

The emergence of K-12 engineering education standards demands that we ask: “How will we adequately prepare and support the educators who will teach engineering in K-12 classrooms, many of whom have no experience in engineering?” In 2012, motivated by a belief that the professional preparation and development of these teachers should be guided by well-reasoned and research-based standards, Cheryl Farmer (The University of Texas at Austin) and Louis Nadelson (Boise State University) launched what would become a national effort to define *Standards for Professional Development for K-12 Teachers of Engineering*.

Using the *Standards for Professional Development for Teachers of Science* as defined in the 1996 *National Science Education Standards* as a framework, Farmer and Nadelson drafted a first set of *Standards for Professional Development for K-12 Teachers of Engineering* in collaboration with Stacy Klein-Gardner (Vanderbilt University and Harpeth Hall School), Elizabeth Parry (North Carolina State University), and Malinda Zarske (University of Colorado). This team then invited 60 engineering educators from across the nation to participate in a workshop at the American Society for Engineering Education (ASEE) annual meeting in June 2012. The thirty-nine educators¹ who participated in this session worked in small groups to provide critical feedback on the draft standards, which were revised in response to this input.

In the winter of 2013 Farmer, Klein-Gardner and Nadelson consulted with David Burghardt (Hofstra University) regarding the alignment of the *Standards for Professional Development for K-12 Teachers of Engineering* with the National Academy of Engineering’s 2009 publication *Engineering in K-12 Education*, on whose author panel Burghardt had served. In response to Burghardt’s feedback, an introductory declaration of the nature, content and practice of engineering was added.

With the content of the standards completed, Farmer and Klein-Gardner collaborated with Jackson Reimers (Vanderbilt University) on a thorough literature review to ensure that the standards are fully aligned with research on professional development and engineering education. An article based on this literature review is currently undergoing the peer review process for consideration by the Journal for Pre-College Engineering Education Research (JPEER).

¹ Leigh Abts (University of Maryland), Gregory Bartus (Stevens Institute), Laura Bottomley (North Carolina State University), Iris Burnham (DaVinci School for Science and the Arts, TX, K-12), Richard Crawford (The University of Texas at Austin), Martha Cyr (Worcester Polytechnic Institute), Lizette Day (Rachel Freeman School of Engineering, NC, K-12), Melissa Dean (Mobile Area Education Foundation), Candy Ellard (Austin Independent School District, TX, K-12), Edie Ervin (American Society of Mechanical Engineers), Louis Everett (National Science Foundation), Cheryl Farmer (The University of Texas at Austin), Lisa Guerra (NASA), Chris Hartmann (PTC), Karen High (Oklahoma State University), Anne Jones (Project Lead the Way), Bill Kelly (ASEE), Stacy Klein-Gardner (Vanderbilt University and Harpeth Hall School, TN, K-12), Paul Klenk (Duke University), Magda Lagoudas (Texas A&M University), Pamela Lottero-Perdue (Towson University), Augusto Macalalag (Stevens Institute), Libby Martin (ASEE), Scott Molitor (University of Toledo), Tamara Moore (University of Minnesota), Louis Nadelson (Boise State University), Araceli Ortiz (Texas Higher Education Coordinating Board), Karen Ostlund (National Science Teachers Association), Albert Padilla (Dr. Michael Conti School #5, NJ, K-12), Elizabeth Parry (North Carolina State University), Thomas Perry (American Society of Mechanical Engineers), Susan Pruet (Mobile Area Education Foundation), Rob Reilly (MIT), Larry Richards (University of Virginia), Christine Schnittka (University of Kentucky), Sharlene Yang (Engineering is Elementary), Shamsnaz Virani (Penn State University), and Malinda Zarske (University of Colorado Boulder)

With the *Standards for Professional Development for K-12 Teachers of Engineering* complete, Farmer, Klein-Gardner and Nadelson asked how such a document could be made most useful to those who would seek to create or identify a particular type of professional development. This consideration led to the idea of developing a *Matrix for Professional Development for K-12 Teachers of Engineering* that would describe how a professional development program might demonstrate a particular level of emphasis (*i.e.*, high, medium, low, none) on each element of each standard. In the spring of 2013, six virtual working groups with a total of 28 members² convened to address this problem and to contribute ideas toward the development of such a matrix. During the summer of 2013, Farmer and Klein-Gardner assimilated the results of the virtual working groups to develop a first draft of the *Matrix for Professional Development for K-12 Teachers of Engineering*. That fall, with financial support from the ASEE, seventeen members of the national engineering education community³ met at the Harpeth Hall School in Nashville in October to build on the work of these virtual groups. Their work enabled Farmer and Klein-Gardner to create a testable draft of the matrix.

In the spring of 2014, 10 providers of engineering professional development⁴ agreed to beta-test the matrix by having their teams apply it to their own programs. Each beta-tester had multiple team members complete the matrix independently, compiled the results into a single response document, noted discrepancies and reported sources of confusion. The results of this process were assimilated in edits to the matrix and in May 2014, the *Standards for Professional Development for K-12 Teachers of*

² Participating group members were Laura Bottomley (North Carolina State University), Dave Burghardt (Hofstra University), Aaron Clark (North Carolina State University), Martha Cyr (Worcester Polytechnic Institute), Melissa Dean (Mobile Area Education Foundation), Arthur Eisenkraft (University of Massachusetts Boston), Edie Ervin (American Society of Mechanical Engineers), Cheryl Farmer (The University of Texas at Austin), Karen High (Oklahoma State University), Christa James-Byrnes (University of Wisconsin – Barron County), Anne Jones (Project Lead the Way), Stacy Klein-Gardner (Vanderbilt University and Harpeth Hall School, TN, K-12), Pamela Lottero-Perdue (Towson University), Augusto Macalalag (Stevens Institute of Technology), Catherine McCulloch (EDC), Louis Nadelson (Boise State University), Steve O'Brien (College of New Jersey), Araceli Ortiz (Texas Higher Education Coordinating Board), Albert Padilla (Dr. Michael Conti School #5, NJ, K-12), Elizabeth Parry (North Carolina State University), Greg Pearson (National Academy of Engineering), Leyf Pierce (North Carolina School of Science and Mathematics, K-12), Susan Pruett (Mobile Area Education Foundation), Jeff Rosen (Georgia Tech University), Sara Torres (Arizona Science Teachers' Association), Bev Vance (Public Schools of North Carolina), Sharlene Yang (Engineering is Elementary), Malinda Zarske (University of Colorado Boulder)

³ Leigh Abts (University of Maryland), Laura Bottomley (North Carolina State University), Martha Cyr (Worcester Polytechnic Institute), Cheryl Farmer (The University of Texas at Austin), Melinda Higgins (Harpeth Hall School, TN, K-12), Karen High (Oklahoma State University), Stacy Klein-Gardner (Vanderbilt University and Harpeth Hall School, TN, K-12), Anant Kukreti (University of Cincinnati), Pamela Lottero-Perdue (Towson University), Augusto Macalalag (Arcadia University), Steve O'Brien (College of New Jersey), Elizabeth Parry (North Carolina State University), Jeff Rosen (Georgia Tech University), Amy Ryan (Harford County Public Schools, MD, K-12), Anne Spence (University of Maryland Baltimore County), Beverly Vance (Public Schools of North Carolina), Sarah White (Williamson County Schools, TN, K-12)

⁴ Martha Cyr (Worcester Polytechnic Institute), Melissa Dean (Mobile Area Education Foundation), Cheryl Farmer (The University of Texas at Austin), Anant Kukreti (University of Cincinnati), Pamela Lottero-Perdue (Towson University), Augusto Macalalag (Arcadia University), Mercedes McKay (Stevens Institute of Technology), Merredith Portsmore (Tufts University), Keri Randolph (Public Education Foundation Chattanooga), Amy Ryan (Harford County Public Schools, MD, K-12)

Engineering and the Matrix for Professional Development for K-12 Teachers of Engineering were declared final and submitted to the ASEE for publication.

It is the hope of everyone who has been involved in this 30-month process that these documents will be used freely and widely by creators, providers and consumers of professional development to identify appropriate professional development opportunities for K-12 teachers of engineering.