O VER the centuries, the engineering profession has evolved to meet the growing needs of society, resulting in demand for and creation of new engineering disciplines. Biomedical, environmental, aeronautical, and computer engineering are four examples of engineering branches that emerged to educate rising generations of engineers to find solutions to new challenges requiring a diverse set of knowledge and expertise. The 2010 report “Engineering: Issues, Challenges and Opportunities for Development” by UNESCO provides a new perspective on engineers’ critical contributions to addressing the large-scale pressing challenges facing society, which include but are not limited to healthcare, housing, nutrition, transportation, and communications. The report further emphasizes that the engineer’s role must be made more visible within society, and better understood by younger generations, if the growing global need for engineers is to be met.

Robotics engineering is on the verge of becoming the next disruptive engineering discipline. Research volume has grown exponentially in recent years, as has technology development by the robotics industry. Many market forecasts predict a significant increase in deployment of robotic systems in the next decade. Much of this increase is expected to be in applications where robots act in direct support of humans, such as healthcare, small-scale manufacturing, leisure and entertainment, the service sector, and defense. In response to this growth, governments across Asia, Europe, and America have launched programs to support research and technology development in these areas.

Robotics is a highly multidisciplinary field, with application areas limited only by imagination. Through its all-inclusive nature, robotics engineering has potential to attract young generations to the engineering profession and educate them with a multidisciplinary skill set to meet global needs for development. As a result, robotics engineering provides opportunities to revitalize science, technology, engineering, and mathematics (STEM) education. Given that students of engineering in 2013 will still be professionally active in 2050, their engineering education should be broad enough that, throughout their careers, they can continue to generate solutions that meet the evolving requirements of global industry and society. It is widely accepted in academia and industry that a good understanding of engineering science; a good understanding of engineering design process; a multidisciplinary perspective; excellent communication skills; high ethical standards; critical and creative thinking; an appreciation of the importance of teamwork; an awareness of economic, environmental, and societal issues; and a desire for lifelong learning are among the attributes of the interface between engineering education and engineering practice. Robotics, the integration of sensing, computing, and actuation in the physical world, can effectively be used to build this interface.

As in other emerging engineering disciplines, robotics engineering educators are facing challenges in designing and delivering multidisciplinary material in a unified manner. Successful implementations of robotics engineering courses and curricula must overcome challenges of creating course and curriculum materials with sufficient intellectual breadth and depth to prepare students for lifelong development while emphasizing relevance and a problem-solving approach. Hands-on projects integrated into course work must be designed to be engaging and level-appropriate while introducing whole system design principles. Finally, development of rigorous assessment tools is needed to evaluate effectiveness of instructional strategies. Together, these efforts will help to ensure widespread adoption and standardization of robotics engineering education materials and will help to guide creation of more precise definitions of the field and its practices.

This special issue of the IEEE TRANSACTIONS ON EDUCATION is a compilation of papers that report on curriculum development initiatives, educational robot platforms, best practices, and experience reports on innovative approaches to robotics engineering education. We received more than 100 submissions from all around the world, another clear indicator of the timeliness and the need for this special issue on robotics education. The selected papers cover a wide spectrum of educational efforts in robotics by reporting on freshmen-level courses to graduate programs. Across these efforts, the reports highlight the synergy between traditional disciplines of computer science, electrical engineering, and mechanical engineering and emphasize the multidisciplinary design skills that form the interface between robotics engineering education and practice. To provide the readers with more guidance and insight into the contents of the special issue, we divided the papers into four clusters.

- Aroca, Gassert, Kulich, McLurkin, Navarro, and Vona focus on robot platforms and learning frameworks from open systems to distance education while discussing learning materials wrapped around the platforms.
- Cierniak, Correll, De Cristoforis, and Riek emphasize learning computation in robotics engineering.
- Capelleri, Crowder, Huang, Neves, and Shiller demonstrate effective project-based activities ranging from introductory to graduate courses.
- Bonarini, Crenshaw, Hamblen, Jung, and Yilmaz concentrate on design and provide a systems perspective to robotics engineering education.

We acknowledge that this is a very broad classification and there is tremendous overlap between the clusters. In closing, we hope that this special issue becomes an archival reference
for many years to come to define robotics as a new engineering
discipline in service of the society.

TASKIN PADIR, Guest Editor
Assistant Professor of Robotics Engineering and
Electrical and Computer Engineering
Worcester Polytechnic Institute
Worcester, MA 01609 USA
(e-mail: tpadir@wpi.edu)

SONIA CHERNOVA, Guest Editor
Assistant Professor of Robotics Engineering and
Computer Science
Worcester Polytechnic Institute
Worcester, MA 01609 USA
(e-mail: soniac@cs.wpi.edu)

Taskin Padir (M’05) received the B.S degree in electrical and electronics engineering from the Middle East Technical University, Ankara, Turkey, in 1993, and the M.S. and Ph.D degrees in electrical and computer engineering from Purdue University, West Lafayette, IN, in 1997 and 2004, respectively.

He is an Assistant Professor of robotics engineering and electrical and computer engineering with Worcester Polytechnic Institute (WPI), Worcester, MA, where he teaches undergraduate unified robotics curriculum and a graduate-level robot control course. His research interests include human-in-the-loop robotic systems, design of robot control interfaces, cooperating robots, control of redundant robot systems, and control of ground vehicles.

Dr. Padir received the Inaugural Rho Beta Epsilon Award for Excellence in Robotics Education in 2010 and the 2011 Romeo L. Moruzzi Young Faculty Award for Innovation in Undergraduate Education for his contributions to WPI’s undergraduate program in Robotics Engineering.

Sonia Chernova (M’11) received the Ph.D. degree in computer science from Carnegie Mellon University, Pittsburgh, PA, in 2009.

She is an Assistant Professor of robotics engineering and computer science with Worcester Polytechnic Institute, Worcester, MA. After receiving the Ph.D. degree, she held a Postdoctoral Associate position with the MIT Media Lab, Cambridge, MA. Her research interests lie in interactive machine learning, adjustable autonomy, and human–robot interaction. Her work focuses on the development algorithms that enable robots to learn through social interaction with humans.