. ... NASA recognizes that on Earth and potentially in space, additive manufacturing can be game-changing for new mission opportunities, significantly reducing production time and cost by 'printing' tools, engine parts or even entire spacecraft." — Michael Gazarik, NASA's associate administrator for space technology in Washington, quoted July 16 by the *EngineeringCareer* website

([www.engineeringcareer.net.au](http://www.engineeringcareer.net.au)). NASA recently used 3-D printing to build a working rocket engine nozzle.

"The perceived quality of life for long-haul truck drivers is poor, and it shouldn't have to be that way," said Hector Vergara, an assistant professor in the university's School of Mechanical, Industrial and Manufacturing Engineering, who is collaborating on the project with researchers at the University of Arkansas.

The approach also could increase freight transportation efficiency and save millions of dollars, he said. Existing approaches include "point to point," where one driver stays with a full load through its entire journey; "hub and spoke" systems that change less-than-full loads at selected points; and "relay" networks that change drivers but keep loads on the same truck.

The new approach combines the relay system and the point-to-point system for full-truckload transport.

The researchers at Oregon State developed a mathematical approach to optimize the design of the dispatching system to move goods and minimize impact on drivers. It's one of the first models of its type to create a mixed-fleet dispatching system at a large scale.

Vergara said the system, which needs more research, can cut the length of trips a driver makes by about two-thirds, keep loads moving while drivers rest, and save significant amounts of money on the number of trucks needed to move freight.

The computer optimization determines the best way to dispatch loads and tells where to locate relay points and how different loads should be routed through the relay network.

### Mother's cancer launched career

#### **SHS honoree aims to prevent healthcare industry mistakes**

When he was 7, Kendall Sanderson's mother had a cancerous breast tumor removed, but complications in the hospital's scheduling protocol forced a three-week delay in the procedure.

So when the recent Northeastern University industrial engineering graduate found out that he could apply the skill of efficiently routing delivery trucks around the country to the healthcare industry, he knew he had found his calling, according to a report on the university's website.

During his sophomore year, Sanderson began working in the Healthcare Systems Engineering Institute and National Science Foundation healthcare center of James Benneyan, a professor of mechanical and industrial engineering with an honorary joint appointment in the Bouvé College of Health Sciences. Sanderson has had three co-op assignments and independent research projects with Benneyan, applying his skills to help prevent the type of mistakes like those the healthcare system made with his mother, who survived.

Sanderson's work earned him one of the university's 17 Outstanding Cooperative Education Awards this spring as well as IIE's Society for Health Systems undergraduate scholarship. He plans to join Benneyan's new \$8 million CMS center as a master's degree candidate and to continue making the healthcare world more efficient throughout his career.

"It's a \$3 trillion industry, and about 30 percent of that can be attributed to inefficient, poorly designed processes," Sanderson said.



### BOOK OF THE MONTH: Successfully letting go

#### **Getting delegation right is one of management's primary responsibilities**



Managers these days too often live by the axiom that to do things right, you have to do it yourself.

That impaired approach leads to harried bosses who are poor delegators working at full capacity, with too many things to do in too little time, according to Brian Tracy, author of *Delegation and Supervision*. Fear, pride, lack of knowledge and training also have some managers tightly clinging to their tasks.

Tracy offers seven keys to effective delegation: Match the person to the job; delegate gradually; delegate the whole task; delegate specific results; encourage participation and discussions; delegate authority and responsibility; and leave the person alone to finish.

The last point is especially important because continuing to check up on the person, offering suggestions and seeking too much feedback are actions that are tantamount to taking responsibility back.

The small book also offers another advantage: In a digital world that compels us to spend much time looking at computer screens via desktops, laptops, tablets or smartphones, *Delegation and Supervision's* 4.5-by-6.5 inch size fits easily into a jacket pocket or briefcase, allowing old school "analog" learning in any location.

*Delegation and Supervision* is published by Amacom Books (\$9.95).

### SITE TO SEE: Should it be TEM or STEM?

#### Engineering, math grads earn more than biologists

College Measures is a nonprofit organization that has crunched data on earnings from universities and community colleges in five states that are working to make such data publicly available: Arkansas, Colorado, Virginia, Texas and Tennessee.

The group's most recent study, "Higher Education Pays: But a Lot More for Some Graduates than for Others," matches student records with state unemployment insurance wage data for graduates."

Until the data about potential earnings among graduates across the nation is unearthed and put to full use, many students will make poor decisions about schools and programs – decisions that will leave them saddled with debt and clamoring for a government bailout," report author Mark Schneider told *USA Today*.

According to the report, students bombarded by rhetoric about STEM education might think that any STEM major yields higher earning.

Yet the objective earnings data show that in each state and at each level of postsecondary credential, graduates with degrees in biology – the field with the largest number of science graduates – earn no more than graduates with degrees in sociology or psychology, according to the report.

Other lessons from the data include that some two-year technical programs are worth as much or more than four-year bachelor's degrees, and what you study matters more than where you study.

The report also is a call to give prospective students more information about probable outcomes of their chosen fields of study, particularly at a time when student loan debt is an explosive political issue.

The full report, along with other previous reports, can be downloaded at [www.collegemeasures.org](http://www.collegemeasures.org).

### Culture wars, grocery store style

#### Publix maintains that 'people power' works versus Wal-Mart

According to *Forbes* magazine, regional supermarket Publix is counting on its commitment to service to counter behemoth Wal-Mart's foray into Florida.

Wal-Mart, the world's largest retailer, has targeted Florida after saturating virtually every other state in the Southeast. Publix president Todd Jones, however, is sure that Publix can compete.

"We believe that there are three ways to differentiate: service, quality and price," Jones said. "You've got to be good at two of them, and the best at one. We make service our number one, then quality and then price."

The financial magazine termed that quote a dig at Wal-Mart's traditional slogan of "Always low prices." It works, as according to *Forbes'* analysis, Publix is America's most profitable grocery chain, with net margins of 5.6 percent last year. The numbers trounced Wal-Mart's 3.8 percent and every other competitor, including Kroger (1.6 percent) and Whole Foods (3.9 percent).

Publix has thrived for 83 years by delivering excellent service by turning cashiers, baggers, butchers and bakers into large shareholders. The employees are trained to help customers, from baggers who actually carry groceries to the car to workers who lead questioning customers to their desired items. The company also aggressively targets wait times with proprietary, predictive software that aims to keep queues at two customers per line.

Right now, Publix has 755 of its 1,073 stores in Florida. Wal-Mart's inroads total 239 locations with grocery markets in the "Sunshine State."

### Personality marks the spot

#### Research states even good people can't be motivated in jobs that don't fit

A new study from the University of Iowa suggests that an employee's personality is a strong motivator for his or her behavior. A growing body of evidence suggests that if a worker's personality doesn't fit the job requirements, the worker will not be motivated by external carrots and sticks, according to Mick Mount and Ning Li, management and organization professors in the Tippie College of Business. Their paper "The Theory of Purposeful Work Behavior," published recently in the *Academy of Management Review*, sets out a "Grand Theory" of what makes people tick at the office.

"Our approach shifts the traditional perspective that employee motivational forces are primarily imposed by external situational factors to a view that individual motivation is generated by the pursuit of high-order goals that emanate from one's personality traits," they wrote.

Their theory uses the Five Factor Model (FFM), which captures five dimensions used to describe human personality: extroversion/introversion, agreeableness, conscientiousness,

#### PRIME NUMBER: Living down

Industrial engineer Rick Broussard and his wife, Chris, have lived 11 feet under the soil of Claiborne Parish in Louisiana for 33 years. Rick Broussard took a year and a half off work to supervise building the home of steel, dirt and **200 yards** of cubic concrete, according to a story in the *Daily Journal* newspaper.

emotional stability, and openness to experience.

Over decades, FFM has proven effective at explaining human behavior. The Mount and Li theory ties FFM personality types to the work environment and the nature of the person's job. The integrated theory maintains that workers' personality traits create high-order goals that they strive to attain in their lives.

When job characteristics allow employees to work toward one of four higher-order goals – status, autonomy, achievement, and communion – workers are more productive.

So it will be difficult for businesses to motivate ambitious, extroverted employees stuck in repetitive jobs. And promising management promotions to a shy worker who is looking for autonomy won't work because the last thing that person wants is to be in charge of others. This implies that businesses must understand which goals matter to employees and match goals with job characteristics.



### Wellness helps, but how much?

#### *Researchers examining interventions at three manufacturing sites*

Iowa State University researchers are studying 60 workers across three manufacturing sites to determine if wellness programs really will cut costs and improve productivity.

"All our evidence says there will be a net positive financial return for the companies," said Mike O'Donnell, program director for the Center for Industrial Research and Service at Iowa State. "While we're relatively sure helping employees become healthier will improve absenteeism rates, the real question is will it impact healthcare premiums?"

The team has created a baseline for employee health based on a holistic approach to physical, financial and emotional health, not just a single indicator such as diet or exercise. The control group received no intervention, while the health risk assessment group completed a six-month program on nutrition, exercise, stress and finances.

Researchers used feedback from staff to design intervention programs specifically for each worksite. They will revisit all three companies in January for another appraisal and combine health results with absentee rates and health insurance claims to calculate the effectiveness of the interventions. Graduate research assistant Kayli Julander expects a range of results.

"Participant A may have lost 30 pounds. Participant B may not have lost any weight, but they improved their cholesterol, and they're eating more fruits and vegetables," Julander said. "Although Participant B might not be seeing the results they want on the scale, they are improving their health."

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