The Attributes of a Global Engineer Project

ASEE's Corporate Member Council

With philanthropic support for the Project provided by The Boeing Company

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Brief Discussion at Your Table (and Report-out):

To what extent is it important to prepare engineering technology students for a global work context?

Learning Outcomes

Upon completion of our time together, you should be able to:

- Explain the significance of preparing engineering technology graduates for a global work context
- Describe the Attributes of a Global Engineer Project
- Use the Attributes to augment, enhance, or support the preparation and performance of engineering technology graduates

Outline

- Significance
- Origin / development of the Attributes of a Global Engineer
- Findings-to-date from the Attributes Project
- Using the Attributes and linkages to related initiatives and activities
- Project next steps / invitation for involvement
- Brief table discussion / report-out
- Q&A / discussion / wrap-up

Significance

- Global Context for Engineering Work
- Global Competence Frameworks in Engineering Education
- Curricular Considerations to Prepare Global Engineers
- Industry Involvement in Preparing Global Engineers

Global Context for Engineering Work

- Universities must prepare a U.S. engineer capable of both **competing and collaborating with his or her foreign counterparts**
- Critical questions include: What skills do technical professionals require to meet its demands? How must they **interact across cultures** to be effective? How can their needs be developed?
- Increasing distance between technology innovators and their markets requires engineering programs to reflect the new realities of **global innovation**
- Engineers need to be acquainted with / aware of cultures for an adequate design of **product and services for global markets**

Arango (1991); Morgan & Richard (1991); Rajala (2012); Nambisan (2005); and Duderstadt (2010)

Global Competence Frameworks in Engineering Education

- Engineering education is now comprised of technical, professional, and *global* skill; the **demands of the 21st century global engineer are significantly different and more complex** than what has been needed
- Academic **preparation of the global engineer is the next major wave of change** that will confront engineering education programs worldwide
- While there is broad agreement within the engineering community for the need to better prepare engineers for global practice, **there is much less agreement as to *what* skills and abilities define global competence**
- NAE challenges colleges and universities to **prepare engineers that are leaders in global engineering fields** with strong communication, leadership, interdisciplinary research, and professional skills **for diverse engineering environments**

Waggenspack et al. (2011); Lohmann et al. (2006); Prados et al. (2005); Whitman et al. (2007); Hirleman et al. (2007)

Curricular Considerations to Prepare Future Engineers

- Curricula is needed that enhances systems thinking, reflects sustainable practices, promotes teamwork communication, and prepares students to **make an impact in the global community**
- Additionally, language expectations, communication skills, multiculturalism, sensitivity issues, and engineering related **global issues in societal, engineering, and business fields** is needed
- Engineering programs that do nothing to address the **challenges of globalization** will soon be irrelevant
- **Integrating global education** into the engineering curriculum to achieve maximum impact on addressing societal needs

Craig (2010); Grandin and Hirleman (2009); Doboli et al. (2009); Zandvoort (2008); VanderSteen and Mushtaq (2010)

Industry Involvement in Preparing Global Engineers

- Is engineering education appropriately realistic for an **increasingly global economy**?
- Does our **curricula meet the needs of employers**, and to what extent should employers influence the nature of the engineering curriculum?
- Feedback from graduates and industry partners can help provide guidance to improving the preparation and ultimate **performance of globally-oriented engineering students**
- Some employers find engineering graduates to be weak in engineering design, innovation, communication, **international teams**, leadership, and associated professional skills
- Involving industry colleagues can help to influence curriculum, engage with students, assist with accreditation, and provide resources for **globally-oriented engineering preparation**

Beckman et al. (1997); Arlett et al. (2010); Jones (2003); May and Strong (2011); Martin et al. (2005)

Enter…the Corporate Member Council

Corporate Member Council (CMC) was established by the American Society for Engineering Education (ASEE) Board of Directors to convey to ASEE the ideas and views of corporations, government agencies, and non-profit organizations with an interest in engineering education and research.

CMC's mission is to foster, encourage, and cultivate the dialogue between industry and engineering educators.

"In 2008, the ASEE-CMC recognized a gap in the needed global and transportable capabilities of its workforce.

As a response, the ASEE-CMC established the International Engineering Education Special Interest Group (SIG) to enhance the employability of engineering graduates and increase the international competitiveness of our corporate members."

--Diane Matt, ASEE CMC President, 2014

The Attributes of a Global Engineer Project

- Project Goals:
  - Provide resources for academicians and/or corporate representatives to enhance an on-going dialogue and engagements resulting in:
    - Increased numbers of globally competent engineers, allowing work and employees to be more transportable
    - Enhanced employability of engineering global graduates
    - Increased international competitiveness of ASEE's members
- The Deliverables:
  - The attributes framework, competencies, and resources for:
    - Preparing a globally-oriented engineer capable of effectively living, working, or performing in a global setting
    - Targeting appropriate interventions at various stages of a global engineer's educational and professional development (Secondary, Postsecondary, Professional)

Key Corporate and Other Stakeholders Involved

- The Boeing Company
- Dupont
- MathWorks
- Rolls-Royce
- Dassault Systems
- Quanser
- John S. Wiley and Sons
- National Academy of Engineering
- International Federation of Engineering Education Societies (IFEES)
- Global Engineering Deans Council

Project Phases

- 2008-09: CMC establishes SIG on International Engineering Education
- 2010 Attributes of a Global Engineer Project formally commences
  - Informed from the work of John McMasters (The Boeing Company)
  - Literature review and content analysis of CMC organizations' job descriptions
- 2010-11: Refinement of Attributes and Survey
  - 48 initial Attributes refined/vetted to a list of 20, organized in 5 broad categories
  - Survey development, translation, and global deployment through IFEES
  - Initial analysis / interpretation and Outcomes-per-Attribute statements developed
- 2012-15: Focus groups / workshops held for additional input into Project:
  - Argentina; Australia; Belgium; Canada; Colombia; Finland; India (January 2015); Japan; Thailand; United Arab Emirates (December 2014); United Kingdom; and United States

Attributes of a Global Engineer

- 20 Attributes informed through:
  - Literature review
  - Content analysis of global engineering job descriptions provided by CMC members
  - CMC peer review/Delphi technique
  - Global focus groups

- Attributes organized in following 5 categories (refer to handout):
  - Technical
  - Professional
  - Personal
  - Interpersonal
  - Cross-cultural

Attributes of a Global Engineer Survey

- Survey developed to ask for perceptions about the most important attributes needed for engineers at various stages of their development
- Translated into 13 different languages and launched through IFEES
- 1,027 "useable case" respondents:
  - 70% English; 30% non-English; responses received from all languages except French
  - 80% Male; 20% Female
  - 50% between ages of 40-60; balance over other age ranges
  - 46% Academicians; 40% Practitioners; 10% Students; balance preferred not to answer
  - Aerospace (17%); Computer Science (13%); and Electrical/Computer (13%) are largest engineering discipline response categories
  - 64% reported having graduate-level *engineering* degree

Overall, the 8 most Important Attributes Identified

Communicates effectively in a variety of different ways, methods, and media

Possesses the ability to think both critically and creatively

Shows initiative and demonstrates a willingness to learn

Functions effectively on a team

Possesses the ability to think both individually and cooperatively

Demonstrates an understanding of engineering, science, and mathematics fundamentals

Demonstrates an understanding of information technology, digital competency, and information literacy

Maintains a positive self-image and possesses positive self-confidence

Attribute Importance by Professional Development Stage

- Upon completion of high school (or global equivalent):
  - Demonstrates an understanding of engineering, science, and mathematics fundamentals
  - Maintains a positive self-image and possesses positive self-confidence

  (***preparedness / readiness / resiliency to study engineering***)

- Upon completion of baccalaureate degree (or global equivalent):
  - Demonstrates an understanding of engineering, science, and mathematics fundamentals
  - Demonstrates an understanding of information technology, digital competency, and information literacy

  (knowledge of the discipline / tools and technologies of the field)

- As an early-career engineering professional (within first 3-5 years):
  - Functions effectively on a team
  - Possesses the ability to think both individually and cooperatively

  (ability to make flexible contributions / accountability to team and for self)

Focus Group Feedback on Attributes of a Global Engineer

- Attributes that need to be emphasized (or, in some cases, added):
  - Cultural sensitivity
  - Tolerance to other people and perspectives
  - Open-minded and ability to adapt
  - Ability to behave ethically across cultures
  - Social responsibility
  - Research and analytical thinking
  - Problem-solving and improvement capabilities
  - Entrepreneurship
- Uses of Attributes project:
  - Teaching / learning processes and student preparation for the workplace
  - Industry involvement as vocal advocate for attributes
  - Linkages to other initiatives (global / national / local)

Attributes and Their Linkages to Other Related Initiatives

- Engineering Grand Challenges
- Engineer of 2020
- ABET, Inc.
- Bologna Process
- Tuning Process
- Lumina Foundation's Degree Qualifications Profile
- AAC&U's Essential Learning Outcomes Framework
- Competency-based / Experience-based Degree Movement
- State / Local Economic Development and Educational Attainment Efforts

High-impact Educational Practices Contributing to the Attributes

- Undergraduate research experiences
- International study abroad
- Service learning / community engagement
- Experiential learning / internships / co-ops
- Involvement in student clubs / associations / organizations
- Team-based / collaborative learning
- Capstone / senior design courses
- Electronic portfolio development and assessment of student learning
- Job shadows / informational interviewing
- Industry field trips / industry guest speakers in classes

Current and Next Steps in the Attributes of a Global Engineer Project

- Academic Year 2014-15 represents final year of the *formal* Attributes of a Global Engineer Project
- White paper presently under review and provided to CMC
- Dissemination in 2015 at CIEC (February) and ASEE (June)
- Ongoing workshops with faculty to integrate Attributes into the curriculum
- Transition to adaptation and adoption in varying contexts:
  - College and university programs
  - K-12 students – pilot in Washington State underway
  - International engineering education associations / consortia
- Still an opportunity for your involvement in the Project

Summary: Project Strengths / Challenges / Opportunities

- Strengths:
  - Corporate voices reflected in origin and concept development
  - Mixed methods approach for attribute development and refinement
  - Prolonged engagement with global stakeholders
- Challenges:
  - Although important, 20 are seemingly too many Attributes to effectively "manage"
  - Competing and co-existing "outcomes" frameworks exist
  - Curricular tightness makes additive educational work impractical
- Opportunities:
  - Attributes offer corporate perspective on related initiatives
  - Integrating attributes with curricular and other efforts is very possible
  - Adaptation / adoption to local contexts encouraged vs. superimposing of all attributes

Brief Discussion at Your Table (and Report-out):

What are your overall impressions of the Attributes?

How are some specific ways you are presently helping your engineering technology students acquire these Attributes?

Q&A / Discussion / Wrap-up

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