A Global Design Competition

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Abstract

Industry has made it clear that engineering graduates should be more prepared to interact in an integrated product team with colleagues around the world. Wichita State University has initiated the Spirit Global Design Challenge mainly due to industry and the Accreditation Board for Engineering and Technology (ABET) and the College of Engineering's Engineering 2020 program which have stressed the need for engineering graduates to function on multi-disciplinary teams and in a global environment. Frequently, these two requirements (teaming and global) are considered independently. The College of Engineering (CoE) at Wichita State University (WSU) has launched a strategic initiative, the Engineer of 2020, in order to prepare graduates for effective engagement in the engineering profession in the year 2020. Both of these attributes are now part of a program required for all engineering students beginning with the Fall 2007 class. This program will make the educational experience more meaningful to the student and the student more desirable to local, national and international industries. One of the key components of the Spirit Global Design Challenge is to integrate teaming in a global environment. This paper describes the motivation for the Spirit Global Design Challenge, its linkage to ABET outcomes, defines global learning and how it integrates into the Engineer of 2020 program, and provides implementation and initial assessment plans.

I. Introduction and Motivation

Industry has made clear the need to graduate engineers with more than just technical skills. A key component for today's graduate is the ability to thrive in a globally collaborative workplace. Engineers must work with global colleagues both in face-to-face and computer mediated environments. Efforts to assess virtual team projects have been performed [1]. This paper describes the Spirit AeroSystems Global Design Challenge (SGDC) which is an effort to integrate design and global communication. The effort is motivated by both a new program at Wichita State University to broaden our engineering graduates and motivated by Industry as well as the Accreditation Board for Engineering and Technology (ABET) criteria.

The SGDC is a collaboration between Spirit AeroSystems and two university partners: Wichita State University and the University of Manchester. Spirit

AeroSystems is the largest tier 1 supplier in the aerospace industry. Spirit provides the aerospace industry aero structures and systems. Spirit has worldwide facilities in Wichita, Kansas; Tulsa, Oklahoma; McAlester, Oklahoma; Prestwick, Scotland; Samlesbury, UK; and joint ventures in Moscow, Russia, Malaysia and China. The challenge will involve students and faculty from the two universities and practicing engineers from two Spirit AeroSystems sites. These people will be divided into two teams which will design a part of an advanced aircraft. This project will provide an experience for our students to work with global colleagues and to experience this collaboration in both face-to-face and computer mediated environments. This paper describes the plans for the pilot implementation in Fall 2008.

II. Literature on Global Learning and Definition

Many have presented the need for engineers to be more aware of global issues, cultural concerns, and even global constraints in design. In fact, Shuman, et al. [2] state that future engineering graduates need "to become highly innovative global 'problem solvers.'" Downey, et al. [3] present the required competencies for an engineer to be "globally competent." Global learning may even impact the lifelong learning of graduates. As students become more aware of differences in clusters, even in engineering design, they realize their need to learn throughout their lives [4]. The definition of global learning is considered by some to be less important than the implementation. According to Hedberg [5], there is a degree of consensus regarding the definition of global learning, but the problem is in regard to "how to attain these ambitious goals."

For the purpose of the SDGC, global learning is defined as the combination of global reach, achieved with modern communication technology, and global perspectives arising from interaction between students living in different countries, to educate the global citizen. Features of global learning include:

- An authentic and substantive goal, such as producing a design for a client or solving an engineering problem
- Working in a multi-disciplinary team with people living in other countries or with a client from another country
- A focus on requiring the students to learn more about culture through improving their intercultural communication competence
- Opportunities for professional presentation of the global learning experience

Integration of global learning into an engineering course involves changes to the learning strategy, taking it from a didactic/pedagogical approach to a heutogogical[1] approach that involves autonomous learning. Typically, students

[1] Heutagogy (often interpreted as a theory of self-determined learning) recognizes that the learning environment needs to be flexible and provide conditions for self-directed (autonomous) learning. In the educational setting, to better meet needs of a learner, the teacher provides goals and resources but the actual course of learning is more flexible and negotiable. In the context of

will need to learn in a team towards some substantive and authentic goal. In the process, they must be able to communicate effectively. That, in turn, requires them to understand the perspectives of each other and themselves, improving their intercultural communication competence.

III. Engineer of 2020

The College of Engineering (CoE) at Wichita State University (WSU) has launched a strategic initiative, Engineer of 2020, in order to prepare graduates for effective engagement in the engineering profession in the year 2020. This initiative is, in part, motivated by two reports from the National Academy of Engineering, of the National Academies, entitled "The Engineer of 2020" [6] and its follow-on report, "Educating the Engineer of 2020" [7]. These reports, written by two groups of distinguished educators and practicing engineers from diverse backgrounds, were developed in response to a concern that engineering students of today may not be appropriately educated to meet the demands that will be placed on the engineer of the future, without refocusing and reshaping the undergraduate engineering learning experience. In the first report, the group provided guiding principles that will shape engineering activities in 2020. The report also states that in order to successfully educate engineers who can effectively contribute in this changing landscape, engineering educators will have to produce graduates who must possess more than just the technical knowledge and skills traditionally taught to engineering graduates.

A number of noted engineering education leaders have responded and commented on these reports. Butcher claims the reports call for "ingenious leaders — ingenious engineers" and calls these engineers, "well-rounded Renaissance Engineer"[s] [8]. Turns, Atman, et al., [9] use these reports as an input to what an engineer needs to know. Dym, et al. present how engineering education is being challenged to require students to consider additional design constraints required as part of a "new fundamentals" [10]. In response to this challenge, the CoE at WSU wishes to establish its leadership in reshaping the undergraduate experience to prepare the engineer of 2020, and at the same time make the educational experience more meaningful to the student and the student more desirable to local and national industries. As such, the CoE proposes that to fulfill the requirements for an Engineering BS degree at WSU, each student will complete the program course requirements including at least three of the following six activities:

1. Undergraduate Research
2. Cooperative Education or Internship
3. Global Learning or Study Abroad

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the WSU Engineer of 2020, providing choices for students (selecting three out of six possibilities) is a good example. Furthermore, current learning theories put more emphasis on experiential learning ("learning by doing"). That idea is integrated in the concept of "heutagogical learning" (Alagic, 2006).

4. Service Learning
5. Leadership
6. Multidisciplinary Education

To satisfy the Global Learning or Study Abroad criteria from the Engineer of 2020 Program at Wichita State University each student must complete one or more of the following:

1. Successfully participate in a global learning project within an existing class; this will typically involve internet-based communications with students, teachers, and colleagues in at least one other country. Global learning projects must include at least one participant from outside the English-as-a-first-language world (e.g., Russia, Japan, China) to be eligible.

2. Successfully complete a study abroad component; this involves participating in a credit-bearing, university-approved study abroad activity in a foreign country. (Note: Students possessing an F-1 VISA qualify for this criteria and must submit a form to the Director of Engineering Education.)

3. Submit a previous global learning or study abroad experience; in this case, the student must prepare a two-page report outlining:
    - Summary of previous experience, including dates and locations
    - Description of the student experience (typically a reflective paper, though not restricted to this)
    - Contact information of faculty/sponsors involved in the global learning experience

The effort described in this paper directly applies to the "Global Learning" criterion of the Engineer of 2020 program. More details on the complete Engineer of 2020 program at Wichita State University can be found in [11].

IV. Linkage to ABET outcomes

The second motivation for the effort described in this paper is the new Engineering Criteria 2000 (EC2000) of ABET which states that graduates must attain the following criteria (criteria that apply directly to this effort are shown in italics):

a) an ability to apply knowledge of mathematics, science, and engineering
b) an ability to design and conduct experiments, as well as to analyze and interpret data
c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability

d) an ability to function on multi-disciplinary teams
e) an ability to identify, formulate, and solve engineering problems
f) an understanding of professional and ethical responsibility
g) an ability to communicate effectively
h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environment, and societal context
i) a recognition of the need for, and an ability to engage in, life-long learning
j) a knowledge of contemporary issues
k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Many of the ABET outcomes are met by several activities (a single activity does not fulfill the requirements). This effort is to improve the skills and knowledge of our graduates and is part of a comprehensive effort to improve our graduates.

V. Implementation Plans

This section of the paper describes the implementation plans for the global design challenge; first plans for the pilot implementation in Fall of 2008 are presented and then plans for the ideal implementation are described. All cohorts (teams) will be given the same design challenge and will compete for the best design.

The pilot implementation of the program is shown in Table 1 for the two cohorts (teams). The pilot implementation includes students and faculty from Wichita State University and Manchester University. In order to ensure a successful pilot, two students from each university are on each cohort. One faculty from each university is a part of a single cohort as is a design engineer from Spirit AeroSystems. The pilot will have four students from each university and each university will fund the students and faculty.

The success of the pilot will be reviewed upon completion. Based on the pilot, necessary modifications will be identified. For example, it is likely that students in the subsequent cohorts may need more intercultural training prior to participation since these cohorts will be working with students from countries that may be more culturally diverse than those working primarily in the UK and USA. Other changes will be implemented from the “lessons learned” from the pilot implementation.

Table 1: Pilot Implementation

• WSU Student 1	• WSU Student 3
• WSU Student 2	• WSU Student 4
• Manchester Student 1	• Manchester Student 3
• Manchester Student 2	• Manchester Student 4
• WSU Faculty	• Manchester Faculty

• Spirit - Manchester	• Spirit - Wichita

The ideal implementation of the program is shown in Tables 2 and 3 for the four cohorts (teams) and includes students and faculty from Wichita State University, Manchester University, Indian Institute of Technology and Moscow University. One student from each university is on each cohort. One faculty from each university is a part of a single cohort as is a design engineer from Spirit AeroSystems.

Table 2: Ideal Implementation (cohorts 1 and 2)

Cohort 1	Cohort 2
• WSU Student 1	• WSU Student 2
• Indian Institute Student 1	• Indian Institute Student 2
• Manchester Student 1	• Manchester Student 2
• Moscow University Student 1	• Moscow University Student 2
• WSU Faculty	• Manchester Faculty
• Spirit - Manchester	• Spirit - Wichita

Table 3: Ideal Implementation (cohorts 3 and 4)

Cohort 3	Cohort 4
• WSU Student 3	• WSU Student 4
• Indian Institute Student 3	• Indian Institute Student 4
• Manchester Student 3	• Manchester Student 4
• Moscow University Student 3	• Moscow University Student 4
• IIT Faculty	• Manchester Faculty
• Spirit - India	• Spirit - Moscow

Typically, only US Citizens are involved on these design projects with industry, but for the pilot, undergraduate students who were not US citizens were encouraged to apply as well. Only Wichita State University undergraduate engineering students were invited to participate. Each of the four (2 on each pilot team) Wichita State University engineering undergraduate students who are selected will receive:

- Stipend,
- Travel expenses for 1 trip to Manchester, England, during Fall 2008,
- 3 hour credit course (senior project or independent study), and
- Fee waiver for the above course.

The faculty selected by Spirit AeroSystems will receive:

- Stipend and
- Travel expenses for 1 trip to Manchester, England, during Fall 2008 (September to Wichita (for U of M faculty) and October to Manchester).

Both students and faculty are cognizant of expectations. Students are expected to: participate in a design experience with a problem defined by Spirit AeroSystems, communicate with student and faculty partners from both universities and Spirit Engineers in both Wichita and Manchester, UK on a weekly basis, meet deadlines set by the team (the timeline may not match semester length and times required may not align with normal working hours), sign an agreement stating commitment to the completion of the project, and have a passport for entry to UK and back to US. Faculty are expected to: participate in a design experience with a problem defined by Spirit AeroSystems, communicate with student and faculty partners from both universities and Spirit Engineers in both Wichita and Manchester, England on a weekly basis, meet deadlines set by the team, sign an agreement stating commitment to the completion of the project, and have a passport for entry to UK and back to US.

The pilot implementation is on track and will begin in the Fall 2008 semester. Students and faculty have been selected. The design project has been identified as a fuselage design effort, provide trade study summaries and detail down select for non-lattice structural configurations to meet prequantified loads, pressures and weight challenges.

Students were selected by an interview team of faculty and Spirit AeroSystems personnel. The students submitted a resume and cover letter. The resume and cover letter were assessed based on a rubric. The students had access to the rubric prior to submittal. The number of applicants was reduced using this rubric and the final applicants were interviewed. The students selected were then asked to sign a non-disclosure agreement and received laptops for the duration of the competition. The faculty for the challenge was selected by the company based on faculty resumes.

VI. Assessment Plans

There are two types of outcomes that will be examined from this project: project results (design) and student learning. The quality of project results will be determined by industry. Spirit AeroSystems have several people involved in this effort and they will determine the "winners" of the competition. This feedback will be invaluable both for the student and the academic institutions. Industrial criteria will be used to make this determination. Student learning will be assessed in two areas: 1) Student attitudes and perceptions about the impact of global issues on design and on design teams and 2) the quality of the resultant design. The first outcome will be assessed with a pre and post test attitude survey and the second outcome will be assessed by a design rubric. A key benefit to this type of effort is in student experience with evaluation both by industry and faculty. Also, industry will be more exposed to academic evaluations of these kinds of efforts.

VII. Conclusion

The student experience in the College of Engineering at Wichita State University is becoming a holistic approach that addresses the total student. Industry needs, accreditation requirements and The National Academy of Engineering reports, "The Engineer of 2020" and "Educating the Engineer of 2020" have made it imperative to implement programs like the Spirit Global Design Challenge. This paper presented an overview of the current plans for implementation at WSU.

This type of effort has significant benefits to both industry and academia. Students are better prepared to design with innovation. The bandwidth for creativity and innovation is increased instilling design in a more diverse environment. Students are exposed to multi-disciplinary teamwork and learn how to be effective while working "globally." Industry benefits by helping to develop and subsequently recruit better engineers. Spirit AeroSystems will become more recognized as a as a Global Integrator. They will also gain access to new and different ideas with access to an unused resource pool. There is also the potential of cost savings by resolving "engineering challenges" that may be solved with the influx of new and diverse talent. Both industry and academia benefit by developing key relationships on a global scale. As more engineers are needed with global collaborative skills, efforts like the SDGC can develop engineers to face the needs of today's (and tomorrow's) industry.

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Dan Allison is currently the Director of Airbus Single Aisle Product Development for Spirit AeroSystems. He is responsible for technology research and development specifically targeted to new programs and products. He joined the company in 2006 after a 28 year career with Boeing. During which time he held many positions including Site executive, General Manager and Director of Quality and Engineering manager at various Boeing facilities. Mr. Allison holds a Bachelor and Masters Degree, both in Mechanical Engineering, from Wichita State University where he was on the Mechanical Engineering curriculum advisory committee and a frequent guest lecturer. He also holds a Master's of Science in Civil Engineering and a Masters of Business Administration from MIT (Massachusetts Institute of Technology). In 2005 he was awarded the Boeing/Phantom works Silver Phantom award and holds several patents.

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Martha Shawver is currently the Senior Associate Provost at Wichita State University where she has served in various roles related to student services, academic programs, Board of Regents liaison, assessment, and international programs. She came to WSU as a nursing faculty and served as chair of the school of nursing and associate dean of the College of Health Professions. Her early research interests and publications were in the area of pain alleviation in patients with cancer and in nursing management. She has consulted and presented to higher education audiences about student services issues. She recently led a campus wide taskforce on globalization of the campus. Shawver holds a Ph.D is from the University of Kansas and an MA from the University of Iowa. She has held academic appointments at the University of Iowa and Hesston College. She has had a life time interest in global events, coming from a family who has lived across the globe. She has studied at the University of Barcelona in Barcelona and in Palma, Majorcca.

Chris Wilkinson was educated at King's College, Taunton and Nottingham University, where he gained a BSc Honours Degree in Materials Science. Post graduation he continued his development through company sponsored programmes at Ashdridge and Insead. He joined BAE SYSTEMS in 1980 and held a wide range of technical and operational roles across different aerospace sectors including commercial aircraft, business jets and space systems. For eleven years he participated in a number of senior management roles within the company's Airbus operations. In late 1999 he left Airbus to work on the integration of key engineering activities of Marconi Electronic Systems into BAE SYSTEMS. In 2000 he joined the Aerostructures business unit to establish its first design engineering capability. In 2006 Chris was part of the senior management team that was involved in the sale of BAE SYSTEMS' Aerostructures business unit to Spirit AeroSystems Inc. He became part of the senior leadership team who invested in the new company. He is a Chartered Engineer and a non-executive Director of a number of charity based organisations involving technology & manufacturing development and healthcare in North West England.

Mrs. Shelly L. Belles joined Spirit AeroSystems in June of 2005. Prior to this, she spent 24 years with The Boeing Company, Wichita Division. During that time, she was responsible for Global Customer Relations and Organizational Development for the Product Definition Organization and she currently has the same assignment. Other assignments included Continuous Quality Improvement Initiative and Supplier Chain Management as a procurement agent. Shelly received her Bachelor of Science from Friend's University in Human Resources in 1998. Shelly helps to develop global organizational programs, policies and procedures, interaction with international customers and suppliers to integrate and leverage different languages, markets, cultures and geographic areas to add value to Spirit with regards to engineering and strategic initiatives.