NETL-RUA
Regional University Alliance

E NEWS

Shared Intellect • Shared Laboratories • Shared Resources

July 2013
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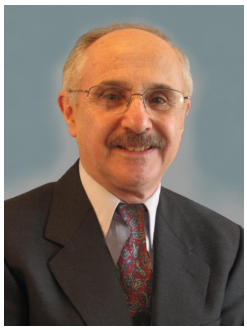
Advancing Energy Systems Analysis: NETL and CMU Support Popular Computer Modeling Software



Ed Rubin

It is staggering to consider how different computing technology was in 1983, the year the Pittsburgh Energy Technology Center (forerunner of the National Energy Technology Laboratory [NETL]) began supporting the Integrated Environmental Control Model (IECM). At the time, few computer models were available to support the U.S. Department of Energy's (DOE) research, and most computers were mainframes or large workstations that only expert programmers could operate. "IECM was created to analyze advanced technology options for controlling emissions that caused acid rain," says Dr. **Ed Rubin**, Carnegie Mellon University's (CMU) alumni chair professor of environmental engineering and science. "It was the first tool to combine engineering design with economics in a plant-level systems analysis framework, with a probabilistic capability for risk and uncertainty analysis." But users had to submit their requests to the programmer, who ran the model and delivered results.

Over time, IECM evolved. As computers got smaller and more powerful, new technologies were added, and a graphical user interface was pioneered. Today, users can download the free software and suit it to their needs, a development unimaginable in 1983. IECM now lets users analyze carbon capture and storage methods' performance, cost, and risk for a variety of power plants. The program is so versatile—for use in process design, marketing

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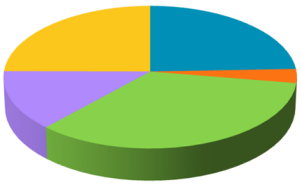
NETL-RUA
Metrics Snapshot

PRODUCTS			
	FY2011	FY2012	FY2013
Publications	194	195	67
Patents Issued	11	12	4
Licenses	9	4	0
Students Graduated	20 PhD	23 PhD	16 PhD
	8 MS	19 MS	3 MS

Product data is updated quarterly.

RESEARCH PERSONNEL



Total = 598

- Graduate Students - 146
- Undergraduate Students - 19
- University Researchers - 204
- URS Researchers - 80
- NETL Researchers - 149

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NETL-RUA-FB@netl.doe.gov

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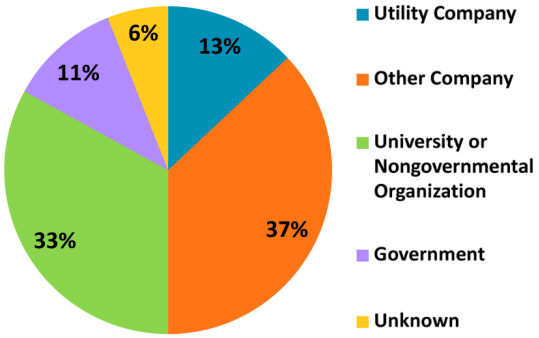
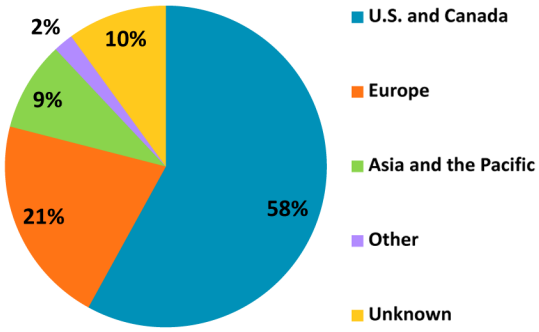
studies, college courses, and other applications—because it solves what Rubin calls the Goldilocks problem: it's not too complicated or too simple; it's just right. "We've [developed] a sophisticated model that has a 'just right' capability for asking and quickly answering a wide range of questions about technologies when you're still at an early stage of decisions and designs," says Rubin.

NETL and CMU, both members of the NETL-Regional University Alliance (NETL-RUA), now work together to support IECM, and their collaboration has been crucial to its success. "We could not have built this model without the work that NETL does," says Rubin, "because in order to model many different technologies and put them together into an integrated power plant framework, we need to rely on other people who've done a lot more detailed work on various power plant and emission control components." Throughout IECM's history, says Rubin, the model has relied heavily on the suite of projects NETL supports.

What excites Rubin is the diversity of IECM's users. (See figures, right.) "Half the downloads come from folks who build and design power plant technologies, and half are nonindustrial users in academia, government, and other sectors," he says. "That diversity, and the positive feedback we get, is what keeps our adrenaline up." The IECM is now accessible to an even larger audience. At NETL's last CO_2 Capture Technology Meeting, they offered free tutorials to attendees. Roughly one-third of all participants stuck around after a full day of conference presentations to participate in the training. "We were amazed at the turnout," says Rubin. CMU has since created video tutorials and posted them online at http://www.cmu.edu/epp/iecm/videos/index.html.

Utilities and other companies make up half of IECM's users, but universities and nongovernmental organizations make up a sizable portion as well.





Although most IECM users are in the United States or Canada, many come from Europe, Asia, or the Pacific region.

Getting the Message: GTC Holds First Conference on Power Electronics, Elicits Attendees' Feedback

Patricia Hoffman (pictured above) emphasized the importance of GTC's goals during her keynote address at the conference.

The average 18- to 29-year-old sends 88 text messages a day,[1] but the electrical grid on which our mobile devices rely has changed little since the days of telegrams. Advanced power electronics offer one way to modernize it. They can obviate the need for new transmission capacity, reduce blackouts, and make the grid more compatible with renewable energy sources. For these reasons, the Grid Technologies Collaborative (GTC) held its first conference on grid-scale power electronics in June. More than 70 students, researchers, and representatives from the energy industry and the government traveled to the Virginia Polytechnic Institute and State University Research Center in Arlington, Virginia, to attend.

The goal of GTC—an NETL-RUA Alliance organization—is to develop new power electronics for the grid. **Patricia Hoffman**, assistant secretary of the DOE Office of Electricity Delivery and Energy Reliability, emphasized the importance of GTC's goals during her keynote address when she discussed how industry, government, and

>> **GTC** *Continued on Page 4*

[1] Jeffrey Kluger, "We Never Talk Anymore: The Problem with Text Messaging," *Time*, August 16, 2012.

Technology Spotlight

Kindling Expertise: AVESTAR Center's Virtual-Reality Training System Educates Workforce of the Future

Starting a fire in a power plant and asking trainees to extinguish it may give them hands-on experience, but is neither cost-effective nor safe. That's why Alliance members NETL and West Virginia University (WVU) did the next best thing. They developed a training system that immerses users in a three-dimensional (3-D), virtual integrated gasification combined cycle (IGCC) power plant. Since the system's deployment at the Advanced Virtual Energy Simulation Training and Research (AVESTAR®) Center in 2012, trainees have used it to practice IGCC plant operations, control, and safety, including scenarios that could never be staged in real life.

Using a gamepad and a head-tracking 3-D visor, a trainee "walks" an avatar through the virtual plant and interacts with equipment. Components of the virtual environment mimic those of real plants. Pipes reflect sunlight, support beams cast shadows, and guardrails are flecked with rust. Trainees also hear the plant—the humming of cooling fans, the roar of gas turbines, and the blaring of sirens.

The AVESTAR Center allows trainees to react to scenarios, such as a virtual gas leak.

The virtual system "represents the IGCC power plant and supplements AVESTAR Center's dynamic simulator that represents the control room," says Dr. **Stephen E. Zitney**, director of NETL's AVESTAR Center. The interaction of these two systems allows control room and field operators to work together to negotiate plant shutdowns, stop leaks, and put out fires, for example. Managers, trainers, researchers, engineers, and students also use the new system. According to Professor **Richard Turton**, who manages WVU's AVESTAR Center, students overwhelmingly like the virtual training—which may benefit them in the future. "Exposure to such systems . . . should make them more competitive in the work environment," he says. The system furthers NETL-RUA's mission to train energy researchers, and will become increasingly vital as cutting-edge gasification technology ignites the energy industry.

"Flexible natural gas and coal-fired power plants are expected to be key sources of clean fossil power in the smart grid era," says Zitney. "Fulfilling that promise, however, requires an adequate supply of well-trained operators."

NETL and Pierpont Extend Power Plant Certification Program

NETL's AVESTAR team is working with Pierpont Community and Technical College to extend their Power Plant Training Certification Program from a one-year curriculum to a two-year curriculum. The expanded curriculum will include more simulation-based training offered at the AVESTAR Center. Students enrolled in the program can use AVESTAR's new virtual immersive training technology. Students will also use new AVESTAR dynamic simulator-based training systems to learn how to operate and control a natural gas combined cycle power plant and a supercritical pulverized coal power plant.

Pierpont's two-year curriculum, operated in partnership with FirstEnergy, will help turn today's students into the skilled and empowered workforce of tomorrow.

Upcoming Event

NETL-RUA will hold its annual fall meeting, the 3rd Annual Energy & Innovation Conference on September 17, 2013

This conference will bring together business and industry leaders from the region and members of the NETL-RUA. The conference will be hosted by NETL-RUA in collaboration with Catalyst Connection.

NETL-RUA Regional University Alliance

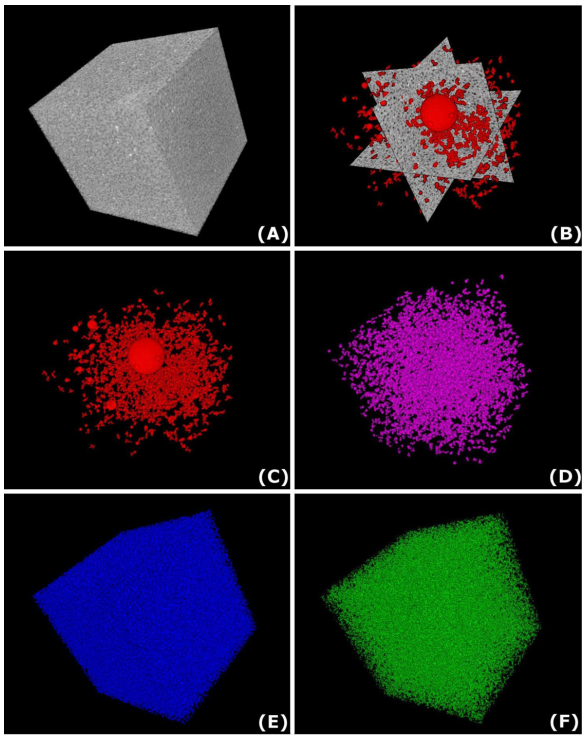
CATALYST CONNECTION™ Your Strategic Partner for Manufacturing Growth

Cement as Never Seen Before

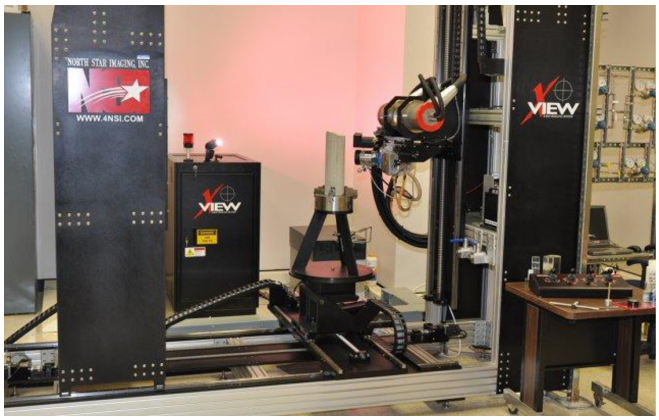
Most people don't think about cement until cracks or holes appear in sidewalks and roads, and even then it does not elicit much excitement. However, the foamed cement used in offshore wells is redefining cement's cool factor. It is formed when a gas—typically nitrogen—is stabilized as microscopic bubbles within a cement slurry. Foamed cement must be sufficiently stable to withstand the high-pressure environments offshore wellbores create. Otherwise, the bubbles could grow, gas pockets could form, and the wells could fail. Historically, scientists struggled with studying foamed cement and its stability as it is used in the subsurface. That is, until recently, when a team of researchers from the NETL Office of Research and Development's Ultra-Deepwater Program stepped in to offer a solution that would change the way foamed cement is studied and viewed.

This NETL-RUA–led team uses an industrial computed tomography (CT) scanner to provide 3-D images of the bubble size distribution that determines the stability of foamed cement and how that distribution varies as cement is pumped into wellbores. To allow CT imaging of cement samples generated under in situ conditions, the team recently transferred field-generated foamed cement samples—created at the Schlumberger Training Pad in Kellyville, Oklahoma—into unique, transparent pressure vessels.

These samples offered researchers the opportunity to study and characterize the foam structure and quality of cement like never before. According to Dr. **Barbara Kutchko**, lead scientist on the project, it is important that the original formation pressure of the foamed cement be maintained when imaging it. "If you generate foamed cement at pressure and then release that pressure, you will get 'snap, crackle, pop' and . . . degrade the structural integrity of the cement." To date, no such studies of foamed cement at formation pressures exist, thus the novelty of the NETL-RUA research. According to Kutchko, the CT scanner lets the researchers insert foamed cements directly into CT-transparent pressure vessels and scan them at in situ pressures. This allows them to gather more realistic statistical information about the cement's quality and stability. Ultimately, the team's research will help ensure the safe operation of deep and ultra-deep offshore wells in which foamed cement systems are used.



*3-D images of foamed cement samples are processed by **Dustin Crandall** and used by researchers to examine the cement's stability in wellbores.*



*The North Star Imaging M-5000 industrial CT scanner located in the CT scanner laboratory at NETL in Morgantown, WV, is operated by **Dustin McIntyre** and his team.*

*Your favorite issues of the NETL-RUA E NEWS are now available on the MOSS and the NETL-RUA website (**www.netl.doe.gov/rua**)*

>> **GTC**, *Continued from Page 2*

academia could work together to improve the grid. After her address, attendees went to one of five breakout sessions, each of which related to GTC's current research and development project: a next-generation power converter.

Steve Knudsen, a scientist with KeyLogic Systems, Inc., attended the "smart control methodology" session, where participants "prioritized possible smart control project areas," said Knudsen. "The session was useful because it let us participate in the planning process for seeking funding for future tasks."

GTC welcomed such participation. As **Wayne Honath**, GTC's Program Development and Industry Relations director, put it, "Those of us within GTC were there to speak very little at the conference, and to listen to and learn from what our guest attendees had to say regarding research needs."

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