Innovation in Curriculum Panel: The Undergraduate GEARE Program

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Introduction

- We live in a knowledge-driven, global economy
- More and more employers are looking to hire global engineers
- But what is a global engineer?
  - The Global Engineer is …
    - … prepared to function immediately and effectively in the global workplace!

- So, how do we get there?
Three Axes of Engineering Education

Global Competency:
- Based on 2005 NAE Report “Educating the Engineer of 2020: …”:
  » Work effectively in diverse & multicultural environments
  » Work effectively in the global engineering profession
  » Synthesize engineering, business, and societal perspectives
  » Ethically responsible in a global, social, intellectual, and technological context
  » Adaptable in a changing environment

Technical Competency:
- Based on 1955 ASEE criteria to modernize engineering education (Grinter Report) by:
  » Science & math
  » Engineering fundamentals
  » Analytical skills
  » Experimental skills
  » Open-ended design & problem solving skills
  » Integration of analytical, problem solving, and design skills

Professional Competency:
- Based on 1996 ABET Board of Directors Engineering Criteria 2000:
  » Leadership, Teamwork
  » Communication, Decision-making
  » Recognize & manage change
  » Multi-disciplinary within and beyond engineering
  » Innovative, Strong work ethic
  » Entrepreneurial and intrapreneurial
  » Curious and persistent continuous learners
Spectrum of Programs to Increase Level of Global Competency

Integrated long-term programs, e.g., International Plan

Independent long-term programs, e.g., traditional one-year SA

Integrated mid-term programs, e.g., language, culture and SA

Independent mid-term programs, e.g., traditional one-semester SA

Integrated short-term programs, e.g., summer research experience

Independent short-term programs, e.g., Maymester or summer course

On-campus programs, e.g., design project with int'l peers

Percent StudentImpacted

0 10 20 30 40 50 60 70 80 90 100

Long-term: two academic sessions or more
Mid-term: one academic session
Short-term: 4 weeks or less
State of Global Competency

• Small percentage of U.S. engineering students have substantial international experience before graduating (5+%)  

• The barriers, real and perceived, are:  
  » Cost  
  » Graduation time  
  » Community (language, leave family and friends, fear of the unknown)  

• Need to design innovative programs so that U.S. engineering students will reach substantial level of global competency before graduation
GEARE Program Overview

• Multiple Pillars
  » Minimum of 12 credit hours of foreign language before going abroad
  » Orientation in foreign culture before going abroad
  » Two internships
    – Domestic internship first
    – Subsequent international internship
  » One semester of study abroad with fully transferable course credits
  » Global design team project
    – Multi-national, multi-university design teams working on industry-inspired projects
GEARE Program Schedule

For Purdue Students

<table>
<thead>
<tr>
<th>1st Sem.</th>
<th>2nd Sem.</th>
<th>1st Sum.</th>
<th>3rd Sem.</th>
<th>4th Sem.</th>
<th>2nd Sum.</th>
<th>5th Sem.</th>
<th>6th Sem.</th>
<th>3rd Sum.</th>
<th>7th Sem.</th>
<th>8th Sem.</th>
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<tbody>
<tr>
<td>Regular Freshman Semester</td>
<td>Regular Freshman Semester</td>
<td>GEARE Selection</td>
<td>May-semester course at Partner Univ.</td>
<td>Foreign Language 1</td>
<td>Foreign Language 2</td>
<td>Foreign Language 3</td>
<td>Domestic Internship</td>
<td>Regular Junior Semester</td>
<td>International Internship</td>
<td>Study Abroad Semester</td>
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<td>Cultural Orientation</td>
<td>1st Cultural Orientation</td>
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<td>2nd Cultural Orientation</td>
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<td>3rd Cultural Orientation</td>
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<td>4th Cultural Orientation</td>
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<td>5th Cultural Orientation</td>
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University Partners

• Focus on Strategic Partner Universities
  » Limit number of universities available for each discipline
  » Ideally, one university per language spoken or per region of the world
  » Elevate these universities to partner status
  » Identify and list pre-approved courses for each university
  » E.g., School of ME at Purdue:
    – KIT, Germany
    – SJTU, China
    – Tec de Monterrey, Mexico (Univ. Carlos 3rd Madrid, Spain)
    – IIT Bombay, India (University of Queensland, Australia)
Corporate Partners

- **Partners**
  - Chrysler
  - Cummins
  - John Deere
  - DOW
  - Ford
  - GM
  - Shell
  - Siemens
  - United Technologies (Otis, Pratt & Whitney, Carrier, etc.)

- **Supporters**
  - GE
  - Kimberly-Clark
  - Bosch
  - Rolls-Royce
  - Whirlpool
GEARE Student Participation

GEARE STUDENTS BY DISCIPLINE

Year

Students


6 10 12 11 8 18 9 7 11 8

AAE ABE CHE CE CMPE EE IE ME
GEARE Student Participation

GEARE STUDENTS BY COUNTRY

Students

Cohort


0 5 10 15 20 25

AUSTRALIA SPAIN FRANCE MEXICO INDIA CHINA CHINA GERMANY

6 9 7 4 6 11 7 5 12 6
Global Experiences of ME Students

Source: International Programs at Purdue website, Study Abroad: Student Reports, Major Stats, 5 Mar 2010

81 of ~280 BSME = 29%
4X participation of US Engineering
& 7X growth rate
Global Experiences of ME Students

(Percentages are total annual study abroad numbers divided by the number of same-year BS+MS+PhD degrees awarded. 07-08 last year US data available from Open Doors. Growth rates from linear regressions. PU degrees estimated 09-10)

US Engrg SA Growth Trend = 0.29%/yr
Purdue ME SA Growth Trend = 2.21%/yr

85 w/ 350 est. PU ME Degrees
8,135 w/ 122,242 Engrg Degrees Awarded in US
Financial Support

• Endowment of $600,000 by retired Siemens VP
• Seed grants from International Office at Purdue
• Industry partners pay yearly participation fee
• Funds are spent on:
  » GEARE Stipend for students
    – Up to $1500 depending on location
    – Compensate travel expenses
    – Equalization of student internship salaries to make different GEARE locations equally attractive
  » Administration
  » Travel by administrators
Quality of Students

- Very good GPAs: 3.7 on average (Several 4.0’s)
- Typical honors include:
  - Outstanding Graduating Engineer 2004
  - Purdue President's Leadership Class (30 of 7,144)
  - Mauzy Emerging Leaders Program (60 of 7,144)
  - National Merit and Indiana Top Resident Scholar recognition
  - Class Student-of-the-year Awardees, HS class Presidents, student rep of local HS Board (1 of 1200)
- Average of 4.5 semesters of university-level language courses by the time they study abroad
- Several students lived abroad
- ~26% women, compared with 13% overall in ME
Student Feedback

- Cultural differences had significant impact on their interactions
- Ability to accommodate to changes in a foreign environment improved with experience
- As they became more confident in new environment, productivity increased
- Foreign students likely to adapt more readily to cultural differences due to familiarity with US culture through mass media
- US students, in contrast, emphasized a much greater personal change due to adaptations to cultural differences
- English was the language of last resort in communications between members of both groups.
- US students indicated that foreign language skills improved considerably in both social and business settings
- Overall, development of communication skills was considered best outcome
Summary

• Typically, outstanding students apply to program
• 2x more women in GEARE than overall
• Internships and study abroad work well
• Multi-university, multi-national design team projects work very well
• Curriculum articulation is necessary, but only a start
• Faculty participation is critical
• Research collaborations will be imperative
• Significant trickle-down effect
Summary

• Administration is time intensive
• Close interactions between partner university and Purdue is a must
• Selection of students is critical
• Resident faculty is must to start program
• Overall program has become extremely valuable experience for students

• Our goal:
  » 5% of Engineering graduating class (1200 students)
  ➔ 60 students per year
Summary

• Minor in Global Engineering Studies
  » 12 credits in one foreign language program
  » One semester of study abroad at partner university
  » Three-month domestic internship at industry partner
  » Subsequent three-month international internship preferably, but not necessarily, at the same industry partner
  » Participation of global design team project