

Preparing Engineers to Work in a Flat World—The WPI Global Perspective Program

Gretar Tryggvason, Ph.D., Richard Vaz, Ph.D., Paul Davis, Ph.D. and Natalie A. Mello
Worcester Polytechnic Institute
Worcester, MA 01609, USA
gretar@wpi.edu, vaz@wpi.edu, pdavis@wpi.edu

Abstract

Working globally is now something that every engineer must be able to do. Many engineering students in the United States, however, have little experience working with people of different cultures. Providing the students with such an experience must increasingly be part of the regular engineering curriculum. The Global Perspective Program at WPI provides just such an experience. The structure of the program is described briefly as well as the impact of the program on the participating students, including their abilities and attitudes. The various logistical issues in operating the program are also addressed as well as how the program can serve as a model for other institutions.

Introduction

As author Thomas Friedman says, the world is now flat.¹ Technological advances have changed the way we live, but the globalization of the economy has amplified the impact of technology on modern societies in ways that were perhaps not obvious at first. The connectivity provided by the Internet has generated new markets for products and services, but has also made available labor that is often both educated and cheap. This is likely to have profound impact on the distribution of wealth in both the developed and the developing part of the world and may, in particular, alter the socioeconomic structure of countries where the general well being of the population has been taken for granted. That education plays a role in the prosperity of nations is not debated, but many authors, like Landes² for example, argue that it is specifically the presence of both knowledge and know-how that determines how well off societies are. The education of engineers is therefore critical to every nation to ensure the prosperity of their citizens.

Preparing engineering students to work in the new world order requires fundamental changes in the technical abilities that engineering schools must provide and the attitude they install. The Internet makes it possible for any individual to find information about literally anything, instantaneously, but the communalization of knowledge also makes evaluating the reliability of information and assessing the quality a bigger challenge than most students are used to. Similarly, the availability of computer programs to do virtually anything, from conducting simple calculations to simulate complex systems to design a complete engineered artifact, empowers the modern engineer to do more than his or her predecessors could ever imagine. These tools do, however, not only require that the engineer knows how to use them, but also requires him or her to be able to first of all to assess what tool is appropriate for a given task and then to be able to evaluate to result in a critical way. In addition to the changes in the technical skills engineers must possess, their non-technical professional skills must be suited for the modern way of doing engineering. Considerable progress has already been achieved in the United States to make communication in the broadest sense an integral part of the engineering curriculum.³ Most programs now require their graduates to exhibit proficiency in oral and written communications and to be able to work on diverse teams. Engineering, possibly more than most professions, require accurate and efficient communications—I have to understand what you are saying and vice versa for the design that we both are working on to function. The surprising thing about communications is not that engineering schools have recently started to emphasize it (motivated by ABET, in some cases), but that there was a need to remind engineering educators that engineers need to communicate! However, in a flat world the ability to communicate takes on a much broader meaning. Not only are engineers frequently working on products that will be made in a different country and marketed to people with different cultures, but the engineering of new products is increasingly done by teams consisting of people located in different countries and with diverse cultural background. Such interactions obviously have enormous potentials for misunderstanding and conflicts. The problem is exacerbated by the fact that many engineering students come from families of modest means where opportunities to experience the richness of diverse cultures have been limited. Giving engineering students the opportunity to develop the attitudes and skills needed to work effectively

in a global economy where they must work productively with anybody anywhere is no longer a luxury, but increasing is a necessary part of the education of the modern engineer.^{4,5} The WPI Global Perspective Program is an example of how such opportunities can become a part of the institutional culture.

The WPI Global Perspectives Program

Projects are central to the undergraduate curriculum at WPI. Every student must complete three projects: A Sufficiency Project (at the sophomore level), an Interactive Qualifying Project (IQP at the junior level), and a Major Qualifying Project (MQP—a senior project). The first project is equivalent to one course and comes at the end of five thematically related courses in the arts and humanities. Each student works with a faculty member to complete a project intended to elaborate on the course work and to give the students an idea of how knowledge is obtained and expressed. The other two projects are each equivalent to three courses. The senior project is similar to senior projects at other institutions, except that it does not necessarily have to include capstone design (although it usually does). It must, however, in all cases “demonstrate application of the skills, methods, and knowledge of the discipline to the solution of a problem that would be representative of the type to be encountered in one’s career,”⁶ to quote from the WPI catalog. The junior project, which is probably unique to WPI, “challenges students to identify, investigate, and report on a self-selected topic examining how science or technology interacts with societal structures and values. The objective of the IQP is to enable WPI graduates to understand, as citizens and as professionals, how their careers will affect the larger society of which they are part.”⁷ Both projects are usually done in teams and last for seven to eight weeks. The junior project teams are almost always interdisciplinary.

To accommodate off-campus projects, the WPI program operates on four seven-week long terms per academic year. The students generally take three courses each term. While on-campus projects are often spread over two or three terms and done while the student is also taking courses, the off-campus projects are nearly always completed in one term, either during the academic year or during the summer term.

A significant fraction of the junior projects are done at off-campus project centers, most of which are outside the US (Australia, Thailand, Hong Kong, Costa Rica, Namibia, and several in Europe). The WPI Global Perspective Program sends teams of students to each of these centers along with faculty supervisors to work on projects that are typically sponsored by nonprofit institutions or government agencies. The sponsor provides local facilities and co-supervises the projects. Students engage in intensive language and culture preparation and develop a project proposal the term prior to the off-campus experience. An increasing number of senior projects are also done abroad. In most cases, the overseas projects are done at permanent project centers where WPI has a long-standing relationship with local sponsors.

The successful operation of the program is to a large degree dependent on a strong commitment from the Institution leadership and the faculty. The WPI Global Perspective Program is administered by the Dean of Interdisciplinary and Global Studies (IGSD), who reports directly to the Provost. IGSD has its own operating budget and staff. Faculty members with permanent affiliations in various academic departments serve as director and associate director and each project center has a director and in some cases an associate director as well. Generally faculty in these positions have reduced teaching loads. For the permanent centers, usually one faculty member will accompany about fifteen students and spend the entire seven weeks at the center. For the larger centers, sometime two faculty members will go with about thirty students. As the regular teaching load at WPI is one course per term, the Institution commitment in terms of faculty time corresponds roughly to the teaching of an upper-level elective course. For the faculty, the commitment is considerably greater. While many find that they can accomplish some scholarly activity away from the campus, most find that attending to the students takes considerably more time than teaching one class. Staffing the project centers, both in terms of faculty accompanying the students, and finding directors willing to work with local people and organizations to define projects is therefore perhaps one of the greatest ongoing challenges in the operation of the program. The global division has, however, been extremely successful in recruiting the needed people, sometimes from the ranks of the most distinguished and productive members of the faculty.

In addition to projects done at WPI-established project centers, faculty members frequently work with individual students or teams of students to design projects in places as diverse as Iceland and India. While each project is supervised by a member of the faculty, the IGSD has formal oversight over such projects and supervises a process to ensure that routine matters such as housing and travel are

addressed.

Students participating in the Global Projects find it a “transforming” experience. Many of the students have not traveled abroad before going to a project center and even those who have visited other countries find that the immersion in the problems faced by people in different countries and different cultures changes their perception of the world and its inhabitants. Almost all feel ready to conduct business abroad and many express comfort with the prospect of spending time in other countries as part of their future careers.

WPI regularly assesses student learning outcomes for all interdisciplinary projects, completed both on and off campus. A faculty team reads the reports written by the students and fills out a questionnaire for each report. The questionnaire addresses the quality of the report in areas ranging from background research, methodology, analysis, and conclusions, to presentation quality and demonstration of major accreditation outcomes. The assessment also examines how the projects contribute to satisfying WPI’s interdisciplinary and (as appropriate) global educational goals. The Assessment Coordinator compiles and analyzes all the reviews, and issues a report based on the findings. Feedback for continuous improvement, whether it is related to advising quality or student achievement, is then implemented through appropriate faculty procedures.

The 2000 academic year assessment process serves as an example. In this review, 196 project reports were read, representing the work of 240 Global Perspective students and 244 on-campus students. The results from that review showed a continuation of the trend observed in previous reviews: there is a significant and growing difference between the overall quality of work produced by students participating in the global program and those who remain on campus. Out of a 5-point scale (5=excellent), the average overall quality of Global projects was 4.20 and that of on-campus student work was 2.98. Less than 3% of the Global reports were rated unacceptable, compared to 29% for on-campus reports. The results indicate that the much more extensive planning for projects conducted off campus, and the additional advising provided by project sponsors invested in producing high-quality results, help account for these striking differences. Consequently, the IGSD has since focused assessment and continuous improvement efforts on improving the on-campus experience by emulating these strengths of the Global Perspectives Program.

The Global Perspective Program at WPI has been in existence since the mid seventies and has grown continuously since its inception. Today, over 500 students, out of a total undergraduate population of 2,700 complete off-campus projects each year. This translates into well over half of all students at WPI will have participated in an international project at graduation. The quality of the Program has been recognized in numerous ways. For a recent example, see reference [8].⁸

Examples

The projects organized by the Global Program deal with a wide variety of topics. The nearly sixty projects done in Thailand since 1998 have included a series of project done to address the concerns of the residents of the Klong Toey slums of Bangkok (such as “Designing a Playground for the Klong Toey Slum,” 2003) and other projects have addressed various topics of importance for the rural population (“Micro-Hydroelectric Power in Kre Khi, Thailand,” 2002, for example). The fifty plus projects in Venice have assembled a very extensive knowledge about the city’s environment and art treasures and include “A Catalog of Venetian Flagstaff Pedestals” (1997) and “Portali e Lunette: Venice’s Artistic Entrances” (2002), for example. Many of the projects done as part of the Global Program have been recognized by Institutional awards. Table I lists a few projects thus recognized in 2004 and 2005 and Table II gives three examples of recent projects in three locations. Many more examples are listed on the WPI Global Perspective Program website.⁹

Conclusions

The modern flat world required engineers to have the skills and attitudes to be able to work with anybody anywhere. Thus, providing engineering students with the opportunities to experience worlds and cultures that are different from their own is no longer an option. How to best do this, however, still poses numerous challenges. The WPI Global Perspectives Program is an example of a program that has been very successful. Although the particular oddities of the WPI academic year may make it difficult to transfer the program to other institutions in exactly the same form as it exists at WPI, its main features and the lessons learned from its successful operation of a large number of years should be easily transferable. The key to the success of the program is that it is an integrated part of the Institution and that the global

experience is tightly integrated into the curriculum. Going abroad fulfills a campus wide program requirement and does not, in particular, delay the student's graduation.

2005 Winners

Irrigation Development to Improve the Lives of Impoverished Children (Kanchanaburi, Thailand)

Composting for Sustainable Waste Management (Puerto Rico)

Assessing Prepay Water Metering in the Informal Settlements of Windhoek (Namibia)

Developing a Robotics Outreach Program (Worcester, Massachusetts)

Preserving the Nautical Traditions and Maritime Heritage of Venice, Italy

2004 Winners

Energy Efficiency Guidelines for Low-Cost Housing (Namibia)

Development of Communal Washing Facilities for the Northwest Settlements of Windhoek, Namibia

The Development of an Irrigation System in the Village of Nong Din Dam

Noise Monitoring in San Juan, Puerto Rico

Increasing Awareness of Lahu Culture through Solar Technology (Thailand)

Table I: Award winning projects for 2004 and 2005. From the WPI Global Perspective Program website.¹⁰

Aquaculture of the Kabeljou in Namibia, 2005

Students: Patrick Weiser, Michael Ragusa, Danya Decoteau, Danielle Flannery

Advisor: B. Addison - HU&A, S. Weininger - CH

Sponsor: Department Fisheries and Marine Resources

Working in conjunction with the Ministry of Fisheries and Marine Resources of Namibia, we made recommendations for lowering the costs of a land-based kabeijou aquaculture industry. We performed a cost-benefit analysis on three major areas of a kabeijou aquaculture industry which are live feed, inert feed, and fish containment units. Although we recommended methods that would reduce yearly costs by N\$ 10.9 million, we concluded that a kabeijou aquaculture industry is still not feasible in Namibia at this time.

Cultural Preservation Using Solar Technology, 2004

Students: Christopher Treat, Justin Crafford, Colin Morel, Benjamin Mar

Advisor: Weininger, S. - CH

Sponsor: Mirror Art Group

Our team worked with the Mirror Art Group to install a solar electric unit in Ban Jalae, a rural hill tribe village in northern Thailand. The photovoltaic system provides electricity for educational equipment in a Cultural Center that showcases Lahu customs and traditions, as part of an effort to increase awareness of Lahu culture and combat assimilation into mainstream Thai society. In addition, we analyzed the cultural and societal impacts of the technology.

Students: Kristopher Houle, Kevin Glynn, Jennifer Schweers

Advisor: H. Vassallo - MGT

Sponsor: Danish Cyclists Federation

This project, completed in Copenhagen, Denmark for the Danish Cyclists Federation, describes the current situation of bicycle theft and security in Denmark and suggests possible solutions to alleviate this problem. Using extensive background research, interviews, focus groups, and field observations, the team determined that a system using radio frequency identification tags and scanning technology would greatly improve on the current frame number system and more easily identify bicycles. Guidelines and important contacts crucial to implementing such a system are included.

Table II: Three examples of Global Perspectives projects. From the WPI Global Perspective Program website.¹¹

References

1. T. L. Friedman. *The World Is Flat: A Brief History of the Twenty-first Century*. Farrar, Straus and Giroux, 2005
2. D.S. Landes. *The Wealth and Poverty of Nations, Why some are so rich and some so poor*. W.W. Norton & Company, 1998.
3. *Criteria for Accrediting Engineering Programs. Effective for Evaluations During the 2003-2004 Accreditation Cycle*. Accreditation Board for Engineering and Technology, Inc. Available at: www.abet.org
4. *The Engineer of 2020: Visions of Engineering in the New Century*. National Academy of Engineering (2004). Available for free online reading at <http://www.nap.edu/catalog/10999.html>
5. *Educating the Engineer of 2020: Adapting Engineering Education to the New Century*. National Academy of Engineering (2004). Available for free online reading at <http://fermat.nap.edu/catalog/11338.html>
6. WPI Undergraduate Catalog 2003/2004. See also: <http://www.wpi.edu/Pubs/Catalogs/Ugrad/Current/>
7. Ibid.
8. Worcester Polytechnic Institute: Teaching Engineers to Work Globally—and 'Walk a Bit Taller'. In *Internationalizing the Campus 2003, Profiles of Success at Colleges and Universities*. A Report from NAFSA: Association of International Educators 105-108.
9. The WPI Global Perspective Program website: <http://www.wpi.edu/Academics/Depts/IGSD/>
10. Ibid.
11. Ibid.