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Sushil Chaturvedi

Old Dominion University, schaturv@odu.edu

Gary Crossman

Old Dominion University, gcrossma@odu.edu

William Swart

Old Dominion University

Joseph Betit

Old Dominion University

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Global Engineering in an Interconnected World: An Upper Division General Education Cluster at Old Dominion University

Sushil Chaturvedi, Gary Crossman, William Swart, Joseph Betit
College of Engineering and Technology
Old Dominion University
Norfolk, Virginia 23529

Abstract

The “Global Engineering in an Interconnected World” cluster of courses fosters among students an awareness and understanding of global technology, quality assurance standards, and differences in cultural, communication, and business practices and their impact on a global work environment. This cluster will prepare the growing numbers of students who will accept employment with global firms or find themselves part of a merger or strategic alliance involving multinational corporations. This newly approved cluster of five courses described in the paper has been approved by the University for satisfying University upper-division general education requirements. As a consequence, students choosing this route to meet their general education requirements do not have to take additional courses to obtain a global perspective in their chosen field of study.

Introduction

Old Dominion University is a comprehensive, state-supported institution located in Norfolk, Virginia, home to one of the world’s largest naval bases and the western world headquarters of the North Atlantic Treaty Organization (NATO). The excellent port facilities also attract many international vessels, making the area a major center for world trade, and there are also located in this region a large number of international manufacturing facilities. The University therefore has natural strengths in activities with international scope.

In recognition of these strengths, the University’s strategic plan for 2000-2005 ¹ includes as one of its ten initiatives a call for Old Dominion University to be recognized as the premier international university of the Commonwealth of Virginia. Amplifying that initiative, the plan goes on to say that “Old Dominion University recognizes its mission to serve as ‘the state’s gateway to the rest of the world and the world’s gateway to Virginia.’ In an effort to consolidate and expand the University’s emerging reputation as a globally focused institution, the University will continue to build and refine its internationally oriented curriculum across all of its colleges. The institution will continue to provide opportunities and support for all faculty to develop the international dimension of the curriculum; to diversify the student body, fully integrating international students into the academic and social life of the university community; to provide a

variety of international experiences and make them available to a broader range of Old Dominion University students; and, through strategic partnerships, to provide opportunities for the University to serve the global interests of the community, region, Commonwealth, and nation.”

At the 2000 National Meeting of the National Society of Professional Engineers,² a group of top executives from selected engineering firms discussed the issues associated with competing in a global engineering environment. Their discussions pointed out that the changes in the world around us are fueled by: 1) demographic shifts; 2) technology transfer and telecommunications; 3) privatization and changing clientele; and 4) sustainability issues. They also noted that the U.S. construction market comprises only twenty percent of the global construction market and that it is static, shrinking, renovative, and increasingly subject to competition from the world’s top non-American design firms. The group cites the following reasons for competing internationally: 1) access to growth markets; 2) client base not limited to government organizations, but also international private sector; 3) reciprocity and relationship building; 4) stability through diversification; 5) opportunities for innovation; and 6) opportunities to learn.

Companies represented at the above meeting, as well as many others, are realizing that global financial pressures will precipitate changes in how students are trained and prepared to meet the challenges associated with global competition.³ In recognition of the need for the higher education to change dramatically, in both shape and structure, to meet the demands of a transformed world,⁴ a summit of leading industrialists and educators was convened in 1997 to explore the forces affecting the engineering profession at the beginning of the 21st century and what these factors mean for the profession. The aim was to formulate a new model of engineering education that would better meet the current and future needs of multi-national companies and the global engineer. At approximately the same time, Siemens organized an international conference entitled “Research and Engineering Education in a Global Society.” Participants identified best practices, discussed strategies, and formulated a declaration for achieving goals in engineering education and global research cooperation, with a view to building a global society in the next century.⁵ Joining in this call for change was the National Science Foundation, which encouraged mutual and beneficial cooperation with other countries in its publication *NSF Engineering: The Long View*.⁶

Universities in general have long supported the view that an international experience is a valuable part of education. However, such an experience is more difficult in a program of study for engineers than some other disciplines. Consider, for example, that 43% of Duke University undergraduate students study abroad, but only 10% of engineering graduates take advantage of this opportunity.⁷ Also, engineering students studying abroad typically will not have the opportunity to take courses that will transfer to their engineering curriculum in English. Some foreign universities are taking steps to facilitate American engineering students’ studying a semester on their campuses. For example, Germany is actively working to attract foreign engineering students to its universities as part of a broader effort to modernize and globalize engineering education.⁸

Based on indicators that the practice of engineering is increasingly global and that today's graduates will have global and multicultural professional experiences, and in regard to the University's strategic plan, the College of Engineering and Technology has taken the first step in globalizing its undergraduate curricula by developing an upper-division cluster titled "Global Engineering in an Interconnected World" as part of the University's general education program. In designing the cluster, we explicitly designed the cluster to be desirable to students wishing to develop a global engineering perspective. As a result, taking the cluster does not add any additional requirements to degree completion and does not require study abroad. However, in recognition of the advantages of an overseas residential experience, the cluster can be expanded to a minor in global engineering when students take a one-semester overseas internship.

General Considerations in Development of the Cluster

The University has an exceptionally strong general education program and in 1998 instituted an upper-level general education requirement of a three-course interdisciplinary cluster. Ten clusters were originally developed, each with six identified courses. All students are required to complete a cluster by choosing three of the courses, one of which must be writing intensive. In order to provide its students (and others at the University) with the opportunity to be better prepared to be productive individuals in a global environment particularly engineering, the College of Engineering and Technology spent over a year in the development of this global engineering cluster. It was approved by the University and became available in Fall 2000.

In the development of the "Global Engineering in an Interconnected World" cluster, henceforth referred to as the GEIW cluster, two factors guided the Global Engineering Taskforce at Old Dominion University. The first factor pertains to the rules and regulations set forth by the University for development of new clusters. In order to qualify as a University upper-division general education cluster, the GEIW cluster had to meet all the requirements that have been described in a previous section and will not be repeated here. However, it must be emphasized that according to University rules a cluster must have a multi-disciplinary theme uniting various courses in the cluster. The second guiding factor relates directly to the thematic nature of the cluster. In order to develop the global engineering theme, the taskforce found it necessary to develop a definition of global engineering. Although this definition may vary depending on individual perspective, for present considerations global engineering has been defined as the conduct of engineering by project management teams in global and multicultural environments, characterized by differing business practices, appropriate technologies, and varying natural and manpower resources.

This definition of global engineering provided not only the major strands for development of the cluster theme, but it also helped the taskforce in identifying existing courses that eventually formed the structure of the cluster. Even though the engineering discipline is universal due to its governance by the same physical principles, regardless of geography, its practice may vary from region to region due to cultural, economic, and resource considerations. The GEIW cluster will educate engineering students at Old Dominion University concerning international themes as

they undertake jobs as part of global operations of multi-national corporations. As the geographical barriers have come down due to the telecom, internet, and computer revolutions, increasing numbers of engineering companies are designing, manufacturing, and marketing products that involve transnational teams. It is not uncommon these days, especially in the automobile industry, for parts to be designed in one country, manufactured in another, and assembled and marketed in a third country. This requires teamwork and collaboration between project teams working across continents and in different time zones. The GEIW cluster will allow students to acquire skills pertaining not only to multicultural and communication aspects but also to enhance their capabilities to work as part of a global network of project management teams working towards a common goal.

Cluster Theme

The “Global Engineering in an Interconnected World” cluster develops an awareness and understanding of global technology, quality assurance standards, and differences in cultural, communication, and business practices, as well as their impact on project teams in a global work environment. Issues pertaining to resource allocation and sustainable development, consequences of environmental degradation from poorly considered industrialization, and issues involved in determining the most appropriate technology in a given situation are also explored. The cluster will prepare students who will increasingly accept employment with global firms or find themselves participating in mergers or strategic alliances involving multinational corporations.

Cluster Goals

With the exception of a new engineering management course, all courses in the “Global Engineering in an Interconnected World” cluster are presently being taught. The cluster is structured so as to provide students with an in-depth focus on the nature, conduct, and framework of global engineering and project management. The goals of the cluster are as follows:

1. To provide the student with a basic understanding of the integrative nature of successful modern practices, which involves not only the technical elements, but also international, cultural, communication, and business factors.
2. To provide the student with an understanding of the interconnected context of global markets, transnational corporate operations, and global technology standards.
3. To provide the student with an understanding of the global nature of natural resources and their management and protection.
4. To expose the student to various international regulatory bodies and standards.
5. To provide the student with the knowledge to work productively in an environment that encompasses different cultures, business practices, resources, and communication and engineering practices, whether working for a U.S. company abroad, an international

company operating in the U.S., or a collaboration of international (including U.S.) companies in solving problems of common interest.

Cluster Course Structure

The cluster addresses global engineering from a conceptual level and does not require prerequisites from the College of Engineering and Technology or the other participating colleges. This cluster should be attractive to engineering, business, and arts and letters majors who are interested in employment opportunities with companies operating in a global environment. The cluster emphasizes the integrative nature of successful modern projects that extend beyond awareness of the technical elements to require awareness of cultural factors and international best practices in a variety of professions.

The following is a list of the five courses in the cluster. Students must take the two required courses and one of the three optional courses. A catalog description of all five courses is provided in Appendix A.

ENMA 422 Global Engineering and Project Management (Required)
ENGL 371W Communications Across Cultures (Required)
GEOG 305U World Resources (Optional)
MGMT 361 International Business Operations (Optional)
CEE 458 Sustainable Development (Optional)

The five courses from three colleges, namely Engineering and Technology, Business and Public Administration, and Arts and Letters, provide subject materials that will contribute to enhanced student understanding of global engineering. The International Business Operations (MGMT 361) course from the Management Department brings to the cluster a focus on international business and cross-cultural and socioeconomic issues that are encountered with global engineering. The Communication Across Cultures (ENGL 371W) course from the English Department explores cross-cultural issues in communication, an important area in global engineering because of the involvement of transnational project teams whose members may belong to different cultures. The Global Engineering and Project Management (ENMA 422) course from the Engineering Management Department provides the foundation for the conduct of global engineering. The Sustainable Development (CEE 458) course from the Department of Civil and Environmental Engineering provides a global perspective on industrial activities that can be sustained in a manner consistent with available regional and global resources, as well as ecological constraints as dictated by the level of social development. The companion course on World Resources (GEOG 305U) from the Geography Department deals with renewable and non-renewable resources and addresses the issue of resource management for a sustainable society.

Assessment of Cluster Goals

Since the cluster has been initiated only recently (Fall 2000), it is too early to perform a detailed

assessment of fulfillment of cluster goals. However, the cluster approval process at Old Dominion University requires a self-assessment of cluster goals by instructors of courses included in the cluster. This assessment is summarized in Table 1. The table indicates that the cluster instructors are reasonably confident about meeting cluster goals with their respective courses.

Table 1 Self-Assessment of Global Engineering in an Interconnected World Cluster

Course	Goal 1	Goal 2	Goal 3	Goal 4	Goal 5	Total
	Basic Understanding of Integrative Nature of Modern Practices (Technical Elements and International, Environmental, Cultural, Communication, and Business Factors)	Understanding of the Interconnected Context of Global Markets, Transnational Corporate Operations, and Global Technology Standards	Understanding of the Global Nature of Natural Resources and their Management and Protection, and Communication Between Various Groups	Exposure of Various International Regulatory Bodies and Standards	Knowledge to Work Productively in an Environment that Encompasses Different Cultures, Business Practices, Resources, Communication, and Engineering Practices	
ENMA 422W	XXX	XXX	X	XXX	XX	12
CE 458	XX	X	XXX	XX	XX	10
MGMT 361	XXX	XX		XX	XX	9
GEOG 305	XX	X	XXX	X	XX	9
ENGL 371W	XX	XX	XX		XXX	9

X addressed, but not a significant part

XX addressed significantly

XXX addressed thoroughly

It is expected that future assessment of fulfillment of cluster goals will consist of the following elements:

1. Comprehensive tests on material presented
2. Written and oral presentations by students
3. Interactive discussion of case studies of international business/engineering/culture practices

4. Feedback on performance of graduates working in a global engineering environment from employers and graduates.

Cluster Support Activities

The educational experience in the cluster will be reinforced through periodic seminars in which experts in global engineering will relate their experiences in the work place. The Hampton Roads area has a large presence of international companies, and the College of Engineering and Technology invites speakers from many of these companies every year to give seminars on issues pertaining to globalization. Students in the cluster will be encouraged to attend these seminars. A website for the cluster will be created, and interesting articles related to global engineering will be posted periodically. Students in the program will be encouraged to become student members in professional societies and other multicultural groups on campus, since many of these groups and societies also offer resource materials and activities that relate to global engineering.

Conclusion

A description of newly approved upper-division general education cluster has been provided. The globalization of engineering curriculum, as implemented in the GEIW cluster, holds significant promise for educating engineers and other professionals whose involvement in global project management teams is increasing. In summary, present strengths of the cluster are: 1) awareness of global technology, quality assurance standards, and business practices; 2) perception of differences in cultures and their impact on teams in a global work environment; 3) insights into issues of resource allocation and usage in sustainable development; 4) understanding of consequences of environmental degradation resulting from poorly considered industrialization; and 5) exploration of issues involved in determining the most appropriate technology to apply in a given situation.

The GEIW cluster is the first step in preparing our students to be successful in any global, multi-cultural environment. Final steps are being taken to develop a minor in Global Engineering. At the graduate level, an interdisciplinary MS in Engineering program with a focus on Global Engineering is being developed. This master's program will leverage existing partnerships with foreign universities and provide multi-lateral opportunities for U.S. and foreign students to study and obtain work experience in other countries.

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SUSHIL K. CHATURVEDI

Sushil K. Chaturvedi is a Professor and Chair of the Department of Mechanical Engineering. He currently serves as Chair of the Global Engineering Taskforce at Old Dominion University. Dr. Chaturvedi received his Ph.D. from Case Western Reserve University in 1975.

GARY R. CROSSMAN

Gary R. Crossman is an Associate Professor of Engineering Technology and Program Director for the Mechanical Engineering Technology Program. He currently serves on the Global Engineering Taskforce at Old Dominion University. Professor Crossman is an ASEE Fellow.

WILLIAM SWART

William Swart is Professor of Engineering Management and Dean of the College of Engineering and Technology at Old Dominion University. Prior to coming to Old Dominion University, he was a Co-PI for the NSF-sponsored Gateway Undergraduate Engineering Education Coalition and Professor of Industrial and Manufacturing Engineering and Dean of Newark College of Engineering at New Jersey Institute of Technology.

JOSEPH W. BETIT

Joseph W. Betit is a Lecturer of Engineering Technology and Surveying Coordinator. He is also the Director of the Office of Spatial and Cartographic Information. He currently serves as a member of the Global Engineering Taskforce at Old Dominion University.

Appendix A

Catalog Descriptions of Cluster Courses

College of Engineering and Technology

ENMA422W Global Engineering and Project Management

An overview of the role of engineering and project management within the context of global competition and transnational organizations. Discussion of the various international bodies and standards impacting the practice of engineering within the US and internationally, including both technical and commercial regulations. Focus will be on operating principles of transnational technical organizations, and on the planning and implementation of international projects. Use is made of the case study method; oral presentations and term reports are required. Lecture 3 hours; 3 credits. Instructor: staff, Department of Engineering Management.

CE458 Sustainable Development

An overview of the social, economic, technical, and environmental aspects of regional, national, and international efforts to achieve sustainable development. Discussion of the integration of industrial activity and ecological concerns utilizing the concepts of global engineering and the principles of zero emissions, pollution prevention, and design for the environment. In addition to lectures, use is made of the case study method. Lecture 3 hours; 3 credits.

College of Business and Public Administration

MGMT361 International Business Operation

An examination of the environment of international business, foreign trade, and the operation of multinational enterprises. Management, marketing, accounting, and financial problems unique to enterprises operating in varying economic, cultural, and political legal environments are investigated. Lecture and discussion 3 hours; 3 credits. Instructor: James P. Johnson.

College of Arts and Letters

GEOG305U World Resources

A geographical analysis of the distribution and accessibility of the world's resources including agricultural land, water, renewable and nonrenewable materials, energy sources, and labor supplies. The course deals with the impact and consequences of increasing pressure on world resources caused by population growth, rising standards of living, and technological change. It examines the differences between reserves and resources, and between renewable and nonrenewable resources. It also considers issues of resource management and the changes that need to be made in the acquisition and use of

resources for the development of a sustainable society. Lecture 3 hours; 3 credits.
Instructor: Christine Drake.

ENGL371W Communication Across Cultures

An interdisciplinary examination of intercultural communication through readings in anthropology, linguistics, and world literature in translation. The class will explore the stages of acculturation, how language reflects culture, and the difference between U.S. culture and other cultures. Class activities will include lectures, guest speakers, videos, simulations, small group discussions, student presentations and role-plays. Prerequisites: 6 hours of composition and 3 hours of literature, or permission of the instructor.
Instructor: Janet Bing.