INTRODUCTION

TO A SPECIAL SECTION ON THE

CACHE 50th Anniversary Conference

The Future of Cyber-Assisted Chemical Engineering Education

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BACKGROUND

The five articles in this special section had their origin at a 2019 conference on the *Future of Cyber-Assisted Chemical Engineering Education*, sponsored by CACHE (Computer Aids for Chemical Engineering Education) as a celebration of the 50th anniversary of the founding of the non-profit corporation. The proposal founding the Computer Aids for Chemical Engineering Committee was submitted to the NSF on July 14, 1969 and the first official meeting of the CACHE organization was held on November 18, 1969 in Washington DC. From its inception, CACHE (cache.org) has promoted the development and distribution of technology-based materials and software in chemical engineering education through projects applying computational chemical engineering, sponsoring conferences, recognizing outstanding contributions, and providing leadership in chemical engineering education.

CACHE 50TH ANNIVERSARY CONFERENCE

The primary focus of the conference was to bring together thought leaders, innovators, educators and industrial practitioners to explore and discuss future directions in the use of computing technology, data science, and the internet-based communications infrastructure to enhance chemical engineering education. A secondary focus was to review and celebrate the accomplishments of CACHE over this period in supporting educational and research innovations.

The conference kicked-off with a tag team review of CACHE accomplishments by Brice Carnahan, Warren Seider, Larry Evans and Tom Edgar. This was followed by overviews of current CACHE initiatives by Frank Doyle (Systems Biology), Peter Cummings (Molecular Modeling) and Richard Braatz (Process Systems). Plenary talks (Figure 1) on the future directions in cyber-enabled ChE education were given by Evan Sorensen "Chemical Engineering Education in the Cyber Era,", Tom Adams "Modernizing the Undergraduate Process Design Curriculum," Richard Turton "Dynamic Models and Operating Training Simulators: Teaching Students About How Process Plants Operate," Linda Broadbelt "Beyond A➔B: Computational Approaches for Education in Reaction Engineering and Kinetics of Complex Systems," and David Beck "Graduate Research & Training in Molecular Data Science through a University -wide Approach to Integrative Data Science Education," followed by a panel discussion with active audience participation. Later, Martha Grover and Robert Hesketh discussed the objectives of a survey on computing in chemical engineering.

There were sessions of invited oral and poster presentations by 20 outstanding young faculty who are innovating in the development of educational media, exploring novel ways of organizing student-instructor interactions to enhance learning and experimenting with alternative knowledge delivery modes. Speakers included Jason Bara, Bryan Boudouris, Alexander Dowling, Ashlee Ford Versypt, Rachel Getman, Andrew Paluch, Jonathan Ver-

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rett, Roman Voronov and Bin Wang. A second innovation forum session included Selen Cremaschi, Helen Durand, Federico Galvanin, Johannes Hachmann, Joseph Kwon, Robert Pantazes, Zachary Ulissi, Kirti Yenkie, Fani Boukouvala and Victor Zavala. The speaker at the closing banquet was Professor John Anderson, President-elect of the US National Academy of Engineering, who gave an entertaining history of his experience with computing in chemical engineering and provided a toast exactly at the time (8:17 pm MDT, 20 July 1969) of the 50th anniversary of the Apollo 11 landing.

The conference served to simulate innovation both in curriculum development as well as in the novel uses of cyber-infrastructure to enhance student learning. As a result of the discussions at this conference we anticipate more intensive use of cyber-infrastructure and tools not just in the process systems-oriented portions of the curriculum (design, control and data analytics) but also in the fundamentals courses, such as thermodynamics, transport phenomena, separations and reaction engineering. We expect that the tools and methods discussed will have impact on both undergraduate and graduate engineering education and particularly to contribute to the innovation in professional master degree programs, which focus on cyber tools. The educational innovations presented will have relevance to other engineering disciplines closely related to chemical engineering, such as material science, bioengineering and biomedical engineering.

The broader impact of the ideas presented and discussed will arise in the enhanced understanding and deeper insights that students will be able to attain by virtue of the rich, multifaceted presentation of traditional topics made possible by cyber-enabled educational methodology. It will also arise by virtue of the student being exposed to the underlying technologies, such as data analytics, data management, artificial intelligence, simulation and optimization, which need to be part of the tool kit of the modern engineer. The conference website contains most of the relevant conference information http://www.cache50th.org. A special CACHE-sponsored session summarizing the important threads of the conference, including several of the presentations, was held at the 2019 AIChE Annual meeting in Orlando to more widely disseminate the findings of the conference.

SPECIAL SECTION ARTICLES

During and after the conference a number of young faculty decided to collaborate on articles that had some common themes, resulting in the five articles in the special section of this journal. Bara and McLemore detail the performance of a units conversion mobile app over a 5-year period. Godwin and Boudouris illustrate the use of on-line videos and team-based projects in a redesigned sophomore material and energy balances course. The article by Yenkie outlines how computational laboratories and team projects are used to reinforce design-thinking in required and elective courses at Rowan University. Ford Versypt et al. survey a number of apps developed for iOS®, Mathematica®, Excel®, R®, WebMO®, MATLAB® and COMSOL®. Finally, Verrett et al. show how the Jupyter Notebook® can be used to promote active learning in a number of courses.

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Figure 1. *Invited Plenary Speakers (Left to Right): Richard Turton, David Beck, Linda Broadbelt, Tom Adams, and Eva Sorenson.*