JOM, Vol. 65, No. 1, 2013
DOI: 10.1007/s11837-012-0523-x

Feature **Study Update**

Opening the Throttle on Innovation

Lynne Robinson

Progress in integrated computational materials engineering (ICME) could be viewed as having an ICME expert consistently available “to work with the foundry engineer or the design engineer,” said Johnnie Deloach, manager, Welding, Processing and Non-destructive Evaluation Branch, Naval Surface Warfare Center and Technology Transition detailee, Office of Naval Research. The fullest benefits of ICME will be realized, Deloach continued, “when the foundry engineer or the design engineer is the same person as the ICME expert. ICME will no longer be seen as a supplement, but will become so ingrained as to be considered a critical tool of the trade.”

An important step on this journey is the TMS ICME Implementation Study, noted Deloach, who is leading one of the study’s teams focused on the maritime industry. “The goal of this project is not just to generate information, but to offer a blueprint for how ICME can be implemented,” he said. “It has the potential to substantially facilitate—in a real concrete way—the adoption of ICME in industry.” TMS is leading the project on behalf of the U.S. Department of Defense, the U.S. Department of Energy, and the National Science Foundation.

The power of ICME to revolutionize materials-intensive product development cycles was discussed in *Integrated Computational Materials Engineering: A Transformational Discipline for Improved Competitiveness and National Security*, a 2008 report released by the National Research Council of the U.S. National Academies. “Before that groundbreaking report, ICME was being practiced in a few pockets of industry. Ford, for instance, had already done cutting-edge work with its Virtual Aluminum Castings project,” said George Spanos, TMS technical director and overall project leader for the TMS ICME Implementation Study. “One thing that the National Academies report accomplished was defining ICME as a sub-discipline, and by doing that, it got a broader group of people to think about how to significantly accelerate new product development, using predictive tools combined with experiments, and integrating them into the full product development cycle.”


George Spanos

“Our intent is to essentially create a ‘field manual’ on how to implement ICME within various industrial sectors.”

—George Spanos, TMS Technical Director and TMS ICME Implementation Study Project Leader

Since that report, ICME efforts have focused in large part on raising awareness, continued Spanos, observing, “There have been lots of symposia and articles published, but not a whole lot of new ‘soup to nuts’ ICME-accelerated projects.” The TMS ICME Implementation Study builds on the broader recommendations presented in the National Academies report “to further lift ICME out of the realm of discussion and make it more tangible,” explained Spanos. “Our intent is to essentially create a ‘field manual’ on how to implement ICME within various industrial sectors.”

“In my view, ICME has grown from ‘a really important idea’ to a ‘growing movement,’” said John Allison, professor, University of Michigan, and lead of the study team focused on the automotive industry. “With the emergence of the U.S. Materials Genome Initiative, as well as similar efforts in

Asia and Europe, it is clear to me that the materials field is at a real tipping point and the opportunity to make major changes in the way we develop new materials and design with old materials lies before us."

"HOW TO" RATHER THAN "WHAT IF"

The TMS ICME Implementation Study examines the needs of three industrial sectors—maritime, automotive, and aerospace—with a team of experts assigned to each of those specific areas. A fourth team has also been charged with studying the "cross-cutting" issues that are shared among each of the industries. "These will hopefully also be common challenges for the entire ICME effort, affording the opportunity to have a broad impact on overall ICME implementation," said Brad Cowles, senior consultant, Cowles Consulting, LLC, and the lead for the study team on cross-cutting topics. Cowles noted that the work of his team really only begins with identifying and consolidating common concerns across the industries examined in the study. "These must be distilled without being diluted, and the team must then develop realistic, actionable recommendations," he said.

A strong initial theme emerging from the early work of the teams is the need to integrate design into the manufacturing and materials development process, said Spanos. "Rather than linear, as most approach it, the product development cycle should involve optimizing multiple aspects concurrently. To accomplish this, scientists, engineers, and designers from many disciplines and subdisciplines—not just materials—with the different models, experiments, and knowledge that they bring to bear need to work together in a truly cohesive way."

In addition to focusing on the "I"—integrated—in ICME, Spanos noted that another priority area for the study is the "E"—engineering—in the acronym. "Our emphasis is providing people with a framework to implement

MEET THE TMS ICME IMPLEMENTATION STUDY TEAM LEADS

Aerospace

Tresa Pollock

Alcoa Professor of Materials and Chair, Materials Department, University of California at Santa Barbara

Tresa Pollock

Pollock is widely recognized for her work on high-temperature materials, including alloys for aircraft turbine engines. Her current research focuses on structural materials and coatings, the use of ultrafast lasers for materials diagnostics, and development of models for ICME efforts. She was president of TMS in 2005, inducted as a TMS Fellow in 2009, and is associate editor of *Metallurgical and Materials Transactions*. Elected to the U.S. National Academy of Engineering in 2005, Pollock was chair of the committee that produced the 2008 study released by the National Research Council of the U.S. National Academies that first articulated the tremendous potential of ICME. She holds a B.S. from Purdue University and a Ph.D. from the Massachusetts Institute of Technology.

Automotive

John Allison

Professor, Materials Science and Engineering, University of Michigan

John Allison

Allison is an internationally recognized scientist whose current research focus is on ICME and advanced materials. During his 27 years as a senior technical leader at Ford Motor Company, he guided teams pioneering ICME methods and helped develop advanced computer software that simulates manufacturing processes, while also predicting the influence of those manufacturing processes on material properties. Allison was president of TMS in 2002 and elected to the U.S. National Academy of Engineering in 2010. With Pollock, he served as vice chair of the committee that produced the 2008 National Academies report on ICME. He earned his Ph.D. from Carnegie Mellon University and is also a graduate of the U.S. Air Force Academy and Ohio State University.

Maritime

Johnnie Deloach

Manager, Welding, Processing and Non-destructive Evaluation Branch, Naval Surface Warfare Center; Technology Transition Detailee, Office of Naval Research

Johnnie Deloach

Deloach has more than 25 years of engineering service in a broad variety of materials-related engineering and research and development programs. His primary areas of concentration are high-strength steels, filler metal development, friction stir welding, non-destructive evaluation, and weldability assessment and procedure development for ferrous and non-ferrous metals used in U.S. Navy ships and submarines. The overriding objective of his research activities is to develop and transition technology that improves the properties of naval alloys and reduces the cost of construction and support of U.S. Navy vessels. DeLoach earned his B.Sc. from Brown University and his M.MSE from Johns Hopkins University.

Cross-Cutting

Brad Cowles

Senior Consultant, Cowles Consulting LLC; Senior Fellow and Discipline Lead (retired) for Materials and Processes, Pratt & Whitney

Brad Cowles

Cowles has extensive experience in aerospace propulsion, materials, and structures. His current focus, as a consultant to industrial and government agency clients, is developing materials-related strategic plans for the aerospace industry. In his 37 years at Pratt & Whitney, he oversaw Materials and Processes technical projects and technology development programs, including strategic planning for future technology. He holds B.S. and M.S. degrees from Florida State University and a master's in management from Rensselaer Polytechnic Institute.

(Photo left): John Allison, leader of the study's automotive team, reviews insights generated by team members.

The study's in-person team meetings balanced small group discussions (photo above) with facilitated brainstorming sessions on key issues, ideas, and technologies (photo right).

an ICME-accelerated product development program in the near-term—roughly one to four years," Spanos said. "We recognize that some conditions may not be ideal to take on this type of challenge, with development of some specific important tools and data resources still years away. In those instances, we suggest strategies to circumvent barriers, while providing an approach that will still be useful and relevant over the long haul as ICME continues to evolve. A way to advance ICME is to get more people to apply it to engineering problems so that we can learn from their experiences."

While ideas and issues, techniques and technologies are central to the work of the study teams, Spanos said it is the composition of the teams themselves that will drive the outcomes—and success—of the project. "The study has a strong industrial representation and we also made sure that designers were included on each team," he said. "Beyond bringing great value to this report, I believe the high-powered, applied professionals composing these groups can also help nucleate ICME-accelerated product development teams."

While the teams do count recognized pioneers in ICME development and practice among their ranks, many other members represent disciplines and organizations that have more recently started exploring the potential of this nascent field. Deloach, for one, said that he sees himself "as a bridge between ICME and the community that must be engaged in transitioning to these new processes. I understand the culture and barriers involved in moving to ICME—to rely more on computational, rather than purely experimental methods."

"I think one of this study's most valuable contributions is that it has forced technologists to look outside their world to the people who will enable ICME and address their needs," Deloach continued. "This means that the final report will not be just 'preaching to the choir,' but will provide people who are not necessarily ICME experts with clear, actionable steps should they choose to implement these approaches."

Cowles echoed this perspective. "There is no shortage of ICME models or efforts, and future development and improvement will likely continue indefinitely," he said. "My hope is that this study will stimulate active involvement of many members of our technical societies and professionals in industry—not just in the development of ICME, but in the recommended efforts to facilitate broad acceptance and implementation."

ACCELERATING MOMENTUM

The final study report will be presented at the Second World Congress on ICME, July 7–11, 2013, in Salt Lake City, Utah. (For additional information, visit the conference website at *www.tms.org/ICME2013*.) Noting that there is already excitement surrounding the study's release, Spanos said a measure of success will be the "snowball effect" that the report generates once teams begin implementing the presented frameworks. "Increasing the number of positive ICME case studies will then have a huge impact on the field," he said. "If we have more than a few successful ICME implementation projects documented, more organizations will buy into it and be willing to invest in an ICME-accelerated project development program. From there, companies will see the benefit of having that expertise on staff and that demand flows to academia to start equipping the next-generation workforce with those skills."

"I think what we'll see is a rapid acceleration of technologies," Deloach agreed. "With the way things generally work now, you can look back over 30 years and really only identify a handful of new materials technologies, because we can move from concept to implementation only so fast. ICME gives us the ability to efficiently investigate things that we can't even really consider today. So, sometime in the future, it's conceivable that by more widely adopting ICME, we'll be able to look back over just 20 years and identify 10 or 15 new technologies in that timeframe, because we will be able to introduce them more quickly."

"Industries are under a great deal of pressure to do things faster, better, and less expensively. The capability to accomplish this exists with ICME," Deloach continued. "This report is intended to inspire people to start using it."

Lynne Robinson is a news and feature writer for TMS.