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ICME After One Decade: Success and Challenges

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In 2008, the National Academy of Engineering issued a report titled "Integrated Computational Materials Engineering: A Transformational Discipline for Improved Competitiveness and National Security." The year 2018 is the 10-year anniversary of this major milestone in the discipline of integrated computational materials engineering (ICME). With the mission of promoting the area of ICME, the ICME Committee of The Minerals, Metals & Materials Society (TMS) is celebrating the 10th anniversary of the National Research Council's (NRC) report with this special issue.

ICME IN EDUCATION

Since the early 21st century, computational resources with increasing power have become conveniently available. The natural consequence of this is that computational thinking now forms a significant part of many fundamental as well as applied scientific fields, including materials science. In their article titled "Computational Materials Science and Engineering Education: An Updated Survey of Trends and Needs," Katsuyo Thornton et al. present a summary of the state of computational materials science and engineering (CMSE) education, based on a survey of materials science department chairs, faculty with computational interests, and employers of materials scientists and engineers. This survey is an update of one previously conducted in 2009.[1] Most significantly, the survey shows increased availability of CMSE courses in most of the materials departments surveyed, and strong support for including CMSE in the core curriculum. Also, the responses from the computational faculty point to a continued need for modules, including software tools and educational materials, that can be readily implemented by materials faculty regardless of their area of expertise.

Terry Wong, *JOM* advisor for the ICME Committee of the TMS Materials Processing & Manufacturing Division, and Muralidharan Paramsothy are the guest editors for the topic ICME - 10 Years Later: Success and Challenges in this issue.

ICME: PRODUCT DESIGN ENTERPRISE ENABLER

Over the past 10 years, a combination of advancements in materials, computer, and data technologies as well as new government policy and funding has enabled significant progress in providing access to materials data. In their review titled "Evolution of a Materials Data Infrastructure," Charles A. Ward and James A. Warren remind us that easy access to materials data in digital form was a key goal mentioned in the NRC's report, and then go on to show us how the development of a Materials Data Infrastructure (MDI) is the natural and necessary evolution of the need for easy access to materials data. In addition to fulfilling the need for materials scientist and engineers to get access to data, Ward and Warren rightly envision that the MDI is also becoming an enabler for materials engineering to tie into a much broader model-based engineering enterprise for product design.

ICME IN RENEWABLE ENERGY

Concerning the ever-growing focus on renewable energy over fossil fuels in today's world, the high temperatures required for efficient operation of solar thermal power plants represent a major challenge. Gaining insight into materials behavior at very high temperatures is critical to improve their techno-economic feasibility. In their article titled "Integrated Computational Materials Engineering in Solar Plants: The Virtual Materials Design Project," Francisco Montero-Chacon et al. propose a multiscale multiphysics approach that accounts for materials composition to (1) predict the behavior of both Inconel 625 and new solar salts, and (2) assess the thermomechanical performance of key components. Their work shows the substantial economic benefits that may be achieved by an ICME approach in the energy sector (due to a better understanding of materials behavior), reducing the cost of prototypes while decreasing

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development times and maintenance costs. Their work also show how ICME techniques can be applied to industries outside of the automotive and aerospace industries documented in the NRC's report 10 years ago.

The following papers being published under the topic of ICME - 10 Years Later: Success and Challenges provide excellent details and research on the subject. To download any of the papers, follow the url http://link.springer.com/journal/11837/70/9/page/1 to the table of contents page for the September 2018 issue (vol. 70, no. 9):

- "Computational Materials Science and Engineering Education: An Updated Survey of Trends and Needs" by Raul A. Enrique, Mark Asta, and Katsuyo Thornton
- "Evolution of a Materials Data Infrastructure" by James A. Warren and Charles H. Ward
- "Integrated Computational Materials Engineering in Solar Plants: The Virtual Materials Design Project" by Francisco Montero-Chacon, Michele Chiumenti, Javier Segurado, and Manuel Doblare

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1. K. Thornton, S. Nola, R.E. García, M. Asta, and G.B. Olson, *JOM* 61, 12 (2009).