Getting Started in Engineering Education Research
Fundamentals of Engineering Education Research

sponsored by the
ASEE Educational Research
and Methods Division

in partnership with
Rigorous Research in
Engineering Education Initiative
CLEERhub.org
And the *Journal of Engineering Education*

ASEE Annual Conference – June 20, 2010 – Session 0230

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Overview
What are we going to do?

- **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

- **Additional 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

Source: Streveler, R., Borrego, M. and Smith, K.A. 2007. Moving from the "Scholarship of Teaching and Learning" to "Educational Research:" An Example from Engineering. *Improve the Academy,* Vol. 25, 139-149.

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

Theory
(study grounded in theory/conceptual framework)

Research that
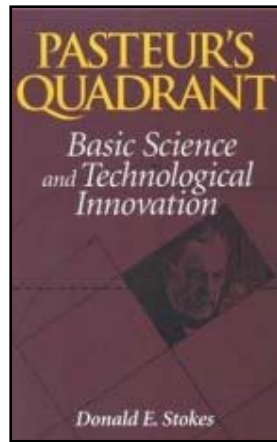makes a difference . . .
in theory and practice

Research
(appropriate design and methodology)

Practice
(implications for teaching)

http://inside.mines.edu/research/cee/ND.htm

Research can be inspired by …

	Use (Applied)	
	No	**Yes**
Yes	Pure basic research (Bohr)	Use-inspired basic research (Pasteur)
No		Pure applied research (Edison)

Understanding (Basic)

Source: Stokes, D. 1997. Pasteur's quadrant: Basic science and technological innovation. Washington, DC: Brookings Institution.

RREE2

Follow-up proposal has been awarded (RREE2)

- Includes a series of 5 short courses*

  – Fundamentals of Engineering Education Research

  – Selecting Conceptual Frameworks

  – Understanding Qualitative Research

  – Designing Your Research Study

  – Collaborating with Learning and Social Scientists

*To be recorded and posted on the CLEERhub.org

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 <u>in your discipline</u>

☞ Compare your lists, <u>and as a group</u>, 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 <u>education</u> research look like?

- What are the **qualities, characteristics, or standards** for **high-quality <u>education</u>** 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

Practical Problem

and helps   motivates

Research Answer   **Research Question**

leads to   informs

Research Problem

Research Process

THIRD EDITION

THE Craft OF Research

WAYNE C. BOOTH

GREGORY G. COLOMB

JOSEPH M. WILLIAMS

Warrant

Claim → **Reason** → **Evidence**

Acknowledgment and Response

Research Reasoning
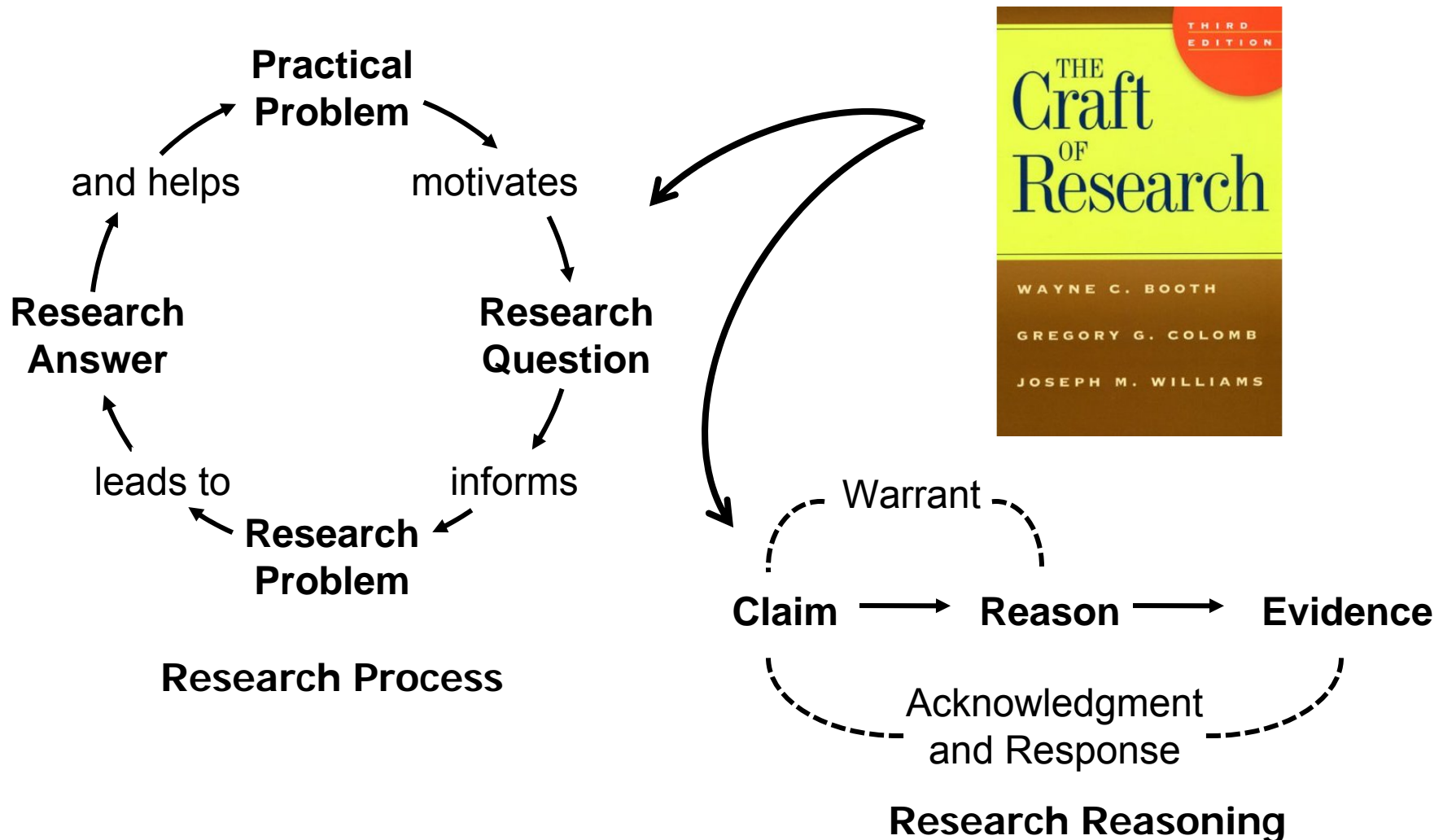
Objective 2

Frame and situate research questions and methodologies

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

Multiple theoretical frameworks

Which comes first: framework or observation?

Can go in either direction

Multiple theoretical frameworks

Going from framework to research question to research study

Framework

Self-determination framework says - students' motivation for a task is affected by the degree of control they have over it.

Therefore

If we manipulate the degree of student control, we should see variations in motivation levels.

Design

Different groups are given different degrees of control over the topic and process of their project and their motivation for the project is measured at various times throughout the semester.

Multiple theoretical frameworks

Going from observation to framework to research question to research study and back to observation

Observation

Some students in a class participate more than others.

Possible Frameworks
•Learning theory: Prior knowledge differences
•Motivation theory: Goal orientations, task value, self-efficacy
•Contextual variables: Course contingencies; classroom climate

Design possibilities
•Measure and regress level of participation on potential variables.
•Manipulate course contingencies or course practices.

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)

- Thomson ISI Citation Index

- Some other journals

A growing global journal
8,500 subscribers, 70 countries, 5 partners

Journal of Engineering Education

www.asee.org/jee

- **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**

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/ijsotl/)
- **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/lst/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/cgibin/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.aaee.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**

Reflect on your experience

What is your experience?

- Silently reflect on your experience as an emerging engineering education researcher
- Jot down
  - What has been the most exciting opportunity for you in this area?
  - What has been the most difficult challenge you have faced?
- Share with the person next to you

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.

Adams, R., L. Fleming, and K. Smith. 2007. Becoming an engineering education researcher: Three researchers stories and their intersections, extensions, and lessons. Proceedings, International Conference on Research in Engineering Education; http://www.ce.umn.edu/%7Esmith/docs/Adams-Fleming-Smith-Becoming_an_engineering_education_researcher-ICREE2007.pdf

Objective 4

Become aware of global communities and their networks

An <u>emerging</u> 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…
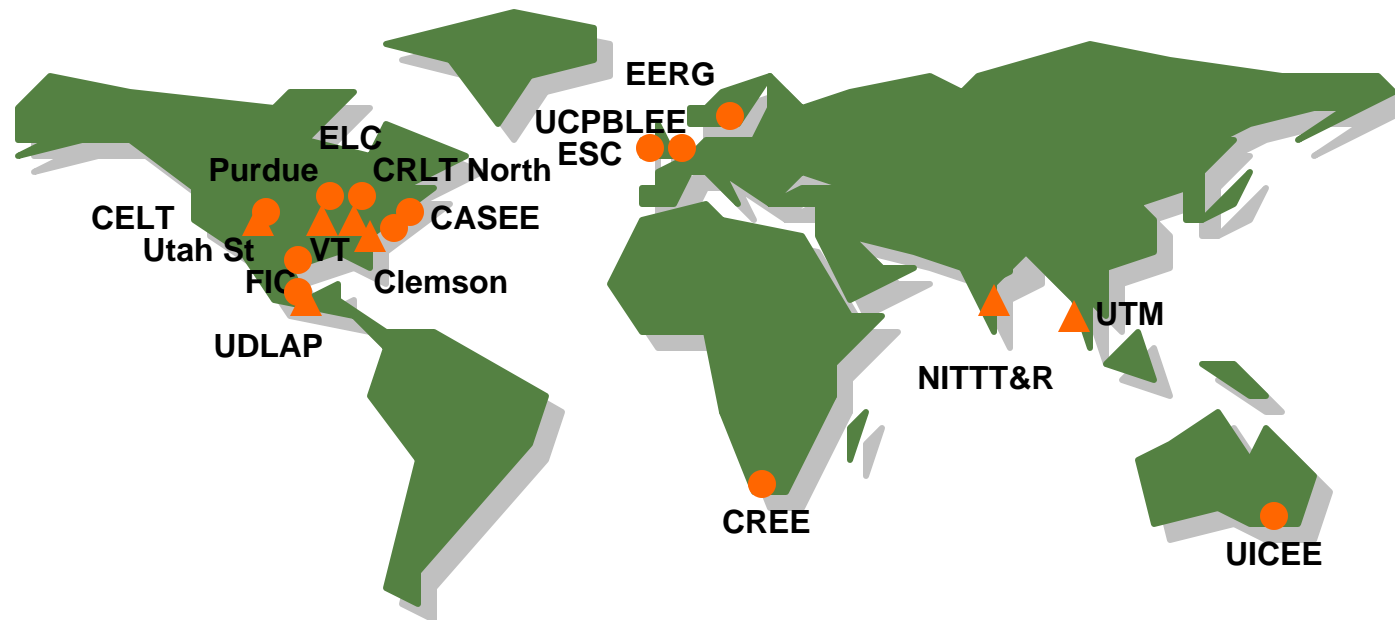
Engineering Teaching and Learning Centers — Australia: UICEE, UNESCO International Centre for Engineering Education; Denmark: UCPBLEE, UNESCO Chair in Problem Based Learning in Engineering Education; South Africa: CREE, Centre for Research in Engineering Education, U of Cape Town; Sweden: Engineering 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; Mexico: Universidad de las Americas, Puebla

Engineering education societies…
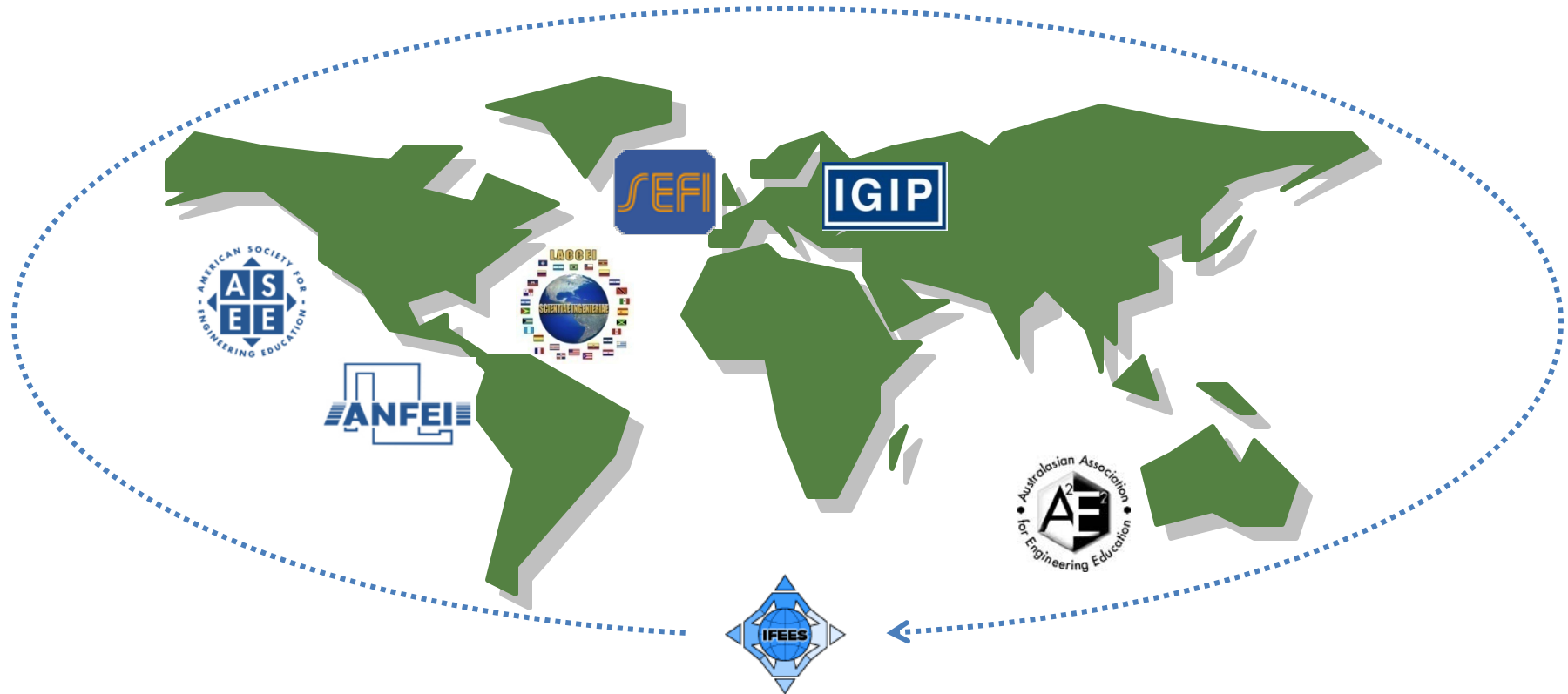
Societies with Engineering Education Research Groups — ASEE, American Society for Engineering Education, Educational Research Methods Division; SEFI, Société Européenne pour la Formation des Ingénieurs (European Society for Engineering Education), Engineering Education Research Working Group; Australasian 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…

FIE 2010

SEFI 2009

GCEE 2009

SEFI/IGIP 2010

FIE 2009

ASEE 2010

GCEE 2010

AAEE 2009

REES 2009

New!
(Started 2007)
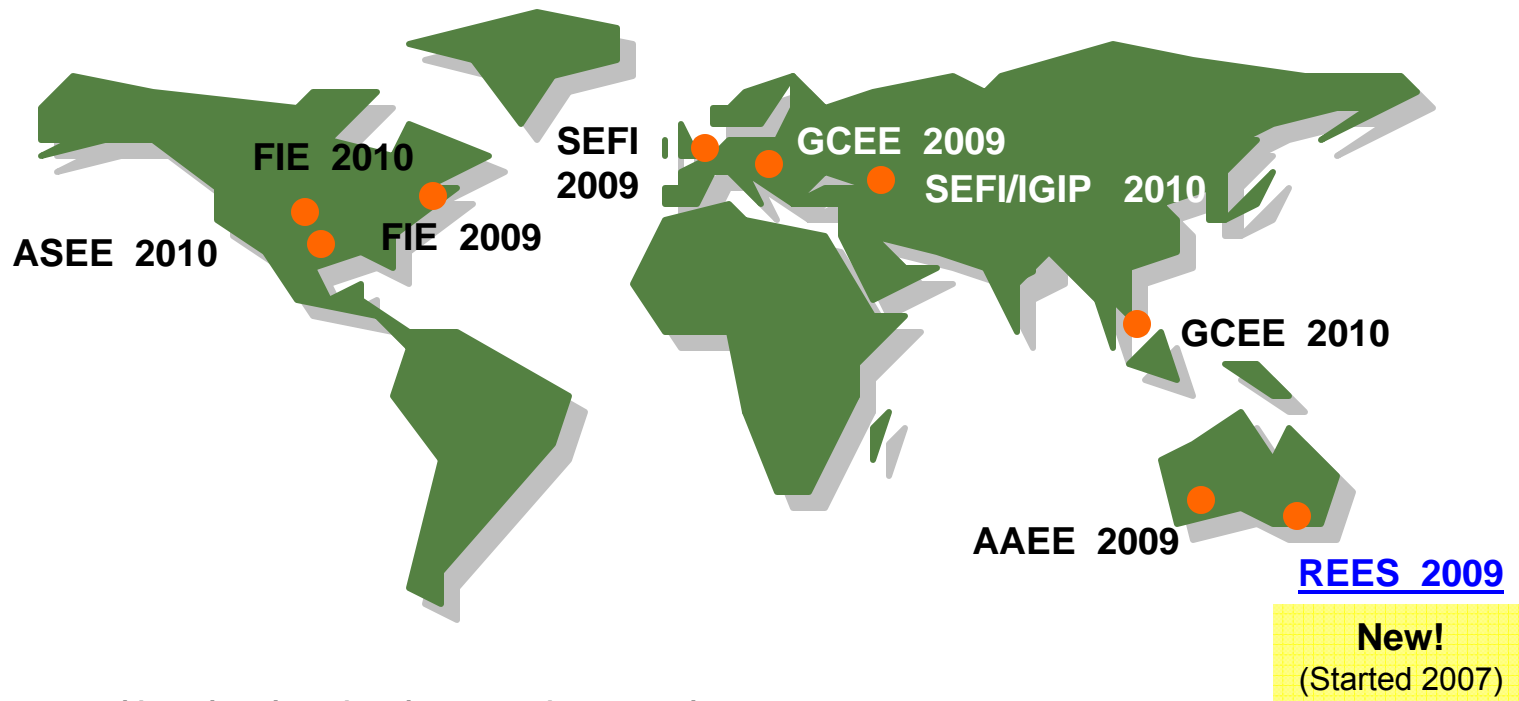
Conferences with engineering education research presentations:
- **ASEE** — Annual Conference, American Society for Engineering Education, see www.asee.org
- **AAEE** — Annual Conference, Australasian Association for Engineering Education, see www.aaee.com.au
- **FIE** — Frontiers in Education, sponsored by ERM/ASEE, IEEE Education Society and Computer Society, /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/

http://cleerhub.org

http://grou.ps/reen

European Society for Engineering Education
Europäische Gesellschaft für Ingenieur-Ausbildung
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Background

Higher engineering education has become field of scholarly research in its own right. It is no longer sufficient that engineering education development is based on experience and beliefs. We need evidence and knowledge about the effect of our educational choices. This development towards a more research based approach is sustained by the growth in conferences, journals and publications dedicated to the subject.
Globally, engineering education research is on the agenda for the improvement of higher engineering education and the development of strategies for solving important issues for the future of engineering education, such as recruitment, the need for new competences and the ability to deal with new types of interdisciplinary and complex knowledge.
Engineering education research in Europe, is characterized by a unique interdisciplinary approach. Engineering education researchers do have various backgrounds in engineering, science, social science and educational psychology investigating higher engineering education. Many universities in the north-west of Europe have their own centres of expertise for educational development where the research component is directly linked to curriculum or staff development.
Due to this European unique approach to engineering education research, it is very important to initiate a more structured network among European engineering education researchers. Establishment of a SEFI working group means an important step towards the creation of such a network.Higher engineering education has become field of scholarly research in its own right. It is no longer sufficient that engineering education development is based on experience and beliefs. We need evidence and knowledge about the effect of our educational choices. This development towards a more research based approach is sustained by the growth in conferences, journals and publications dedicated to the subject.Globally, engineering education research is on the agenda for the improvement of higher engineering education and the development of strategies for solving important issues for the future of engineering education, such as recruitment, the need for new competences and the ability to deal with new types of interdisciplinary and complex knowledge.Engineering education research in Europe, is characterized by a unique interdisciplinary approach. Engineering education researchers do have various backgrounds in engineering, science, social science and educational psychology investigating higher engineering education. Many universities in the north-west of Europe have their own centres of expertise for educational development where the research component is directly linked to curriculum or staff development.Due to this European unique approach to engineering education research, it is very important to initiate a more structured network among European engineering education researchers. Establishment of a SEFI working group means an important step towards the creation of such a network.

Objectives

The overall objective for the SEFI Working Group on Engineering Education Research is to create a European community of engineering education researchers in order to contribute with research evidence to the advancement of engineering education.

Specific objectives are:

- to raise awareness of the need of a research approach to the development of engineering education,
- identify and define the research area of engineering education and the engineering education researchers,
- to support the establishment of engineering education research as a discipline in Europe as a whole as well as regionally,
- to establish and contribute to European research projects,
- to collaborate in the training of PhD students and to establish a European standard for doctoral training for engineering education researchers
- to influence and strengthen the engineering education research dimension at SEFI annual conferences
- to actively support the development of the SEFI journal European Journal of Engineering Education as a platform for research on engineering education

For further information, please contact: Dr. Jonte Bernhard - jonbe@itn.liu.se
http://eersefi.ning.com/
http://euro-eng-ed-research.pbworks.com/FrontPage

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Next Steps

What Are Your Plans?

- Silently reflect on your interests and plans for becoming an engineering education researcher

- Jot down
    - What do you plan to do next?
    - What are your longer range plans?

- Share with the person next to you

Please fill out the post-workshop questionnaire

Thank you!

An e-copy of this presentation may be found at:
http://CLEERhub.org

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