



Defining the Global Engineer

Going beyond international
programs to preparing
globally competent engineers

Jack R. Lohmann

Vice Provost

Georgia Institute of Technology



An e-mail from John Grandin...



The task in this session is to attempt to define what we mean by the global engineer.

- Can we define the global engineer? Can we say what qualifications are needed for the global workplace?
- Can we say how close we are to providing that? Or how far we are off the mark?
- Is this an urgent matter in your opinion?

“Sort of”

“Don’t know”

“Absolutely!”

My message

You are the “do-ers” in global engineering

1

- **Converted (perhaps evangelical)**
 - You are the leading advocates for preparing our students for the global marketplace

2

- **Battle Hardened (maybe battle weary)**
 - You are experienced in implementing and operating international programs

My message

How do we move our institutions beyond simply offering international programs to designing and assessing educational experiences which instill *global competence*?

1. Can we define a “global engineer”?

In the U.S., many reports, articles, presentations



Understand...

- complex systems
- new materials
- information systems
- m/d design
- global markets
- business practices
- social considerations
- political contexts
- safety
- sustainability
- manufacturability
- reliability
- maintainability
- and...

Be...

- culturally sensitive
- socially aware
- politically astute
- broadly knowledgeable
- lifelong learner
- team player
- effective communicator
- speak foreign languages
- ethical
- innovative
- entrepreneurial
- flexible
- mobile
- and...

Global engineer or super engineer?



And...

...be faster than a speeding bullet

...be more powerful than a locomotive

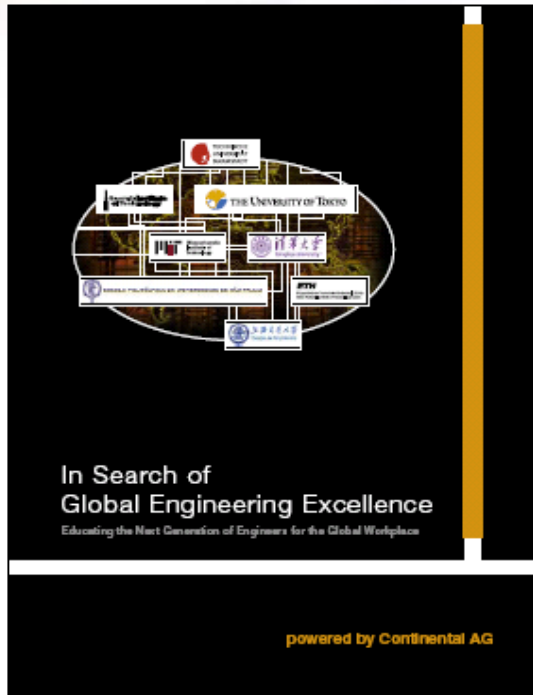
...able to leap tall buildings in a single bound

Can we really instill all this!?

A global challenge, too

An international study by eight universities

Report to be released
November 10, 2006



Participating universities

- ETH Zürich
- Georgia Institute of Technology
- Massachusetts Institute of Technology
- Shanghai Jiao Tong University
- Technische Universität Darmstadt
- Tsinghua University
- Universidade de São Paulo
- University of Tokyo

A Year-Long Study

- Examined engineering in our countries
- Considered programs to prepare engineers
- Offered set of recommendations

Sponsored by Continental AG

The results of the study will be presented tomorrow by
Bernd Widdig, MIT, at 1:45-3:15 p.m.

A common goal in different settings

World-class education

Brazil

- ▲ Technology transfer
- ▼ Technology development

China

- ▲ Engineering HR potential
- ▼ Innovation and creativity

Germany

- ▲ Innovation, precision, quality
- ▼ Flexibility and mobility

Japan

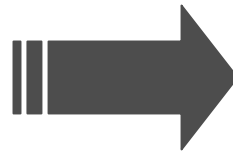
- ▲ Resource-efficient, flexible
- ▼ Industrial & educational mobility

Switzerland

- ▲ Science, problem-solving
- ▼ Entrepreneurship

United States

- ▲ Robust, technologically advanced
- ▼ Foreign-born talent



“Global Engineer”

- Technically adept
- Culturally aware
- Broadly knowledgeable
- Entrepreneurial
- Innovative
- Lifelong learner
- Understands world markets
- Commercially savvy
- Flexible
- Mobile
- ...



Four conditions impeding world capacity
to better prepare global engineers

Four Recommendations

Recommendation No. 4

There is an urgent need for research on engineering in a global context.

The phenomenon of global engineering is still emerging. There is a need for a theoretical foundation on learning behaviors and models as well as on organizational processes and management methods focused on instilling global competence in engineers.



A fairly common challenge

The need for more rigorous education research

Guest Editorial

Quiet No Longer: Birth of a New Discipline

KAMYAR HAGHIGHI
Head, Department of Engineering Education
Purdue University

THE MESSAGE IS OUT

We are familiar now with the landmark studies of the 1998 Boyer Commission's *Remaking Undergraduate Education*, of *Elusive Excellence* (1), BEET's *The Quiet Crisis: Fading Away in Publishing, American Scientists and Technical Talent* [2], the National Science Board's *Reshaping America's Potential* [3], and the National Academy of Engineering's *The Engineer of 2020* [4], to mention just a few who delivered the clarion call for change.

Tomorrow's graduates, they said, will compete in an emerging global economy that is fueled by rapid innovation and marked by an astounding pace of technological breakthroughs. Engineers will navigate a shifting societal framework enhanced by technologies that lengthen life spans, enable yet-to-be imagined means of communication, create wealth and economic growth through accelerated product development cycles; require multi-disciplinary efforts in emerging areas; and link virtual engineering teams from global locations. The thorough integration of technology with society will challenge the analytical skills, creativity, and leadership of engineers; demand participation of engineers in public policy; and require ethical adaptations to circumstances of developing countries. Political and economic relations between nations, the global marketplace, national security issues, and multiglobal influences will dramatically shape engineering practice.

But will our high technology sector have the talented engineers prepared to compete and be leaders in this world to be? Unfortunately, the well-documented wide-spread call for transformation also reflected alarming trends of fading interest, poor preparation, a lack of diverse representation, and low persistence of our current and future U.S. engineering students.

NO MORE GUESSWORK

The responsibility falls on higher education institutions to respond decisively to the fundamental obstacles that preclude substantial and necessary educational transformation. Our foremost job is to build a time-critical coherent research agenda for engineering education that integrates a vital cycle of knowledge production and improvement of practice. Engineering education research is the most effective avenue through which we can address overarching and grand questions such as, What are the characteristics of expediting learning and knowing? and How can we best prepare

engineers for their role in society? This will include basic research questions like:

- What is fundamental knowledge in engineering?
- What is the nature of problem identification, formulation and solution?
- What distinctive skills lead to successful open-ended problem solving?
- How do we know if students have gained conceptual understanding of engineering subjects and how do we articulate, develop and transfer that understanding across multiple academic disciplines?
- How do engineers learn in ways that are similar and different from learning in other disciplines?
- What role do experiential learning practices, such as service learning, play in developing critical skills for a productive professional career?
- How do engineers design?
- How do you nurture critical thinking, innovation, and ingenuity?
- How can best practices in teaching and learning be evaluated and addressed?
- How does basic research in engineering education provide the basis for incorporating educational technologies that support specific pedagogies of teaching and learning?
- How do the science of learning and findings of cognitive research enter the engineering education process?

Only the scholarly practice of engineering education can answer these questions and equip our engineering community to adopt, develop, and use best pedagogical practices for teaching, retaining, and evaluating students. We must conduct the research that leads to tools that define and transform the learning experience and most effectively incorporate technology into classrooms, including best practices for non-STEM disciplines in adapting to emerging technologies. We must reevaluate our program development and adaptation efforts with learning research in order to enhance diversity, encourage equity, and develop a long-term and successful recruiting pipeline. We can no longer afford, as British philosopher Bertrand Russell said, "an enterprise of methodical guessing" when it comes to raising our future engineers.

A NEW DISCIPLINE FOR A NEW COMMUNITY OF SCHOLARS

In his famous book of 1962, *The Structure of Scientific Revolutions*, Thomas Kuhn identified four components of a "disciplinary matrix" as shared theories, models, values (aesthetics and quantitative predictions), and exemplars (concrete problems-solutions).

October 2005

Journal of Engineering Education 351

“We can no longer afford an enterprise of methodical guessing when it comes to educating our future engineers.”

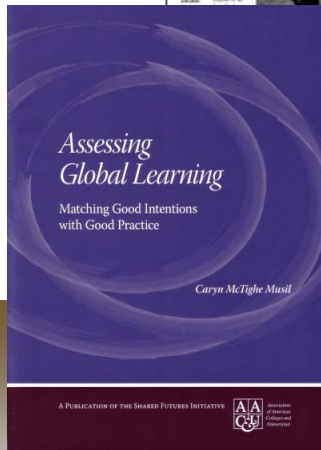
Kamyar Haghighi
Purdue University

Guest Editorial
Journal of Engineering Education
October 2005

We need more research on defining, developing, and assessing global competence (and not just for engineers)

2. How close are we?

We don't really know

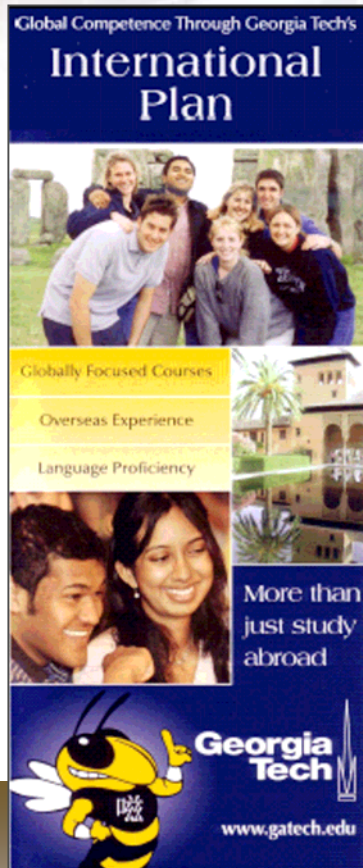


- Most studies focus on study abroad, and dwell on actuarial and logistical aspects or student satisfaction
- According to one study*
 - Less than 10% of study abroad programs measure career-related outcomes
 - Less than 15% assess intercultural proficiency

* Sideli, K., "Outcomes Assessment and Study Abroad Programmes: Commentary on the Results of the SECUSSA/IIE Electronic Sampling, *International Educator*, 2001.

How to instill global competence?

An empirical rather than philosophical question



Language

- How does it matter? By language? By location?

Experience

- Study vs. work vs. research? In combination?
How long?

Global knowledge

- Which subjects best? Which before, which after
experience?

Career enhancement

- Career mobility? Advancement? Effectiveness?

Program elements

- Which are just nice? Which are critical!

Bottom Line – Do our programs really make a difference?

A research study

Defining and assessing global competence



March 2006*

Research Plan

Global competence in engineers 127

Table 2. Assessment schema for the International Plan.

Participative goals, student learning outcomes, program objectives	Assessment methods	Performance criteria
Participative goals <ul style="list-style-type: none"> • Student participation 	Registration and participation counts by semester	150 students, FY05 200 students, FY07 250 students, FY08 300 students, FY09 300 students, FY10 To be determined pending collection of appropriate data
Outcome placement <ul style="list-style-type: none"> • Outcome placement 	Exit survey, commencement survey, alumni and employer surveys ¹	To be determined pending collection of appropriate data
Second language proficiency <ul style="list-style-type: none"> • Communicate in a second language 	Pre-post experience competency tests administered by School of Modern Languages ² Survey of employers of graduates ³ Self-report on post experience survey Post international experience reflective essay	Pre-post experience competency tests administered by School of Modern Languages ² Survey of employers of graduates ³ Self-report on post experience survey Post international experience reflective essay
Comprehensive global knowledge <ul style="list-style-type: none"> • Demonstrate knowledge about cultures within a global and comparative context • Demonstrate knowledge of global issues, processes, trends, and systems • Demonstrate knowledge of at least one other culture, nation, or region, such as beliefs, values, perspectives, practices, and products • Analyze and evaluate • Identify and appreciate the diversity of knowledge of other cultures in current field • Apply and synthesize • Create an appreciation for diverse cultures in terms of language, art, history, etc. • Interact comfortably with people in a different cultural environment and be able to work in further international or intercultural organizations 	Completion of required global economics and international affairs coursework and portfolio of course projects Pre-post international experience questionnaire Post international experience reflective essay	Pre-post international experience questionnaire and results from the first year of data collection will be used as a baseline. Where available, pre-exit survey data may also be used to determine a baseline. The experience in language testing, student choosing to use English during their international readiness experience may also be used. The ACTFL and/or ACTFL Intermediate Mid, and these choices in their chosen language during their international experience may also be used. The ACTFL proficiency of Intermediate High.
Global disciplinary practice <ul style="list-style-type: none"> • Use cultural lenses of reference and alternate perspectives to think critically and solve problems within the discipline in the context of at least one other culture, nation, or region • Collaborate professionally with persons of different cultures, and function effectively in such cultural work environments. 	Standardized inventory of international competence Survey of employers of graduates ³ Senior design projects and presentations, will be conducted using appropriate rubrics	Survey of employers of graduates ³ Senior design projects and presentations, will be conducted using appropriate rubrics
International sensitivity <ul style="list-style-type: none"> • Accept cultural differences and tolerate cultural ambiguity • Comfortably assimilate within other cultures 	Pre-post international experience questionnaire Post international experience reflective essay Survey of employers of graduates ³	Pre-post international experience questionnaire Post international experience reflective essay Survey of employers of graduates ³

¹These inventories are already in use and required by the Office of Assessment.
²All students electing for the second language option will be tested upon return from their international experience as part of the requirement for the International Plan designation. However, only a sample of the students will be tested before their experience for purposes of assessment.

Who?

A comparative, longitudinal study of several cohorts of GT's 2,400 freshmen.

Approach

Compare the nearly 1,100 students that graduate with some international preparation to those with little or none.

*Lohmann, Rollins, and Hoey, "Defining, Developing, and Assessing Global Competence in Engineers," Special Issue: Engineering Competencies in an Engineering Curriculum, *European Journal of Engineering Education*, Vol. 31, No. 1, March 2006

Research design

- Global competence – product of education and experience
 - ***Second Language Proficiency:***
Communicate via speaking, listening, reading, and writing
 - ***Comparative Global Knowledge:***
Know major social-political-economics processes and systems
 - ***Intercultural Assimilation:***
Assimilate with ease into foreign environments
 - ***Disciplinary Practice in a Global Context:***
Communicate the practice of major in a global context
- Research methods
 - Actuarial measures; student demographics
 - Surveys; standardized tests (language, intercultural ability)
 - Pre-/Post-experience essays; evaluation work products

We're pleased, but...

Next steps

1

- **Single institution**

- Generalizability beyond GT will be limited

2

- **Single culture**

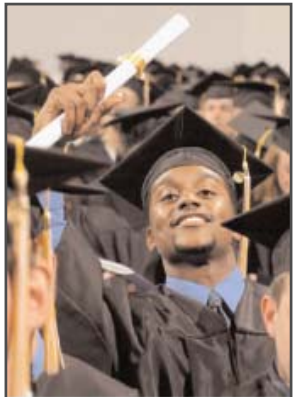
- Validity beyond the USA is questionable

Returning to my message

We — in this room — need to continue to lead the way and rigorously evaluate the educational impact of our global programs.

3. Is this an urgent matter? Absolutely!

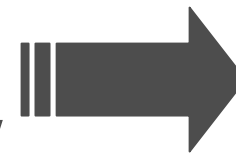
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Sort of; What qualifications *really* matter?



Don't know;
Need more research



Broaden participation;
Focus our efforts





Thank You!

Questions?
Comments?
Advice?

Jack R. Lohmann
Vice Provost
Georgia Institute of Technology

