

A Workshop on Building Capability and Communities in Engineering Education Research

sponsored by the

National Science Council
National Ping Tung University
of Science and Technology
Meiho Institute of Technology

in partnership with

Annals of Research in Engineering Education
Journal of Engineering Education
Rigorous Research in
Engineering Education Initiative

Kaohsiung—Taipei, Taiwan • 2-5 February 2009




Jack R. Lohmann
Georgia Institute of Technology



Karl A. Smith
Purdue University and
University of Minnesota


Overview

What are we going to do?



**A Workshop on
Building Capability and Communities
in Engineering Education Research**

sponsored by the
National Ping Tung University of Science and Technology
and the Helio Institute of Technology
in partnership with the *Annals of Research in Engineering Education*,
the *Journal of Engineering Education*, and the *Journal of
Rigorous Research in Engineering Education*



Focus
Engineering education research is a rapidly growing field of scholarship for many engineering faculty. A global community is developing, supported by seminars, conferences, journals, and workshops. The focus of this half-day workshop is twofold:

- (1) Introduce engineering faculty interested in developing or extending their capability to engage in educational scholarship how to approach and move their work in the direction of educational research.
- (2) Share with interested participants strategies to build and sustain a community of engineering education researchers and to help them network with other global communities.

This interactive workshop is open to up to 50 engineering faculty who are considering or are currently engaged in scholarly work focused on teaching and student learning. It is especially designed for faculty who wish to make engineering education research an important part of their scholarly portfolio, including collaborating with social science colleagues to address engineering education questions and opportunities, seeking funding for engineering education research, and publishing the results of their work in peer-reviewed education and educational research journals and similar forums.

Outcomes
The intended outcomes from the workshop are to help participants to:

- (1) identify the practical features of engineering education research and how they compare with technical engineering research;
- (2) frame research questions, situate them within appropriate theoretical frameworks, and consider alternative research methodologies;
- (3) gain familiarity with Web-based and print resources, specifically the *Journal of Engineering Education*, *Annals of Research in Engineering Education*, *Scientific Research in Education*, *The Craft of Research*; and
- (4) become more aware of emerging global communities and their networks, and how to connect with them.

Resources
The following online resources are available for the workshop participants. Participants are encouraged to peruse these resources before the workshop.

- Adams, R., K. Smith, and L. Fleming. 2007. Becoming an engineering education researcher: Three researcher stories and their intersections, extensions, and evolutions. *Proceedings, International Conference on Research in Engineering Education*. <http://www.iceee.usm.edu/ICREE2007/Papers/007.pdf>
- Annals of Research in Engineering Education*. <http://www.annree.org>
- Borjas, M., R.A. Drexler, R.L. Miller, and K.A. Smith. 2008. A new paradigm for a new field: Communicating representations of engineering education research. *Journal of Engineering Education* 97 (2): 147-162. <http://www.aee.org/conferences/information/2008/Lecture4-NewParadigm-for-a-New-Field.pdf>
- Booth, W.C., G.D. Colomb, and J.L. Williams. 2008. *The Craft of Research*. 3rd ed. Chicago, IL: The University of Chicago Press. Not available online. Sample copies will be made available during the workshop. Participants are encouraged to locate another to purchase the book after seeing the sample copies.
- Center for the Advancement of Scholarship on Engineering Education. <http://www.aee.edu/center/center.html>
- Journal of Engineering Education*. <http://www.aee.org/publications/journal.html>
- Guide for Authors. <http://www.aee.org/publications/journal/guide.html>
- Special Issue, July 2008. Educating Future Engineers: Who, What and How. <http://www.aee.org/publications/journal/special.html>
- National Research Council. 2005. *Scientific Research in Education*. R.L. Shavelson and L. Towne, eds. Washington, DC: The National Academies Press. <http://www.nap.edu/catalog/10920.html>
- Smith, K.A. 2008. Contributing to building engineering education research capabilities. *IEEE Transactions on Education* 49 (1): 1-3. <http://www.aee.org/conferences/information/2008/BuildingCapabilities-BuildingResearchCapabilities.pdf>
- Drexler, R.A., and K.A. Smith. 2008. Conducting rigorous research in engineering education. *Journal of Engineering Education* 97 (2): 103-105. <http://www.aee.org/conferences/information/2008/BuildingCapabilities-Scientific-Research-in-Eng-Edu.pdf>

Location
International Conference Center
Kaohsiung, Taiwan
February 2 and 3, 2009

Please contact Dr. Ann-Rong Tang, Professor and Chair, Graduate Institute of Business and Management, Miehlo Institute of Technology, 27 Ping-Kuang Rd., Aqpo-Ning, Pingtung, Taiwan, ROC; e-mail: gsbme@i2a.great.com; telephone: 011 886 8 2780621 ext. 8515.

Organizers
Jack E. Luftmann is vice provost for Faculty and Academic Development and professor of Industrial and Systems Engineering at the Georgia Institute of Technology. Dr. Luftmann has held appointments at the University of Michigan, the University of Southern California, the University of Central Florida, and the U.S. National Science Foundation. He is a Fellow of the Institute of Industrial Engineers, the American Society of Engineering Education, and the European Society for Engineering Education, and editor of the *Journal of Engineering Education*.

April A. Smith is Cooperative Learning Professor of Engineering Education, Purdue University West Lafayette, IN, and Moore-Alumni Distinguished Professor of Civil Engineering, University of Minnesota. Dr. Smith has been actively involved in engineering education research and practice for over thirty years. He is a Fellow of the American Society for Engineering Education and past Chair of the Educational Research and Methods Division, and Editor-in-Chief of the *Annals of Research in Engineering Education*.

October 2008

- Welcome and introductions
- Topics of the workshop
 - Background and context
 - Features of engineering education research
 - Research questions and methodologies
 - Print and online resources
 - Global communities and their networks
- Format of the workshop
 - Interactive and team-based work

[Resources](#)

Who's here?

- Your [workshop leaders](#)



- Introduce yourself to those near you

Background and Context

Workshop frame of reference

- **Workshop is about**

- Identifying faculty interested in engineering education research
- Deepening understanding of engineering education research
- Building engineering education research capabilities

- **Workshop is NOT about**

- Pedagogical practice, i.e., “how to teach”
- Convincing you that good teaching is important
- Writing engineering education research grant proposals or papers
- Advocating all faculty be engineering education researchers

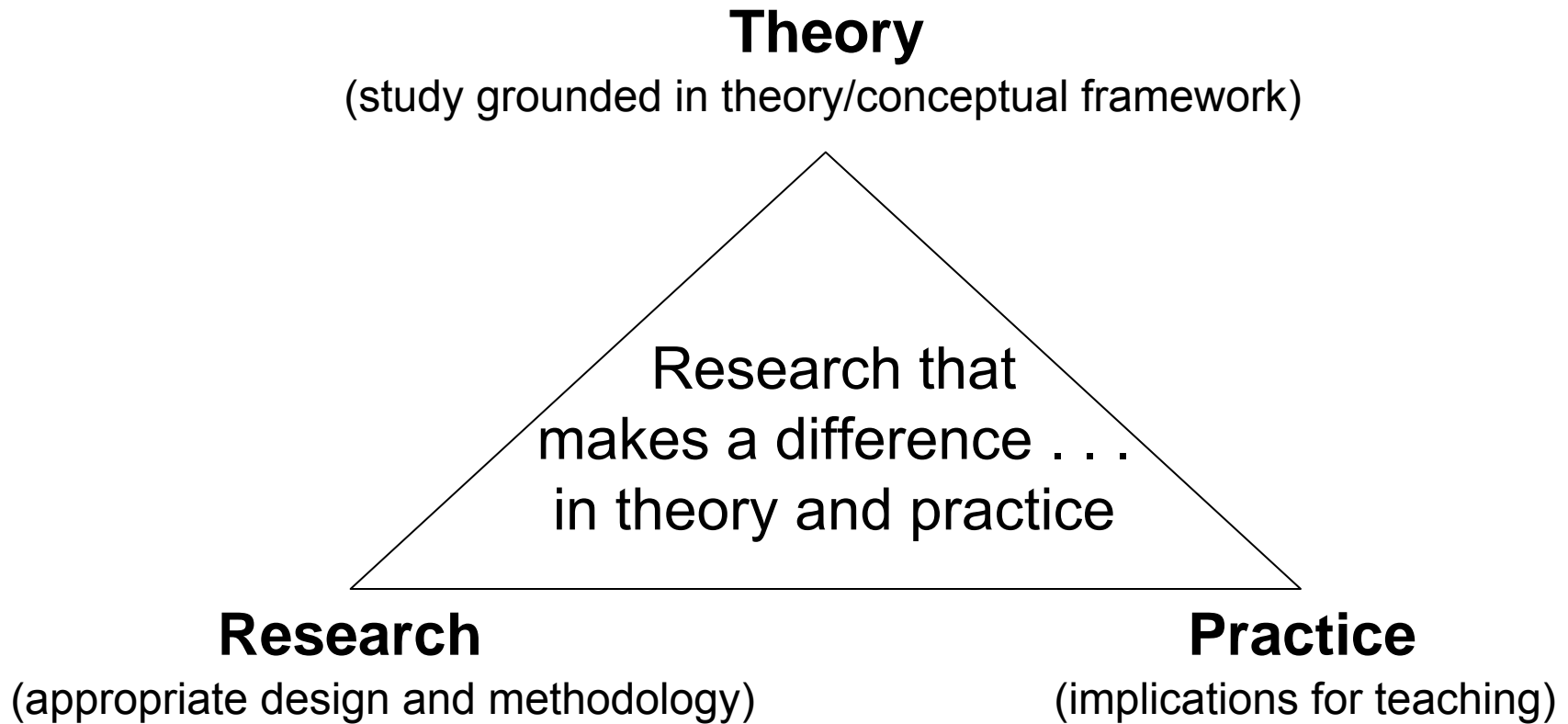
Levels of inquiry in engineering education

- **Level 0** Teacher
 - Teach as taught
- **Level 1** Effective Teacher
 - Teach using accepted teaching theories and practices
- **Level 2** Scholarly Teacher
 - Assesses performance and makes improvements
- **Level 3** Scholar of Teaching and Learning
 - Engages in educational experimentation, shares results
- **Level 4** Engineering Education Researcher
 - Conducts educational research, publishes archival papers

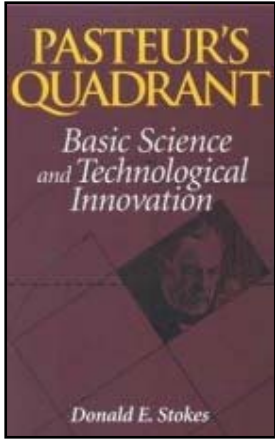
Some history about this workshop

- **Rigorous Research in Engineering Education (RREE1)**
 - One-week summer workshop, year-long research project
 - Funded by National Science Foundation (NSF), 2004-2006
 - About 150 engineering faculty participated
- **Goals**
 - Identify engineering faculty interested in conducting engineering education research
 - Develop faculty knowledge and skills for conducting engineering education research (especially in theory and research methodology)
 - Cultivate the development of a Community of Practice of faculty conducting engineering education research

RREE Approach



Research can be inspired by ...



**Understanding
(Basic)**

Yes

No

Use (Applied)

No

Yes

Pure basic research (Bohr)	Use-inspired basic research (Pasteur)
	Pure applied research (Edison)

RREE2

- **Follow-up proposal has been awarded (RREE2)**
 - Includes a series of 5 short courses
 - 1) Fundamentals of Educational Research
 - 2) Identifying Theoretical Frameworks
 - 3) Designing Your Research Study
 - 4) Collaborating with Learning and Social Scientists
 - 5) Understanding Qualitative Research
 - To be available on the WWW as they become available

Today's objectives




- 1) Identify principal features of engineering education research
- 2) Frame and situate research questions and methodologies
- 3) Gain familiarity with several print and online resources
- 4) Become aware of global communities and their networks


Objective 1

**Identify principal features of
engineering education research**

What does high-quality research in your discipline look like?

- What are the **qualities, characteristics, or standards** for **high-quality** research in your discipline?
- Think of it this way: “**Research in my field is high-quality when....**”

 Individually, list the qualities, characteristics or standards in your discipline

 Compare your lists, and as a group, develop a list of high-quality research qualities, characteristics or standards

What does high-quality research in your discipline look like?

- (Workshop list)

- (Workshop list)

What does education research look like?

- What are the **qualities, characteristics, or standards** for **high-quality education** research?

 Individually, list:

- 1) Which qualities, characteristics, or standards identified so far DO NOT apply?
- 2) What qualities, characteristics, or standards can you envision that are DIFFERENT for education research?

As a group, combine your lists.

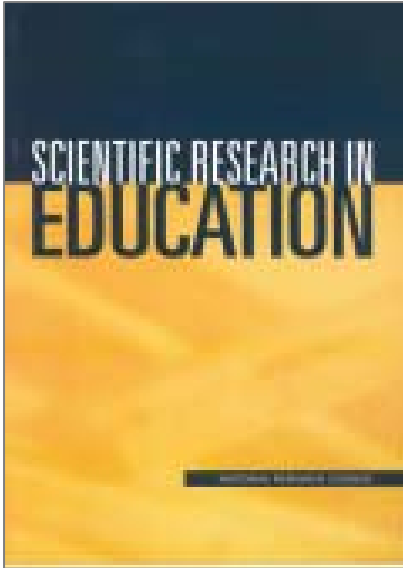


What does education research look like?

- (DO NOT apply list)

- (DIFFERENT list)

Guiding principles for scientific research in education



1. Pose **significant questions** that can be investigated **empirically**
2. Link research to relevant **theory**
3. Use **methods** that permit **direct investigation** of the question
4. Provide coherent, explicit chain of **reasoning**
5. Replicate and **generalize** across studies
6. Disclose research to encourage professional **scrutiny and critique**

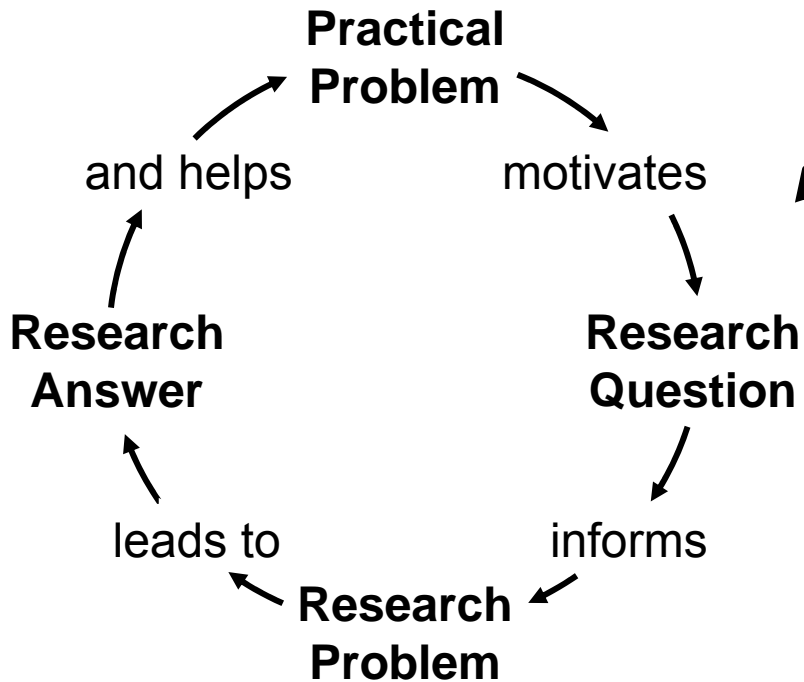


- How do our lists compare with the NRC six?

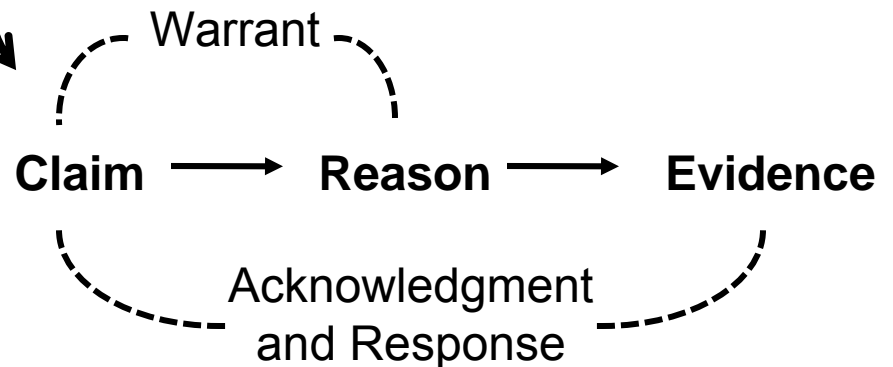
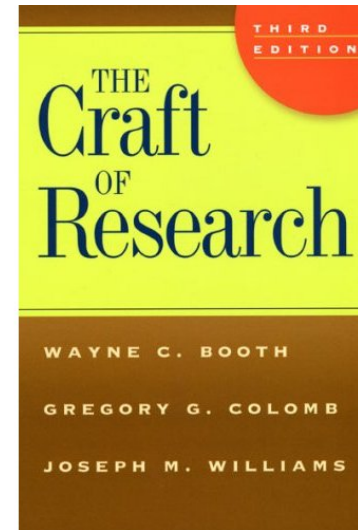


- Is a global list possible? Do cultural contexts matter?

The research process and reasoning



Research Process




Research Reasoning

Objective 2

**Frame and situate research
questions and methodologies**

Which comes first: framework or observation?

- **Going from framework to research question to research study**
 - e.g., the experiential learning cycle
 - **Going from observation to framework to research question to research study and back to observation**
 - e.g., classroom community
-  – Please describe observations that have sparked your curiosity

Most common frameworks in educational research

- **Theories of learning**
- **Theories of motivation**
- **Theories of development**
- **Theories of contextual effects**

See RREE 2006 workshop materials Web site for details <http://www.ce.umn.edu/~smith/ndlinks.html>

See Marilla Svinick's slides—Conceptual frameworks: Finding a conceptual framework that is appropriate for your question. [RREE-D2-Marilla-conceptual1.ppt](#)

Becoming an Engineering Education Researcher—Adams, Fleming & [Smith](#)

1. Find and follow your dream.
2. Find and build community.
3. Do your homework. Become familiar with engineering education research.
4. Remember what it is like to be a student—be open to learning and the associated rewards and challenges.
5. Find balance. You will feel like you have multiple identities.
6. Be an architect of your own career.
7. Wear your researcher “lenses” at all times.
8. Use research as an opportunity for reflective practice.

Objective 3

**Gain familiarity with several
print and online resources**

Books, journals, online resources

- The Craft of Research
- Scientific Research in Education
- Journal of Engineering Education (JEE)
- Annals of Research on Engineering Education (AREE)
- Thomson ISI Citation Index
- Some other journals





A growing global journal

8,500 subscribers, 70 countries, [5 partners](#)

- [Founded in 1910](#)
 - “technical” journal/magazine for 80 years
 - mission refined in 1993 and again in 2003
- **Mission**
 - “...serve as an archival record of scholarly research in engineering education”
- [Manuscript types](#)
 - Research investigations
 - Research reviews
- [Six review criteria](#)



www.asee.org/jee

NOTE!

“The Relationships Between Students’ Conceptions of Learning and Their Preferences for Classroom and Laboratory Learning Environments,” by Chia-Ching Ling and Chin-Chung Tsai, National Taiwan University of Science and Technology, to appear in the *Journal of Engineering Education*, April 2009

AREE

www.reeonline.org



- Link journals related to engineering education
- Increase progress toward shared consensus on quality research
- Increase awareness and use of engineering education research
- Increase discussion of research and its implications
- **Resources–community recommended**
 - Annotated bibliography
 - Acronyms explained
 - Conferences, professional societies, etc.
- **Articles – education research**
 - Structured summaries
 - Reflective essays
 - Reader comments

Thomson ISI Citation Index

- **Thomson ISI** (Institute for Scientific Information)
- **Science Citation Index**
 - Category: Education, Scientific Disciplines
 - 23 journals in medicine (10), engineering (7), and science (6)
- **Social Science Citation Index**
 - Category: Education and Educational Research
 - 105 journals, including education (52), social sciences (28), natural science (9), medicine (6), engineering (1, JEE), other (9)

Some more journals

Where you can find articles on research in engineering and technology*

- **Chronicle of Higher Education** (<http://chronicle.com/>)
- **Cognitive Science** (<http://www.cognitivesciencesociety.org/about.html>)
- **Cognition and Instruction** (<http://www.jstor.org/journals/07370008.html>)
- **College Teaching**
- **Cultural Studies in Science Education**
- **Design Studies** (<http://www.sciencedirect.com/science/journal/0142694X>)
- **Education Researcher** (<http://www.jstor.org/journals/0013189X.html>)
- **Journal of Higher Education** (<http://logon.jstor.org/journals/00221546.html>)
- **Interdisciplinary Journal of Knowledge and Learning Objects** (<http://ijklo.org/>)
- **International Journal for the Scholarship of Teaching and Learning** (<http://www.georgiasouthern.edu/ijstol/>)
- **International Journal of Computer-Supported Collaborative Learning** (<http://ijcscl.org>)
- **International Journal of Problem-Based Learning** (<http://docs.lib.purdue.edu/ijpbl/>)
- **International Journal of Science and Mathematics Education** (link: Int'l Journal of Science and Mathematics Education)
- **Journal of the First-Year Experience**
- **Journal of the Learning Sciences** (<http://www-static.cc.gatech.edu/computing/1st/jls/>)
- **Journal of Engineering Education** (<http://www.asee.org/jee>)
- **Journal of Higher Education** (<http://www.jstor.org/journals/00221546.html>)
- **Journal of Research in Science Teaching**
(<http://www3.interscience.wiley.com/cgi-bin/jhome/31817?CRETRY=1&SRETRY=0>)
- **Mind, Culture, and Activity** (<http://lchc.ucsd.edu/MCA/Journal/index.html>)
- **Review of Higher Education** (http://www.press.jhu.edu/journals/review_of_higher_education/)
- **Sociology of Education** (http://www.asanet.org/cs/root/leftnav/publications/journals/sociology_of_education/homepage)
- **Science & Education**
- **Students in Transition**

Some more journals

...with engineering or technology in their titles*
(mostly focused on curriculum development and position papers)

- **Australasian Journal of Engineering Education** (<http://www.aeee.com.au/journal/>)
- **Chemical Engineering Education**
- **Engineering Education: Journal of the Higher Education Academy Engineering Subject Centre**
- **European Journal of Engineering Education** (<http://www.tandf.co.uk/journals/titles/03043797.asp>)
- **Global Journal of Engineering Education** (<http://www.eng.monash.edu.au/uicee/gjee/>)
- **IEEE Engineering Science and Education Journal** (<http://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=2222>)
- **IEEE Transactions on Education**
- **International Journal of Electrical Engineering Education** (<http://journals.mup.man.ac.uk/cgi-bin/MUP?COMval=journal&key=IJEEE>)
- **International Journal of Continuing Engineering Education and Life-Long Learning** (<http://www.inderscience.com/browse/index.php?journalID=6&year=2008&vol=18&issue=1>)
- **International Journal of Engineering Education**
- **International Journal of Mechanical Engineering Education** (<http://journals.mup.man.ac.uk/cgi-bin/MUP?COMval=journal&key=IJMEE>)
- **Journal of Professional Issues in Engineering Education and Practice** (<http://scitation.aip.org/epo>)
- **Journal of Science Education and Technology**
- **Journal of STEM Education**
- **Journal of Women and Minorities in Science and Engineering** (<http://www.begellhouse.com/journals/00551c876cc2f027.html>)
- **Research in Engineering Design** (<http://www.cs.cmu.edu/~sfinger/red/red.html>)
- **Technology and Children** (<http://www.iteaconnect.org/Publications/t&c.htm>)
- **Technology Teacher** (<http://www.iteaconnect.org/Publications/ttt.htm>)
- **Transactions on Engineering Education**



Other
journals in
Taiwan?
Asia
Pacific?

Objective 4

**Become aware of global
communities and their networks**

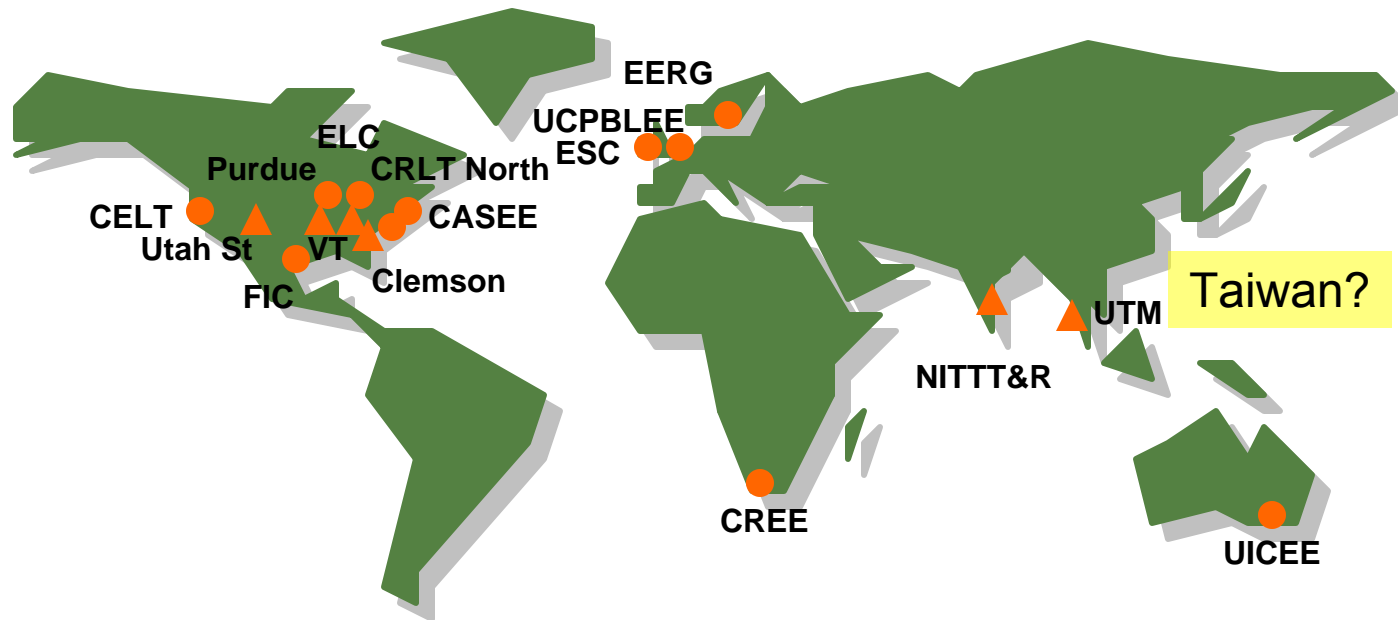
An emerging global community



- Groups, centers, departments
- Engineering education societies
- Forums for dissemination

What follows is a **sample** — it is NOT an exhaustive list!

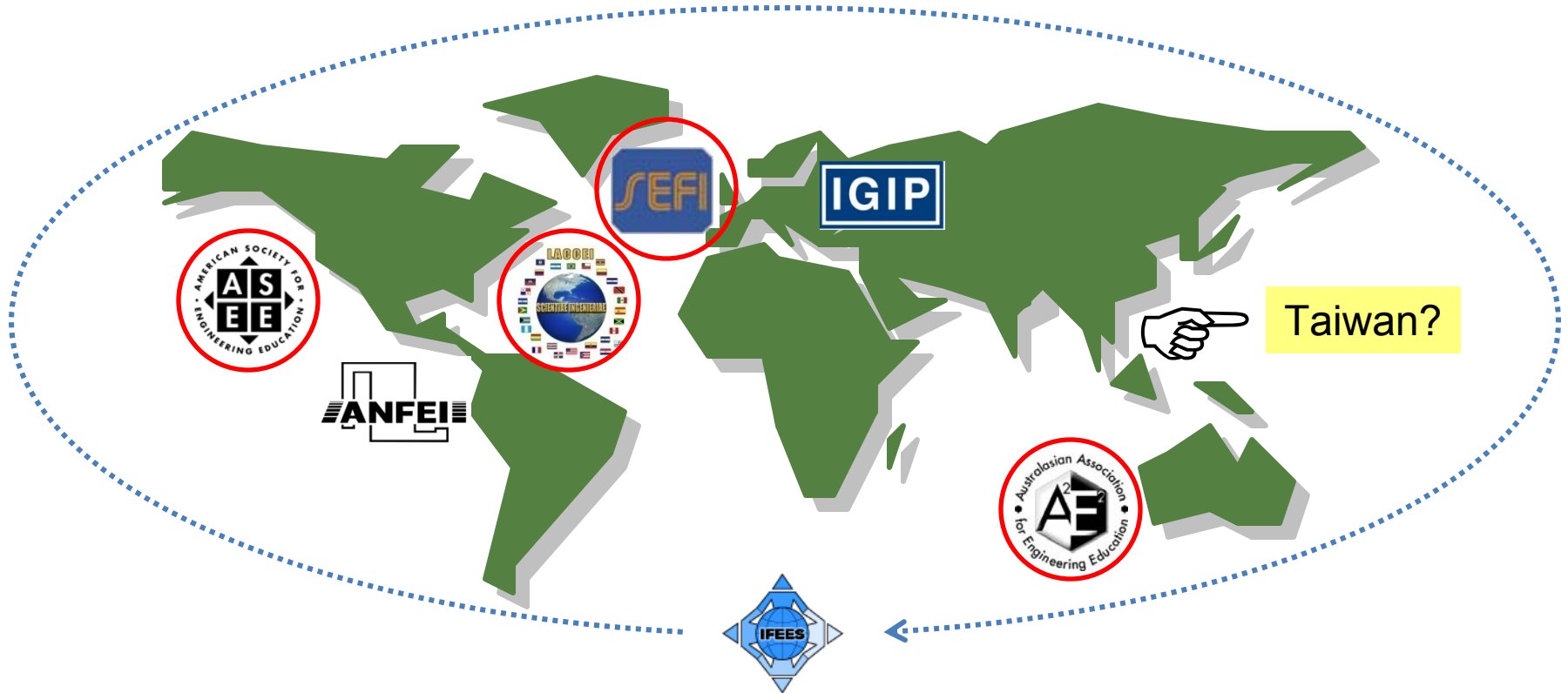
Groups, centers, departments...



● **Engineering Teaching and Learning Centers** — Australia: UICEE, UNESCO International Centre for Engineering Education; Denmark: UCPBLEE, UNESCO Chair in Problem Based Learning in Engineering Education; South Africa: CREE, Centre for Research in Engineering Education, U of Cape Town; Sweden: Engineering Education Research Group, Linköping U; UK: ESC, Engineering Subject Centre, Higher Education Academy; USA: CELT, Center for Engineering Learning and Teaching, U of Washington; CRLT North, Center for Research on Learning and Teaching, U of Michigan; Faculty Innovation Center, U of Texas-Austin; Engineering Learning Center, U of Wisconsin-Madison; CASEE, Center for the Advancement of Scholarship in Engineering Education, National Academy of Engineering.

▲ **Engineering Education Degree-granting Departments** — USA: School of Engineering Education, Purdue U; Department of Engineering Education, Virginia Tech; Department of Engineering and Science Education, Clemson U; Department of Engineering and Technology Education, Utah State U; Malaysia: Engineering Education PhD program, Universiti Teknologi Malaysia; India: National Institute for Technical Teacher Training and Research.

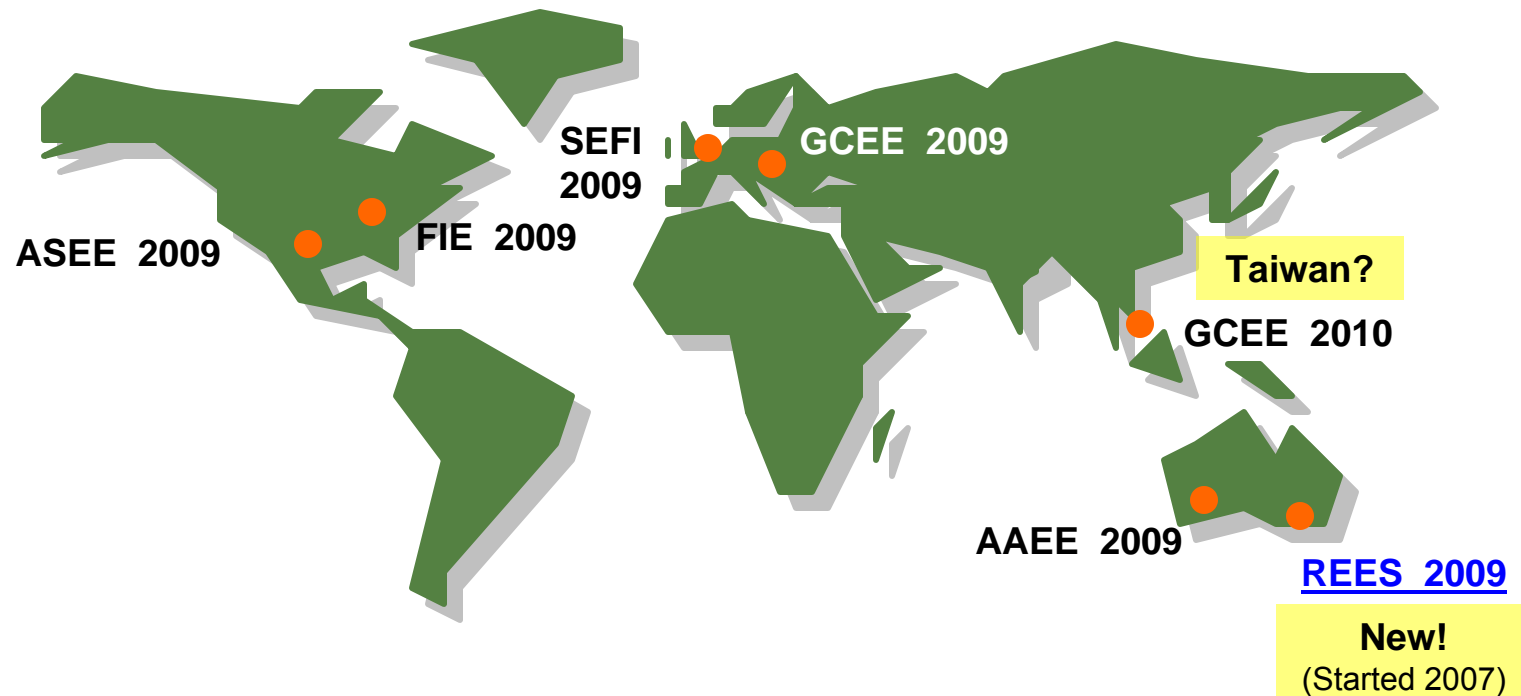
Engineering education societies...



Societies with Engineering Education Research Groups — ASEE, American Society for Engineering Education, Educational Research Methods Division; SEFI, Société Européenne pour la Formation des Ingénieurs (European Society for Engineering Education), Engineering Education Research Working Group; Australasian Association for Engineering Education, Engineering Education Research Working Group; Community of Engineering Education Research Scholars, Latin America and Caribbean Consortium for Engineering Institutions

Societies with Engineering Education Research Interests — Indian Society for Technical Education, Latin American and Caribbean Consortium of Engineering Institutions, Asociación Nacional de Facultades y Escuelas de Ingeniería (National Association of Engineering Colleges and Schools in Mexico), Internationale Gesellschaft für Ingenieurpädagogik (International Society for Engineering Education), International Federation of Engineering Education Societies

Forums for dissemination...



Conferences with engineering education research presentations:

- **ASEE** — Annual Conference, American Society for Engineering Education, see www.asee.org
- **AAEE** — Annual Conference, Australasian Association for Engineering Education, see www.aee.com.au
- **FIE** — Frontiers in Education, sponsored by ERM/ASEE, IEEE Education Society and Computer Society, [/fie-conference.org/erm](http://fie-conference.org/erm)
- **GCEE** — Global Colloquium on Engineering Education, sponsored by ASEE and local partners where the meeting is held, see www.asee.org
- **SEFI** — Annual Conference, Société Européenne pour la Formation des Ingénieurs , see www.sefi.be
- **REES** — Research on Engineering Education Symposium, rees2009.pbwiki.com/

Thank you!

An e-copy of this presentation may be found at:
<http://www.ce.umn.edu/~smith/links.html>

Kaohsiung—Taipei, Taiwan • 2-5 February 2009



jlohmann@gatech.edu



ksmith@umn.edu