

Enhancing Student Learning Through International University–Industry Cooperation: The GO GREEN Course*

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This article describes a partnership between a US institution, a German institution, and several German industries for the purpose of teaching an interdisciplinary, international course which emphasizes sustainability, globalization, and different cultures and their integration into the engineering and engineering technology curriculum. The course, entitled GO GREEN (Green Organizations: Global Responsibility for Environmental and Economic Necessity), employs experiential learning activities that would be impossible if not for the cooperation and generosity of the German industry partners. A conceptual framework for the course is presented; reasons for involving German industry partners in teaching sustainability and globalization are explained; course development and planning processes are discussed; delivery and implementation strategies are highlighted; and the evaluation framework is articulated. Issues and considerations for course replication are included at the conclusion of the article.

Keywords: International; industry-education cooperation; globalization; multicultural; sustainability; undergraduate research

OVERVIEW OF THE GO GREEN COURSE

GO GREEN BEGAN in 2002 and has served nearly 40 undergraduate engineering and technology students, as well as science, leadership, and other students. The three-credit-hour course highlights design, engineering, manufacturing, technology, and leadership sustainable practices in German organizational settings, including the environmental, social, and economic issues inherent in sustainability decisions, as well as international organizational global practices. GO GREEN also focuses on the students' learning about and understanding of the German culture.

The GO GREEN course has three distinct parts:

- A portion of the course is taught at Indiana University–Purdue University Indianapolis (IUPUI), an urban research university with nearly 30,000 students in Indianapolis, Indiana, prior to the trip to Germany.
- A portion is taught through experiential learning at site visits during a one-week field experience in and around Mannheim, Germany, in conjunction with a higher education partner, the Berufsakademie Mannheim, and five or more German industrial partners.
- A portion of the course is taught at IUPUI after the group returns from Germany.

What makes this course special is the partnership with German industries and businesses in order to highlight best practices of sustainable development for student learning. The field experience in Mannheim includes lectures to students by industry partner hosts, lectures and/or discussions by other company representatives, and tours of various parts of the industry. The involvement of these generous German industry partners has allowed this course to flourish.

GO GREEN has evolved to emphasize both undergraduate education *and* undergraduate research opportunities related to sustainability via two three-credit-hour learning experiences (three-credit course-based experience; three-credit research-based experience). Some students participate in the one-week GO GREEN course and then add a field-based undergraduate research component that permits them to spend additional time in Germany conducting applied research in an area of sustainability.

WHY TEACH SUSTAINABILITY IN ENGINEERING EDUCATION?

Why teach sustainability to engineering and engineering technology students? Sustainability or sustainable development is considered a social aspect or social competency of engineering along with environmental protection, decreasing green-

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house gas emissions, increasing water and energy efficiency, developing renewable energy resources, and eliminating waste or resource recovery, to name just a few. These social aspects have been widely practiced in Europe for many years. In the United States, engineers, business professionals, and others are just beginning to pay attention to them. Environmental interest started after World War II when *Silent Spring* by Rachel Carson was published in 1962 and *The Population Bomb* by Paul R. Ehrlich in 1968. Rachel Carson's book was met with considerable resistance and denials. A propaganda campaign to refute her work and credibility by chemical companies, corporate interest groups, and even the American Medical Association was launched. The attack on her has been compared to the assault on Charles Darwin when he published *The Origin of Species* [1].

In the 1960s and 1970s, people concerned with the environment and the economy started forming groups. One such group is the Club of Rome, which was founded in 1968 by Aurelio Peccei, an Italian scholar and industrialist, and Alexander King, a Scottish scientist. Still very active, this group is best known for a book published in 1972 by several members titled *Limits to Growth*, which predicted dire consequences for the earth due to the overuse of its resources, all because humanity was growing too quickly [2]. Like Rachel Carson's book *Silent Spring*, *Limits to Growth* was met with controversy. Although criticized, the book sold over 30 million copies and was translated into 30 different languages. Today, the authors are respected for their groundbreaking research into early signs of wear on the planet. An update on the original book, titled *Limits to Growth: The 30-Year Update*, was published in 2004.

In 1980, a group in Germany formed the Green Party. The Green Party was established originally by a band of grubby ideal pacifists who started out by demanding that Germany withdraw from NATO, raise gas prices extremely high, and legalize hash and other drugs. While they have changed their positions on these issues over the past 25 years, they have grown into Germany's biggest power player and strongest environmental party in the world. Other similar organizations have developed including Natural Step, founded in 1989 by Swedish cancer scientist Karl-Henrik Robert, and the World Business Council for Sustainable Development, founded in 1995 in Geneva, Switzerland.

The term "sustainable development", adopted by the Agenda 21 program of the United Nations, was best defined by the 1995 World Summit on Social Development as a "framework for our efforts to achieve a higher quality of life for all people, while still having economic development, social development and environmental protection all mutually interdependent and mutually reinforcing components" [3]. Simply stated, the Native American Iroquois Indians mandated their chiefs

to consider all actions on their descendants through the seventh generation when making decisions about their land [3]. The United States Environmental Protection Agency defines "sustainability" as the ability to achieve economic prosperity while protecting the natural systems of the planet and providing a higher quality of life for its people [4].

Sustainable development is a contemporary issue for all societies to embrace. It does have the attention of engineering groups all over the world, including the United States, even though the US has not mainstreamed the concept in engineering education. The American Association of Engineering Societies, American Institute of Chemical Engineering, and American Society for Mechanical Engineers International-Environmental Engineering Division made a declaration on behalf of these organizations to the World Summit on Sustainable Development held in Johannesburg, South Africa, in 2002 to commit to creating a sustainable world [5]. In addition, the American Society for Engineering Education (ASEE) Board of Directors in 1999 approved this statement: "ASEE believes that engineering graduates must be prepared by their education to use sustainable engineering techniques in the practice of their profession and to take leadership roles in facilitating sustainable development in their communities" [6]. The National Academy of Engineering has also addressed sustainable development issues, publishing several reports on sustainability, including "Sustainable Federal Facilities: A Guide to Integrating Value Engineering"; "Life Cycle Costing, and Sustainable Development"; "Harnessing Ingenuity for Sustainable Outcomes, Technology and Sustainable Development"; and "Sustainable Development and Systems Engineering."

Many countries in the European Union (EU) [7] have legislation which forces the producers of products to be the disposers of those same products at the end of the product's life. This change has forced innovation on the front end of product design and development, reducing waste and pollution at all points by having a product's end-of-life become another product or part of another product or recycled [8]. William McDonough, a sustainable architect, coined the phrase "waste equals food", which means the waste or end-of-cycle product should become the *food* or part or all of some new product. A simple example of "waste equals food" is a "waste to energy" facility that turns garbage into energy. In this example, waste is the garbage turned into energy, which later becomes heat or power, which is the food. McDonough also coined the term "cradle to cradle" when talking about a product's life cycle. McDonough professes that everything now and in the future must be designed so that the products, packaging, systems, processes, etc., should have no waste. In other words, we eliminate the "cradle to death" life cycle, which has been practiced since the industrial

revolution [9]. This is one of the same concepts German industries follow: eliminate waste.

In the US, sustainability is beginning to resonate in corporations. A prime example is Interface Incorporated. Equipped with knowledge and tools from people like William McDonough, Michael Braungart, Karl-Henrik Robèrt, Paul Hawkins, Rachel Carson and many others, Ray Anderson started his revolutionary quest in 1996 to move his carpet company, Interface, to become a truly sustainable organization. Successful, yet still working towards becoming a restorative organization, Interface has moved through a remarkable change [10]. The story of how this company was changed can be found in Ray Anderson's book *Toward a Sustainable Enterprise: The Interface Model: Mid-Course Correction*. Interface is one of the most successful sustainable transformations of a US company.

WHY USE GERMANY AS A SITE FOR STUDYING SUSTAINABILITY

Why study sustainability in Germany? Germany's industries were chosen as best practices for sustainable development for several reasons. First, Germany is recognized as a leader in the area of sustainable practices—even within the European Union (EU)—and has been actively engaged in instituting environmental policies for over 30 years. This effort began with the 1972 Paris Summit, where European heads of state and governments started working on environmental issues. The Amsterdam Treaty (ratified May 1, 1999) gave environmental issues the legal basis they needed to take hold in Europe; thus the promotion of sustainable development in the European Union became an important issue in the European Commission Treaty. Nearly 200 legal acts cover all areas of the environment. As part of the EU, Germany is a leader in economic sustainable development and practices in business and industry. In fact, Germany and The Netherlands have both been credited with using new methods and tools to strengthen their governments' policies and regulations aimed at improving environmental performance in industry and products. These countries' governments have played a leading role in decreasing greenhouse gas emissions, increasing water and energy efficiency, developing renewable energy resources, and eliminating waste and/or achieving resource recovery.

Second, a pragmatic reason for anchoring this project in Germany was IUPUI's long-standing partnership with the Berufsakademie Mannheim. Since 1990, IUPUI and the Berufsakademie Mannheim have participated in cooperative education endeavors in which students and faculty work on internships or applied research projects in and around the communities of the host campus. The relationship with the Berufsakademie permitted

IUPUI faculty access to industry partners to facilitate arrangements and opportunities for sustainability-related teaching and research. Faculty at the Berufsakademie coordinated the initial meetings with the appropriate representatives at German companies. As the course has expanded, other German industry and government parties have been added as a result of efforts undertaken by faculty colleagues at the Berufsakademie. Additionally, the Berufsakademie provides students in the course with space, technology, and other related resources to assist in the teaching, learning, and research processes.

Finally, and perhaps most significantly, Germany provides a dynamic, experiential learning laboratory to equip students with an understanding of global perspectives. This is truly important, because the engineering professional of today and tomorrow must be able to work in an environment increasingly characterized by the changing nature of international trade; the use of new innovative technologies, materials and processes that inform research and practice; the growth of information technology; complex interactions across many disciplines; the need to understand real-world engineering systems; and the ability to grasp global issues and to work with culturally diverse people.

GO GREEN PARTNERS AND THEIR CONTRIBUTIONS

The GO GREEN course uses sustainable practices and processes in German corporations for experiential learning. These sustainable practices vary depending on the industry; however, many are common to all. For example, eliminating waste and conserving water and energy are common sustainable practices in all German industries. German industries have realized new innovative technologies while working towards these sustainable goals. The course uses a diverse selection of businesses and industries. As of this article, the GO GREEN industry, academic, and municipal partners are Berufsakademie Mannheim, Daimler/Chrysler (Rastatt), BASF (Ludwigshafen), ABB (Ladenburg), MVV Energie (Mannheim), Freudenberg (Weinheim), Fraunhofer Institute for Solar Energy Systems (Freiburg), Solar-Fabrik (Freiburg), and the city of Freiburg, University of Applied Science Magdeburg, the town of Ladenburg, Bayer (Leverkusen), Bodensee Wasserversorgung (Stuttgart), Roche Diagnosis (Indianapolis), and Interface (Atlanta). Many of these partners were acquired through the school's long-term partnership with the Berufsakademie Mannheim. Some were obtained through networking at international and national conferences or through acquaintances.

A key strength of the GO GREEN course has been to have, from the very beginning, a capable and well-networked academic institution—Beruf-

sakademie Mannheim—to facilitate the identification of and connection with industrial partners in the host country (Germany). Table 1 provides an overview of the international partners and their roles and contributions to the GO GREEN course.

The Berufsakademie Mannheim is an academic cooperative education institution of higher education. Conceived 30-plus years ago out of the need to have college graduates enter the workplace quicker than the traditional German university graduation rates, the Berufsakademien were born in the state of Baden-Württemberg through a partnership agreement between the state government and business and industry [12] [13]. In 1990, IUPUI established an internship exchange program with the Berufsakademie Mannheim, one of the first Berufsakademien established. In addition to many successful student internship exchanges, half of which were with engineering and technology students, the two institutions also participated in short-term faculty exchanges. Eventually, these exchanges led to the development of the GO GREEN course. Since the development of GO GREEN, the faculty and administrators at

the Berufsakademie Mannheim have agreed to assist GO GREEN faculty in student paperwork, in contacting German businesses and industries, and in acting as emergency contacts for students extending their stay.

DaimlerChrysler is a global automotive corporation with a wide range of vehicles and brands [14]. The company's strategy is to offer excellent products with outstanding customer value, leading brands, innovative technology leadership, and global presence and networking. DaimlerChrysler is committed to sustainability by committing to sustainable decisions that look at three dimensions of responsibility: economic performance, resource availability, and social responsibility. In addition, DaimlerChrysler is aligning its "Facts on Sustainability" for the first time with the requirements that are set forth by the Global Reporting Initiative (GRI) guidelines. The GRI guidelines are the United Nation's globally recognized requirement guidelines for reporting achievements in sustainability so that they are comparable with other companies. Since the plant opened in 1997, DaimlerChrysler has been

Table 1. International partners and their contributions to the GO GREEN course

• International Partner	• Role/Contributions to Sustainability-Related Research and Teaching Opportunities
Berufsakademie Mannheim	<ul style="list-style-type: none"> • Serves as the principal academic liaison in Germany • Provides teaching and research space for projects • Facilitates in-country connections with additional partners
DaimlerChrysler	<ul style="list-style-type: none"> • Provides manufacturing perspectives in Rastatt and Stuttgart • Emphasizes corporate community relations related to sustainability • Exhibits global business perspective
BASF	<ul style="list-style-type: none"> • Provides green chemistry and chemical plant perspectives • Emphasizes eco-analysis approach to sustainable decisions • Exemplifies environmental impact on community
ABB	<ul style="list-style-type: none"> • Provides electrical and distributed generation equipment manufacturing perspectives • Showcases corporate strategic leadership for sustainability
MVV Energie	<ul style="list-style-type: none"> • Provides example of co-generation, district heating and cooling, waste-to-energy, biomass facilities and eco-transportation perspectives • Highlights governmental role in shaping sustainable policies and practices
Freudenburg	<ul style="list-style-type: none"> • Provides example of sustainable product manufacturing • Provides example of sustainable business growth (i.e. new company made from scraps from old company) [11] • Links German business practices to the US
Freiburg Industry and Government	<ul style="list-style-type: none"> • Provides research capabilities at the Fraunhofer Solar Research Institute (example of industry working with research institute) • Showcases opportunities for business development in solar photovoltaic tile manufacturing at Solar-Fabrik • Provides opportunities to see local sustainable villages (Vauban)
University of Applied Science Magdeburg	<ul style="list-style-type: none"> • Provides undergraduate student research opportunities in three university institutes (water management, alternative materials, and alternative energy)
Ladenburg	<ul style="list-style-type: none"> • Provides civic engagement in sustainable practices over a 2000-year time horizon • Connects students with community leaders and others for dialogue and research on sustainability
Bodensee Wasserversorgung	<ul style="list-style-type: none"> • Provides research opportunities in water management • Tests procedures for water purification
Heidelberg	<ul style="list-style-type: none"> • Provides cultural and university connection aspects for understanding German daily life issues surrounding sustainability • Permits acquisition of cross-cultural competence and appreciation
Mannheim City Government	<ul style="list-style-type: none"> • Provides research and experiential learning opportunities for US students • Enables a comparison between German and US public policies and government regulations

producing the Mercedes Class A car; in June 2004, the Rastatt plant also started producing the Mercedes Class B car, a compact sports tourer. The GO GREEN class is provided a lecture and a walking tour of the Rastatt campus, which is rich in examples of sustainable processes. In addition, the class discusses various projects with the two heads of environmental management. A tour of the new assembly line is also provided.

BASF is a global leader in the chemical industry, employing 93,000 employees worldwide, operating production facilities in 38 countries, and serving customers in over 170 countries [15]. Because of the complexity of the chemical manufacturing processes, coupled with the dynamic nature of operating in multiple countries—each of whom have differing laws and regulations related to environmental stewardship—BASF has developed a Sustainability Council, chaired by a board member, to ensure that sustainable principles are followed company wide. The Sustainability Council draws upon both the work of various project teams that develop quantifiable indicators and environmental and social standards, and reports on sustainability practices. The BASF host provides a lecture, discussion, and class exercise on the BASF “Eco-Efficiency Model” for decision-making as well as a tour of a large part of the BASF campus, including the water treatment facility and the safety center.

ABB is a global leader in energy, and its automation technologies assist customers by improving performance and at the same time lowering environmental impact. ABB is located in more than 100 countries with a workforce of over 100,000. Seeking to balance economic, environmental, and social priorities, ABB views sustainable development as integral to all aspects of its business. ABB’s sustainable policy is to improve the social and environmental performance continuously. In addition, ABB wants its employees to take initiatives to improve the quality of life in the communities where ABB operates. ABB has a research facility in Ladenburg, Germany. The GO GREEN course contact is the ABB German Sustainable Officer located in Ladenburg; ABB provides the class with a lecture about the company and its sustainable initiatives and commitments internationally. In addition, students see some of the company’s current research projects. Students interact with several key employees at the facility, including the German Sustainable Officer.

MVV is a modern, innovative energy producer and service provider of electricity, gas, district heating, water, energy-related services, and environmental energy. While MVV is not a global energy company, it is in Germany, Poland, and the Czech Republic. Like, ABB, BASF, and DaimlerChrysler, MVV is committed to the environment and reducing greenhouse gas emissions, which is why they have invested in the development of the latest technologies in the use of decentralized energy-producing biomass plants.

In Mannheim, MVV has a waste to energy plant, a biomass plant, and a cogeneration plant that heats Mannheim through district heating. All of these facilities are simultaneously saving and making energy for the citizens of Mannheim. After a lecture on how the plant works (waste to energy, biomass or co-generation), the class is provided a tour of the facility. Later the class is given a lecture on MVV’s overall strategies and goals, and on other businesses. The GO GREEN host is a representative of the CEO.

GO GREEN students travel to the city of Freiburg, approximately one hour and twenty minutes by a fast train from Mannheim, where they visit a solar research facility (Fraunhofer Solar Research Institute), a solar factory (Solar-Fabrik), and a sustainable village (Vauban). The class is hosted by the City Planner of Freiburg, who escorts the class for the day to all of the locations. Starting with the Fraunhofer Solar Research Institute, the class hears a lecture from one of the researchers on what kind of research is being done at the institute. In addition, a tour of the facility is also provided to the students. Then the class moves to SolarFabrik for a short talk and tour of the solar factory, where solar panels are assembled. Students are then taken to the sustainable village of Vauban. After an outside tour of the area and question and answer time, the students move to the center of the city, where they can spend some time as they wish.

GO GREEN COURSE

The central focus of the GO GREEN course is to introduce the concept of sustainability to engineering and technology students; to represent sustainability from an interdisciplinary perspective (design, manufacturing, engineering, technology, and leadership); to provide opportunities for historically underrepresented students (e.g., women, urban, first-generation, and non-traditionally aged learners) to participate in an engaging international educational experience; and to encourage understanding of cross-cultural and organizational issues through experiential learning. The specific learning objectives of GO GREEN are summarized in Table 2.

TYPE OF STUDENTS SERVED, UNIVERSITY-PROVIDED SUPPORT, AND THE LOGISTICS OF GO GREEN

IUPUI is a large, urban institution (30,000 students), and the student population can be considered diverse on a number of different variables. These include: minority and historically underrepresented students; non-traditionally aged learners; women; first-generation college students; and learners who occupy multiple social roles simultaneously (e.g. parent, worker, community

Table 2. Learning objectives for GO GREEN course

Category	Objectives
<ul style="list-style-type: none"> • Basic Knowledge in Sustainability and Globalization 	<ul style="list-style-type: none"> • Acquire the basic knowledge of issues in sustainability as they relate to global business and industry • Understand how to integrate sustainable concepts into manufacturing and engineering of the processes of products • Utilize information from the course to apply sustainable knowledge to personal, academic, and professional lives • Understand and analyze the interconnectivity of global concerns
<ul style="list-style-type: none"> • Best Practices in Sustainability 	<ul style="list-style-type: none"> • Examine and evaluate case studies of sustainable practices in business and industry • Visit international industries and organizations that practice sustainability to gain first-hand knowledge of operations • Identify trends and business practices in various sustainable organizations • Benchmark global practices against domestic requirements and standards
<ul style="list-style-type: none"> • Cross-Cultural Experiences 	<ul style="list-style-type: none"> • Acquire first-hand knowledge of German culture and language • Participate in global learning exchanges through formal and informal means • Appreciate the dynamics of international business, education, and lifestyle • Reflect on and write about the similarities and differences in the human condition from a global context

leader). An attractive feature of the GO GREEN course is its ability to provide an international teaching and research experience to students who would normally not have such an opportunity [16]. Given the busy nature of learners and the scarcity of time, money, and other resources, the GO GREEN course provides an efficient and effective manner to equip students with these types of learning, research, and cross-cultural experiences.

Whenever international travel experiences are considered for students, one principal concern is cost. GO GREEN costs typically include: tuition (up to six credits, depending on a student's participation in the course and additional research component); travel, lodging, and per diem; university-mandated insurance; course-related expenses (e.g. textbooks); and other incidental expenses. For students electing to participate in both the teaching and research components of GO GREEN, there are opportunities for competitive funding available from the IUPUI campus to support undergraduate research. Several GO GREEN participants have successfully secured such funding throughout the life of the program. For others, costs associated with GO GREEN have been paid for by the individual student. Thus, the minimum cost associated with GO GREEN is typically less than \$2,500 USD (for students participating in the course-based component alone). Faculty have received modest stipends from the university to cover travel and other related costs; yet, due to the limited number of students (usually 10–15 per year), the institution is typically unable to compensate faculty in terms of salary. Thus, GO GREEN is viewed as both a “labor of love” by the faculty and a commitment to the university's mission of teaching and civic engagement.

The GO GREEN course provides students with an opportunity to experience international travel and cultural awareness. As part of the learning process, students are responsible for handling all of their travel arrangements (flights, transfers,

lodgings, etc.), in consultation with their faculty mentor and German research partner. This truly independent, experiential learning component is included for several reasons. First, students have consistently indicated they desire flexible arrival and departure travel arrangements to permit journeys to other parts of Europe either before or after GO GREEN activities. Second, the limited number of participants exempts the group from travel-related discounts associated with student groups with a larger, critical mass of participants. Third, the nature of individualized field-based research projects at various locations throughout Germany (and potentially elsewhere) requires customized travel plans for students who participate in that component. Finally, the wide availability of travel-related distribution channels (e.g. Travelocity, Orbitz, Expedia, travel agencies, airline reservations centers, discounters) permits students to search, identify, and select transportation and lodging arrangements based on their unique circumstances and criteria.

Despite the individualized nature of travel planning, however, GO GREEN faculty mentors do provide orientation and other assistance to students, many of whom have never traveled this extensively outside of the US. Issues in pre-departure orientation include cultural awareness, logistics for international travel (e.g. flying overseas, landing procedures for clearing customs, information on train schedules and local mass transit), and contact information for faculty mentors and industry partners in Germany. For course-related purposes, faculty mentors stay and reserve a “block” of rooms at a local hotel in Mannheim, Germany, and past experience indicates that several students simply choose to book to stay at the same hotel (which, in essence, serves as a central meeting-point for many course-related activities). For the research-related component of GO GREEN, faculty mentors from IUPUI, the Berufsakademie Mannheim, or both, are typically

available to assist with the launch of specific student research placements.

DELIVERY AND IMPLEMENTATION STRATEGIES

The need to engage students in critical thinking, powerful pedagogies, experiential education, and meaningful reflection is well noted [17–21]. As such, GO GREEN has three broad learning components: foundation-level learning opportunities; experiential learning opportunities; and undergraduate research opportunities. In *foundation-level learning*, students complete independent readings on issues related to sustainability; in addition, students who are involved in undergraduate research develop an applied research project proposal for field-based investigations with industry partners in Germany.

Experiential learning includes participation in the three-credit-hour GO GREEN course. This course begins on the IUPUI campus, where issues of sustainability are discussed, industry partners are studied, and pre-departure issues are communicated and clarified. The intensive week-long session in and around Mannheim, Germany, is the main experiential learning activity. Students participate in site visits, lectures, tours, observations, and other forms of learning with industry partners. Assignments related to GO GREEN typically include a cross-cultural paper and an in-depth research paper on sustainable industry comparisons. Upon return to the US, students re-group for a debriefing meeting at IUPUI, where assignments are submitted, lessons learned are discussed, and, in a spirit of fun and community-building, pictures and stories are shared.

Finally, *undergraduate research learning* permits select students to participate in an additional three-credit-hour research experience related to sustainability. Working with faculty mentors from IUPUI, the Berufsakademie Mannheim, and the relevant industry partner, students conceptualize and complete independent research projects

related to sustainability. Students collect field-based data (via interviews, observations, content analysis, surveys, etc.), interpret and analyze the data, and communicate their findings in both a written research report and an oral presentation at IUPUI. Table 3 provides examples of the types of undergraduate research learning opportunities available through GO GREEN.

EVALUATION FRAMEWORK

Evaluating the aims, purposes, and, most importantly, the outcomes of educational programs is always a difficult task [22, 23]. Nevertheless, GO GREEN faculty have been engaged in formative and ongoing evaluation since the program’s inception in 2002. The main evaluation framework employed has been informed by using Kirkpatrick’s four levels of evaluation: reaction, learning, behavior, and results [24].

Reaction evaluation involves gathering feedback on participant experiences with, satisfaction from, and willingness to recommend the program. This has been accomplished by participant-completed feedback sheets for course- and field-based components. This feedback centered on the extent to which participants enjoyed the learning experience, including presentations, readings, site visit activities, and supporting materials. Feedback gleaned from the reaction stage has, in general, been positive and has been used to modify content and delivery to enable subsequent participants to potentially have a more satisfying learning experience.

Learning from course- and field-based components has been assessed through short-answer questions that participants completed both during the classroom-based portion of instruction and through subsequent post-work (including their research projects). Feedback gleaned from the learning stage has been used to determine the extent to which certain concepts were understood or needed further reinforcement.

Encouraging participant *behavior* to reflect

Table 3. Examples of GO GREEN undergraduate research project opportunities

Discipline	Examples of Undergraduate Research Projects
Science	• Bio-mimicry related to sustainable design and product development
Engineering	• Energy conservation practices in commercial, industrial, and residential environments (e.g. solar collectors for building exterior skin) or EU recycle mandate on vehicles
Design	• Comparisons of green roofs and other construction-related differences
Manufacturing	• Development of manufacturing processes (e.g. automotive painting, healthy indoor air quality for workers, cradle-to-cradle concepts for materials resource maximization)
Technology	• Analysis of new innovative technologies that support sustainable practices in specific industries and organizations
Leadership	• Change management practices in creating, implementing, and nurturing a culture of sustainable practices
Public Policy	• Building design codes, energy consumption, and recycling issues; new laws and regulations—European Union; regulation

concepts covered in the GO GREEN course is important if those concepts are, indeed, to become institutionalized over time. As a result, IUPUI is in the process of tracking participant behaviors (e.g. enrollment in additional sustainability courses, completion of additional research or experiential learning opportunities such as internships or further study abroad) to determine what, if any, changes have occurred as a result of a student's experiences with the GO GREEN course.

Finally, examining the ultimate, long-term results of courses such as GO GREEN is always difficult. However, IUPUI will be attempting to use both quantitative and qualitative indicators (e.g. job placements related to sustainability, subsequent coursework at the undergraduate or graduate levels related to sustainability, technology transfer as a result of research projects undertaken) in an effort to identify the impact of the course.

ISSUES AND CONSIDERATION FOR COURSE REPLICATION

The GO GREEN course represents an excellent example of an international, university–industry cooperative learning experience for students. It is one approach to integrating sustainability into the engineering curriculum, primarily through an experiential, interdisciplinary, international approach. Issues and consideration for course replication, therefore, include curriculum issues, faculty issues, student issues, and partner issues.

Curriculum issues include the identification of sustainability as a teachable concept and its relationship to other engineering curriculum concepts. The Accrediting Board for Engineering Technology (ABET) has identified several program-level learning outcomes to which both sustainability and international/cross-cultural learning apply, including: an understanding of professional and ethical responsibility; the broad education necessary to understand the impact of engineering solutions in a global societal context; a knowledge of contemporary issues; and an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice. Thus, for courses in sustainability such as GO GREEN, care must be made to link assignments, readings, and activities to existing assessment processes designed to document student learning outcomes. Equally important is the need to explicitly, intentionally, and continually stress the integration and application of sustainability to other engineering courses and concepts.

Faculty issues involve selecting people who are interested in and passionate about—and who can derive personal and professional satisfaction from involvement in—sustainability and international

educational experiences. Closely related to faculty selection is faculty development. Teaching an emerging and interdisciplinary concept such as sustainability and doing so in an international context requires a unique set of knowledge, skills, and dispositions. Thus, it is necessary for faculty involved in such endeavors to commit to learning new concepts, exploring new modes of teaching, and forging relationships with others in a position to facilitate contacts with industry partners. Faculty compensation, rewards and other issues of support should be addressed, and the connection of a faculty member's broader research and/or teaching interests must be considered. Finally, planning for how to evaluate course components, primarily student reaction and learning, is needed.

Student issues include the identification, selection, and preparation of students to participate in a course such as GO GREEN. Finding students with an interest in environmental aspects of engineering and equipping them with knowledge of sustainability is paramount if their learning is to be maximized. Additionally, adequate preparation for international travel and cross-cultural experiences must be provided, and funding and other logistical issues must be reconciled. For students interested in studying sustainability in-depth, how to sufficiently engage in undergraduate, field-based research must be determined.

Partner issues are particularly important, since so many activities in a course like GO GREEN would simply be impossible without the support and interest of companies and organizations involved in sustainability. Clearly, IUPUI has benefited from the use of a host-country academic affiliation with the Berufsakademie, and the forging and expansion of that relationship occurred over several years. Such in-country affiliations have been useful in the identification of partners and in handling some of the minor logistics on-the-ground. In the experience of GO GREEN faculty, most industry partners have been eager to showcase best practices, educate students about sustainability, and, in many instances, permit undergraduate students to be involved in field-based research. Flexibility—on both sides—concerning dates, times, activities, etc., can go a long way toward maintaining and enhancing an ongoing relationship. Finally, any issues such as proprietary information, security clearances, accommodation for individuals with disabilities, etc., should be acknowledged and resolved prior to the experiential learning component of the course.

Properly arranged and managed, an international course in sustainability can truly become sustainable, but not without an ongoing sense of purpose and commitment by all stakeholders involved—a lesson that holds equally true for the concept of sustainability itself.

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