A forum for emerging systems and control technologies.

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STUDENT DESIGN COMPETITIONS:

LEARNING BY DOING

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Tentative future issues of *Dynamic Systems & Control Magazine*

June 2018
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Design Competitions: Learning by Doing

This issue of the magazine shines a spotlight on design competitions, with a focus on control and robotics. Based on a suggestion at a recent Dynamic Systems and Control Conference, the intent of this issue is to introduce readers to several student design competitions. In general, these contests serve to excite students with real-life challenges that help students to apply lessons learned in their courses. The competitive spirit fostered by these contests also helps encourage students to go beyond what seems possible and to give them the opportunity to savor the sweet taste of victory.

Although the emphasis is on student experiences, the hope is that these vignettes also serve to illustrate the rich vein of possibility for researchers and potential sponsors, who might well consider getting involved in future competitions.

The articles selected for this issue demonstrate the full variety of available experiences. The first article, by Diane Peters from Kettering University, describes the AutoDrive competition, sponsored by GM and SAE, a contest primarily for undergraduate students, but with help from graduate students. The aim of this three-year competition is to develop a fully-autonomous vehicle capable of handling a wide variety of driving challenges. The second article, by Steve Florence, Nikhil Bajaj and George Chiu from Purdue University, highlights the FIRST robotics competition, a set of challenges primarily for K-12 students, but with significant input from College students. The third article, by Taskin Padir from Northeastern University, focuses on two research competitions on humanoid robots, sponsored by DARPA. Here, the aim is primarily graduate students focusing on cutting-edge research.

I hope you enjoy these articles and, as always, I welcome your suggestions for topics for future issues.

Peter Meckl
Editor, *DSC Magazine*

COVER IMAGES: DARPA, KETTERING UNIVERSITY, NORTHEASTERN UNVIERSITY, AND PURDUE UNIVERSITY.

MECHATRONICS EDUCATION INNOVATION WORKSHOP: A SUMMARY REPORT

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The Internet of Things, robotics, and smart systems are beginning to make demands on academic programs to deliver a more modern and complete treatment of the necessary skills, methodologies, and technologies to meet the requirements of industry. Mechatronics, with its inherent interdisciplinary character, offers a vehicle to address these challenges and opportunities. Mechatronics education programs can modernize engineering curricula offerings, make them relevant to students' interest, and address workforce demands for graduates who have broad interdisciplinary training and practical experience with project work.

Even as academic institutions design and implement mechatronics programs that impart students real-world experiences, there is a need to determine if, and how students' education, training, and hands-on project skills are applicable in the workplace. In response, on November 14-15, 2016, NYU Tandon School of Engineering and Quanser, with generous support from the National Science Foundation, organized a workshop on *Mechatronics Education Innovation*. The event brought together more than 70 academics and representatives of industry from US, Canada, UK, and Denmark, as well as diverse perspectives on important educational paradigms, innovations, and best practices.

The workshop opened with the Industry Panel, chaired by Dr. Tom Lee from Quanser. The discussion focused on three main themes: business and societal drivers, key needs of industry, and effective relationships with academia. Alex Catalan (Fiat Chrysler), Jeannie Falcon (National Instruments), Jean-Philippe Laguerre (Dassault Systems), David Mittelman (4th Law), and Paul Karam (Quanser) agreed that mechatronics programs should prepare graduates who are able to learn new skills throughout their careers, apply critical thinking, and work with real-life constraints of deadlines, resources and requirement trade-

Participants of the Mechatronics Education Innovation Workshop.

offs. From the technical point of view, graduates need to be able to understand, simplify, and optimize complex systems. The mechatronics programs should focus on building strong fundamentals in sensors, actuators, interfacing, embedded control, multi-domain modeling, and real-time computing among others, and provide students with hands-on, project-based learning experiences.

The Academic Panel, chaired by Dr.Vikram Kapila from NYU Tandon, introduced the workshop participants to some of the successful mechatronics programs. Dr. George Panoutsos (University of Sheffield), Dr. Mathew Feemster (US Naval Academy), Dr. David Auslander (University of California, Berkeley), Dr. Vladimir Vantsevich (University of Alabama, Birmingham), and Dr. Michael Gennert (Worcester Polytechnic Institute) described the key components of their programs' design and curricula, and discussed the successes and challenges of building and maintaining mechatronics programs at their institutions. In the following open discussion, the workshop participants addressed the challenges of curriculum modernization. The general opinion was that integrating electrical, mechanical and computer engineering was more feasible when developing a new, stand-alone mechatronics programs, than when incorporating mechatronics as a specialization or thrust within traditional mechanical or other engineering programs. The other major challenge mentioned was the resource-intensive character of mechatronics courses, including both hardware costs and load on the faculty, as well as the need to find new and more effective teaching approaches in order to fit traditional engineering subjects, new emerging concepts and project-based experiences into the curricula. This proved to be especially difficult at the undergraduate level, while the graduate-level curriculum could be more flexible. The workshop participants also discussed the roles of two-and four-year colleges and their graduates in the industry, and how to enable college students to transfer to university-level programs.

The Best Practices Panel provided an opportunity to delve deeper into the 'nuts and bolts' of some exemplary mechatronics education programs and their outcomes. The presenters included Dr. Sunil Agrawal (Columbia University), Dr. Sabri Cetinkut (University of Illinois, Chicago), Dr. Mark Colton (Brigham Young University), Dr. Venkat Krovi (Clemson University), and Dr. James Mynderse (Lawrence Technological University).

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Following the panel presentations and discussions, the participants worked in small breakout groups to identify needs and challenges for mechatronics education programs. The following themes emerged from the discussions and report-out session.

- The industry wants academic institutions to deliver fundamentally sound "educational" programs instead of "training" programs, with a careful balance between abstract theoretical concepts and industry-relevant applications.

- With the emerging transition from automation-focused to intelligent mechatronic systems, there is an urgent need to integrate an array of new concepts in mechatronics education programs.

- The faculty is often challenged by a lack of effective resources for mechatronics instructional materials, dedicated laboratory space, and availability of experienced teaching assistants. With the accelerating pace of technology, mechatronics courses also need to be frequently revamped to stay current.

These themes were highlighted in the workshop wrap-up, delivered by Dr. Kapila. Building on the workshop discussions, he highlighted several areas, such as autonomous and electric vehicles, space robotics, and IoT, where the most exciting applications of mechatronics and robotics are expected to come over the next 10 years.

The role of industry input to academia remained undisputed, however the educators stressed the need to balance the industry influence with their educational goals. Some of the practical aspects where industry could help enhance the education included offering real-world applications for student projects, internship opportunities for students and faculty, and direct interactions as adjunct faculty and industry advisory board members.

While the two-day workshop could not address and find solutions to all the challenges, it served as a catalyst for creating an online space where the conversations and discussion could continue. With the support of Quanser, and moderated by Dr. Lotfi from the Southern Illinois University Edwardsville, mechatronicseducation.org, a community site for mechatronics educators, was launched in March 2017. As of June 2017, the community has more than 100 members. The important discussions also continued through additional live events inspired by the Mechatronics Education Innovation Workshop. With the support of Quanser as a main industrial partner, similar events were organized globally throughout 2017 at the University of Sharjah (UAE), in Austin, Texas, and at the Technical University of Denmark. Additional mechatronics education-focused workshops will be held later in 2017 in Mexico and Malaysia. ■