Integrating Global Experiences into Engineering Education:

The Global Perspective Program at WPI

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Worcester Polytechnic Institute
Frontiers of Engineering Education
Preparing Students for Life and Work in the 21st Century

- **Rapid changes**
  - technological, societal, political, economic

- **Evolving demands**
  - flexibility and adaptability
  - ability to work across boundaries and understand connections

- **Rethinking --- the “educated engineer”**
Challenges in Engineering Education

- Defining the global engineer; rethinking the curriculum
- Integrating professional skills into the curriculum
- Addressing ABET:
  - function on multidisciplinary teams
  - communicate effectively
  - understand the impact of engineering solutions in a global/societal context
  - engage in life-long learning
  - Professional responsibility and ethics
Impactful international programs for engineering and science students that are scalable and sustainable

- **Impact** depends on design, duration, depth, learning outcomes
- Some program models serve few students and may not prove scalable
- Some depend on individual champions or temporary funding and may not be sustainable
Worcester Polytechnic Institute

- Private technological university
- 3500 undergraduates, 1100 graduate students, 280 FT faculty
- 50% engineering, 35% science, 10% business
- $18M research + 25 PhDs annually

- Project-based curriculum since 1970
- 50% of WPI undergraduates complete at least one project abroad before graduation
Required Projects at WPI

- **2nd year: Humanities and Arts Capstone**
  - Depth in chosen area
  - Research paper, performance, composition, etc.

- **3rd year: Interactive Qualifying Project**
  - 9 credit hours, interdisciplinary
  - Problem at interface between society and technology

- **4th year: Major Qualifying Project**
  - 9 credit hours, in major field
  - Senior design or research problem
  - Includes industrial internship-like experiences
WPI Global Perspective Program

- 65% of students complete at least one project at an off-campus Project Center (fulltime, 7 week term)

- About 50% do at least one project overseas (usually interdisciplinary)

- 2 faculty advise 6-7 projects with 24-28 students

- Context-driven problem solving for local organizations

- 20% of faculty involved each year (10% as residential advisors)
WPI in the World
Typical WPI Student’s Academic Year

1 semester = 2 terms
1 term = 7 weeks

6 courses / semester
3 courses / term

A Term
Art History
Calc IV
Gen. Physics

B Term
Intro to Statics
DEQ’s
Soc.Sci. Methods

C Term
Project in Bangkok

D Term
Anatomy
ECE Course
Fluid Mechanics

Proposal

Project = 3 courses
Educational Objectives

- Research skills
- Problem solving
- Dealing with ambiguity
- Critical thinking
- Written & verbal communication
- Teamwork
- Awareness of cultural and social issues
- Professional and personal growth
Required program components

Multilevel assessments
*Primary: Student/Alumni*
*Secondary: Advisor/Sponsor*
*Tertiary: Program*
Accountability and Assessment

- Projects graded by faculty advisors
  - Research, results, deliverables
  - Written report, oral presentation
  - Process, teamwork, professionalism

- Program reviews
  - Internal and external
  - Outcomes rated according to rubrics
  - Useful for program improvement, accreditation, and more

- Follow up with sponsors
  - Were the results useful?
  - Will they do it again?
Comparison of On-Campus & International Project Outcomes

<table>
<thead>
<tr>
<th>Category</th>
<th>On-campus projects</th>
<th>International Projects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall report quality</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Multidisciplinary teams</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Lifelong learning</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Impact of engineering on society</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Exposure to global issues</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Contemporary issues</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Handling proprietary information</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Social responsibility of engineers</td>
<td>2</td>
<td>3</td>
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</tbody>
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Rating scale: 1 = poor, 5 = excellent
Self-Directed Learning

- Pre/post application of SDLRS instrument comparing on-campus to off-campus
  - On average the off-campus cohort showed larger improvement in SDLRS scores (not statistically significant)
  - Students with lowest pre-SDL had largest increase
  - Some students with higher pre-SDL showed negative changes
Summary of Alumni Survey Results

- Survey probed professional impact (24 items), personal impact (9 items), and world views (6 items)

Summary of Statistically Significant Results

- **Professional**: 18 positive for off-campus cohort; 6 no difference

- **Personal**: all 9 positive for off-campus cohort

- **World view**: all 6 positive for off-campus cohort

- 36 items showed significantly higher positive impacts for women compared to men
The Andrew Heiskell Awards For Innovation In International Education 2003-2004

WPI: One of Ten Institutions Honored for Exemplary Internationalization, 2002-2003

Theodore M. Hesburgh Certificate of Excellence, 2003 for "The WPI Global Perspective Program"
Association of American Colleges and Universities recognized WPI as one of its sixteen Leadership Institutions, for “its vision and program as an exemplary way of infusing liberal and global studies into pre-professional education.”

A Global Approach to Engineering

University push their future engineers to study abroad, with limited success.

By SCOTT CARLSON

Before she arrived in Namibia, Tara Epstein had her trip planned out as precisely as a line plotted on a grid. She and three other engineering students from Worcester Polytechnic Institute had come to the South African country to help set up alternative-energy programs for poor villages, and Ms. Epstein had written up a daily schedule and plan of action herself and her colleagues.

In time, all of that went out the window. They arrived to find that they would have to cobble together some of their projects from scraps and that there was little in the way of an office or laboratory, and even less passing for a computer or Internet connection.

"Before the end of the trip, I learned up a lot," Ms. Epstein says. "Here we are on a ground, headed to a village where we don’t know if they are expecting us or not. This four of us end up sleeping in a two-person tent in the middle of a cow field. It puts things into perspective. You’re not in the lab. You’re doing real work."

Within WPI’s global-studies program for engineers, an experience like this is considered a grand success. The point of that program, and of many like it at colleges across the country, is to pull undergraduate engineers out of familiar campus environments and make them engage other cultures—in China, India, Thailand, Germany, Mexico, and other countries.

It is training for a profession that is becoming increasingly global. American manufacturing has largely moved overseas. Those manufacturing sites are also the homes of future customers. American companies forecast immense growth for their products in modernizing countries like India and China, and engineers need to understand those cultures before designing products for them, say supporters of international-engineering programs.

ABET, which accredits college engineering programs, has made a "broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context" part of its criteria.

Moreover, more American engineers will need better understanding abroad. They will need to understand that going to be a minority on design teams in the future," says E. Daniel Holzman, director of a global-engineering program at Purdue University.

Employers, most important, are hunting for graduates with international experience. Mr. Holzman says that students who have participated in his program are in "high demand" after they graduate, and that some land supervisory jobs.

But so far, American colleges have made few forays in the global-engineering market. John Wall, a vice president at Communis Inc., a major manufacturer of diesel engines that supports the international-engineering program at Purdue University, says he would like to hire more students with international experience. He says, however, that they are not enough coming out of American colleges.

"Engineering is a social exercise, and being able to relate across cultural boundaries is getting very important," Mr. Wall says. In illustrating cross-cultural communication, he cites an example from his own experience working with engineers at offices in Asia: When asked to do an impossible task, an Asian engineer will never say no, as an American might. "What you’ll hear is "Well, try. You have to be sensitive to that, how they will qualify it."

Constraints of Structure: Globalization affects not only engineers, of course. Many colleges are struggling to raise participation in study abroad across every field. Nationally

THE CHRONICLE

of Higher Education

June 1, 2007

WPI student team featured in

**Italy’s Endangered Art**
By Erla Zwingle,
Photographs by O. Louis Mazzatenta *National Geographic Magazine*, August 1999

WPI’s Fabio Carrera, Founder and Center Director of the Venice Project Center featured in

**Venice Under Siege**, National Geographic Channel’s *Out There* television show, aired May 2002
Impact on the Campus

- Faculty culture
  - involvement across campus
  - pride in program

- Student culture
  - global preparedness, awareness
  - “make a difference”
  - find passion, broaden horizons

- Institutional culture
  - “signature program”
  - focus of marketing
  - development and alumni

- External relations
  - national coverage
  - global partnerships
Why Global Projects Work for WPI

- Central to curriculum, fit to academic calendar
- Broad faculty participation
- Support learning both in the major and in general education
- Project learning enhanced by immersion in an unfamiliar setting
- Help students understand social, cultural, and global contexts of their future professions
Lessons Learned

- Instructional design built on known pedagogy
- Comprehensive health/safety and risk management
- Multilevel assessment is crucial
  - Engage external experts
- Many outcomes overlap with ABET
- Can’t do it in a day - start small and build
- Find what works in your context; think outside the box
- Collaborate with colleagues on/off campus & across departments
- **Global program—great tool for recruitment and retention**
For More Information

http://www.wpi.edu/academics/igsd/gpp.html

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WPI Faculty Adopted Learning Outcomes

- Oral communication skills, using appropriate, effective visual aids.
- Demonstrate the ability to write clearly, critically and persuasively.
- Select and implement a sound approach to solving an interdisciplinary problem.
- Maintain effective working relationships within the project team and with the project advisor(s), recognizing and resolving problems that may arise.
- Demonstrate an understanding of the project's technical, social and humanistic context.
- Analyze and synthesize results from social, ethical, humanistic, technical or other perspectives, as appropriate.
- Critically identify, utilize, and properly cite information sources, and integrate information from multiple sources to identify appropriate approaches to addressing the project goals.
- Select and implement a sound approach to solving an interdisciplinary problem.
External Recognition

- #1 among US colleges & universities for technical students studying abroad
- Among top 5 doctoral universities in percentage of all students studying abroad
- TIAA-CREF Hesburgh Award Certificate of Excellence (faculty development)
- NAFSA Association of International Educators, one of 10 exemplary programs (International education)
- American Association of Colleges and Universities, one of 16 Greater Expectations Leadership Institutions (liberal education leadership)
- The “popular” press: National Geographic; Smithsonian; Chronicle of Higher Education; US News & World Report; Christian Science Monitor; NY Times; Better Homes & Gardens
Costs

- Students pay their own travel and living costs ($4K to $8K)

- Faculty advisors are the greatest resource implication of the program

- Sponsors at some sites pay a project fee to subsidize program costs (typically $20K for senior technical projects)

- Division raises 20% of its operating budget

- **Overall cost/credit to the university is comparable to an on-campus course** (about $1000 per 3 CH per student)