

AC 2010-1885: DEVELOPMENT OF A MASTERS DEGREE ON SUSTAINABILITY MANAGEMENT

Shekar Viswanathan, National University, San Diego

Howard Evans, National University, San Diego

Development of a Master's Degree Program on Sustainability Management

Abstract

This paper summarizes the development of a unique, master's degree program in sustainability management based on fundamental concepts relating to energy, environment, products and processes. The interactions among practitioners and academicians at the National University that lead to the development of this program are highlighted. This interdisciplinary program taught by faculty members from three different schools, namely the school of engineering and technology, the school of business and management and the college of letters and sciences is expected to make this degree program relevant and appealing to professionals from many disciplines.

Introduction

The term "sustainability" began with the 1987 publication of the World Commission on Environment and Development's report, defined as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs."^{1,2} A combination of forces, including an unprecedented growth in population, economy, urbanization, and energy use, is imposing new stresses both on the earth's resources and on society's ability to maintain or improve environmental quality. To respond to this problem, a movement began in the last decade, inside businesses to change the way companies operate, specifically in terms of the ways in which they dealt with not only hazardous chemicals but also the entire concept of waste. To meet these new challenges, many corporations, cities, states, and countries began introducing new policies and programs that demonstrated a gradual shift in emphasis from pollution control to pollution prevention to sustainable practices. As a result, many public and private corporations began looking for academically qualified people in sustainability to stimulate technological innovation, advance competitiveness, and improve the over-all quality of life. According to a recent MonsterTRAK study, "80 percent of young professionals are interested in securing a job that impacts the environment in a positive way, and 92 percent give preference to working for a company that is environmentally friendly."³ To meet this demand, many universities have introduced courses and programs highlighting sustainability concepts⁴.

This paper highlights the processes adopted in creating a unique, relevant, and accessible master's program in sustainability management. Input from experienced practitioners from public and private companies and organizations were incorporated, without diluting the academic relevance and quality maintained by academics involved in curriculum development. The paper also summarizes the step-by-step approach used in developing this program including the concepts of sustainability and systems approaches adopted across disciplines. This interdisciplinary program is taught by faculty members from three different schools namely the school of engineering and technology, the school of business and management, and the college of letters and sciences thus making this program both relevant and appealing to professionals from many disciplines. Case study

materials are used for understanding sustainability and institutional behavior. Special emphasis is given to approaches that focus on achieving behavioral change, satisfying organizational leadership requirement, identifying tools and resources required to achieve effective institutional change. In addition, this paper summarizes program learning outcomes, course learning outcomes, and the assessment processes that are currently being used.

Description of National University and Its Student Body⁵

Founded in 1971, National University (NU) is an independent, nonprofit institution of higher education. Since its establishment, the university has dedicated itself to providing educational opportunities to a diverse population of working, adult learners. With more than 22,000 full-time students, National University is the second largest private, non-profit California institution of higher education, with a 37-year history of educating traditionally underserved populations. National University is ranked 7th nationally and 2nd in California for awarding degrees to ethnic minority populations. Thirty-four percent of National's students are from minority populations and fifty-eight percent are female. NU is ranked sixteenth out of 3,000 institutions nationwide in awarding graduate degrees to minority students. NU also received the California Council on Excellence (CCE) Eureka Award for Performance Excellence in 2002 and in 2003. National University's central purpose is to promote continuous learning by offering diverse instructional approaches, encouraging scholarship, engaging in collaborative community service, and empowering its constituents to become responsible citizens in an interdependent, pluralistic, global community. National University students earn their degrees in a unique one-class-per-month format, and attend classes at night so they can continue to move forward in the workplace. Programs in this format can be completed faster than they would be at a traditional university, albeit in an intense fashion. Each graduate course has 40.5 hours of class room contact. Students are allowed to take only one course at a time.

National University's Master's Degree in Sustainability Management

National University's Master of Science in sustainability management degree (M.S.) program is designed to bring provide methods and theory appropriate to the study of sustainability by exploring the concepts of sustainability and practical applications.

Curriculum Design

To initiate the development of this program, a comprehensive search of all available programs was completed. In addition, the search of job titles related to various sustainable job postings was done. Some of the position titles are listed below.

- Sustainability Manager
- Sustainability Analyst
- Sustainable Design

- Professional Engineer
- Environmental Consultant
- Sustainability Consultant
- Energy Efficiency Analyst
- Operations Manager
- Project Manager
- Resource Manager

Based on these job descriptions, a draft of program learning outcomes (PLOs) was developed. These PLOs were circulated among a group of professionals involved in local sustainability initiatives (<http://sustainsd.wordpress.com/>) to ensure that the learning outcomes are consistent with the employer requirements. With their help, the program learning outcomes were finalized.

Program Learning Outcomes (PLOs):

Upon completion of the MS program, graduates from sustainability management will be able to:

- PLO # 1- Understand the importance of sustainability concepts.
- PLO # 2- Acquire scientific knowledge and methods required to evaluate the sustainability of systems.
- PLO # 3 - Learn to design, manufacture, and operate processes in an environmentally conducive manner.
- PLO # 4- Demonstrate critical thinking skills required to analyze problems in their social and environmental context.
- PLO # 5 - Develop economically, environmentally, and socially sound sustainable decisions
- PLO # 6 - Evaluate the impact of products, processes, and activities through life cycle assessment
- PLO # 7 - Communicate through graduate level oral and writing skills.
- PLO # 8 - Demonstrate understanding of professional and ethical responsibility.

Contributions to the development of this program include individuals with the following credentials and experience:

- Director of Innovation of a large energy corporation
- Manager of a large engineering and environmental consulting firm dealing with over \$100 MM annual projects and 150 people
- Sustainability manager of a leading wireless corporation
- Environmental and safety manager of a leading wireless corporation
- Energy project manager from NAVY
- Engineering manager of a power equipment producer

- Financial consultant
- Engineering supervisor of a Photovoltaic cell manufacturer
- Energy consultant of a center focused on sustainable energy practices

It is clear that to achieve the above mentioned PLOs, the curricula should be trans-disciplinary. It can be achieved through the integration of basic fundamental concepts along with application concepts. It was felt that such an appropriate mix of trans-disciplinary content can be accomplished by bringing together viewpoints from experienced academics and also from expert practitioners from outside academia. The trans-disciplinary result is reflected in the nature of the program courses listed below.

- SEM 601. Introduction to Sustainability
- SEM 602. Enterprise Excellence
- SEM 603. Sustainable Innovation
- SEM 604. Life Cycle and Risk Assessment
- SEM 605. Energy Management
- SEM 606. Environmental Management
- SEM 607. Watershed Management
- SEM 608. Sustainable Buildings
- SEM 609. Sustainable Supply Chain
- SEM 610A. Capstone Course
- SEM 610B. Capstone Course

Table 1 depicts the descriptions of each course in this program. The curriculum can be divided into three broad modules namely foundation module, application module, and practicum module. The first four courses in the foundation module provide concepts where as the next five courses in the application module offer application details. The last two courses represent practicum module where a research thesis is completed by the students by applying fundamentals learned in the program to solve a practical research problem. Specifically, the introduction to sustainability course provides a fundamental understanding of principles and concepts of sustainability. The enterprise excellence course deals with concepts related to metrics development and measurement by covering relevant statistical concepts. The courses on sustainable innovation and life cycle and risk assessment are introduced as a part of foundation management courses. The application courses namely energy management, environmental management, watershed management, sustainable buildings, and supply chain reinforce the fundamental concepts as well as their applications to related areas. It is important to recognize that this program is intended to attract students who wish to become scholar-practitioners working in the field of sustainability. Hence this requires an approach to education that is learner-centered, participative, experiential, case/problem-focused, and team-based. As long as these criteria are met, the goal of this program to educate professionals with the capacity to transform theory into practice in collaborative and empowering ways can be achieved. This modular structure produces a flexible curriculum design where adding or dropping a particular course can be done at any time in response to the changing needs in the

marketplace. Also, the list of application courses can be constantly modified based on the need of current practitioners.

The pedagogical approach followed in this program encourages students to interact with their peers. This is because the curriculum has been designed in such a way that it requires students to work in small groups to solve specific problems. Each problem represents real world situations and they require students to draw on their diverse views and experience to solve them. The instructional methods used are also diverse: they include the participative, interactive, and experiential approaches. Besides these, students are also given case studies to analyze either individually or as a team. The program relies on teaching through various approaches including case study analysis, video presentations from institutes such as American Institutes of Chemical Engineers, and Institute for Supply Chain Management, lectures by special guests who are experts in a particular topic, field visits to locations relevant to the topics discussed, and the Internet for gathering and assessing information. Besides the implementation of these different methods, students also have direct access to talented professionals who are employed full time in the field of study as reflected in Table 3, as many of these individuals work as adjunct faculty for National University. The opportunity to interact with such individuals not only gives the students valuable exposure to real world issues but also enables them to establish contacts with professionals in their field of study..Lastly, National University's requirement that students maintain individual learning journals to only identify the various experiences they were exposed to but to also reflect on the type of impact that each of these experiences had on them is likely to enable them to recognize the aspects of learning they consider as being most relevant to their field of interests. Throughout the academic process, students are asked to.

Degree Requirements

To receive a Master of Science in Sustainability Management, students must complete 49.5 quarter units involving eleven courses. A total of 9.0 quarter units of graduate credit may be granted for equivalent graduate work completed at another institution, as it applies to this degree, and provided the units were not used in earning another advanced degree. Students should refer to the section in the graduate admission requirements for specific information regarding application and matriculation.

Program Prerequisites

Candidates for the program must possess a Bachelor's degree in engineering, engineering technology, sciences, business, management or a closely related area from an accredited university. Interested students from other disciplines may be admitted to the program but may be required to complete additional courses. Non-degree students will not be allowed to enter this program. For those who have a general non-science and non-engineering degree, admission would be based on relevant experience and the following program prerequisite:

CSC 220 - Applied Probability and Statistics or equivalent

This course may be waived if its equivalent has been completed at the undergraduate level with a grade of “C” or better.

Program Courses

Course Title	Course Description
SEM 601 Introduction to Sustainability	An introduction to sustainability concepts. An interdisciplinary approach is used by combining environmental, economic, and social dimensions of sustainable development by looking into relevant local, regional, and global environmental issues. Various sustainable forces that may impact an organizational operation will be discussed.
SEM 602. Enterprise Excellence	Overview of statistical tools needed to measure business improvement related to sustainability. Step-by-step guide to develop and institute metrics for sustainability improvement will be provided. Enterprise excellence including process improvement analysis and management systems for business, industry, academic, government and military organizations will be covered.
SEM 603 Sustainable Innovation	Presentation of the concepts of sustainable innovation through culture, innovation network and leadership. Specifically, concepts such as innovation leadership are addressed. Focuses on innovation drivers and their implications in stimulating and managing innovation in the workplace. Relevant case studies will be used.
SEM 604 Life Cycle and Risk Assessment	Hands-on experience on how to conduct life cycle and risk assessments. Practical application of these methodologies into products and processes will be discussed. In addition, environmental management systems such as ISO 9000 / 14001 will be discussed.
SEM 605 Energy Management	Overview of sustainable energy management practices in order to increase energy efficiency, and decrease the release of energy-related pollutants into the environment. Coverage materials related to not only energy from conventional sources but also renewable. Special focus on energy conservation will be discussed. Various techniques to lower energy use will be discussed.
SEM 606 Environmental Management	Comprehensive overview of applicable air pollution, water pollution, drinking water and toxics environmental laws and regulations in the U.S. In addition, various pollution sources, and their impact are presented. Specific strategies to develop and implement environmental management practices are presented.
SEM 607 Watershed Management	Overview of the watershed management and planning process. Relate interdisciplinary topics such as the use of public policies, regulations, and management tools to effectively manage water

	resources for a sustainable future. Specific case study examples will be used to illustrate the concepts.
SEM 608 Sustainable Buildings	Examination of environmental, economic and social benefits of green building. Specifically addresses the various methodologies that can be integrated into the built environment for energy savings while maintaining the highest indoor environmental quality. Specific strategies to secure LEED certification will be presented.
SEM 609 Sustainable Supply Chain	Examination of how supply chain can be used to improve the sustainable operations of an organization. Specific topics would include the development and implementation of supply chain and organizational policies to meet the global requirements. Relevant case studies will be used to reinforce the concepts.
SEM 610 A Capstone Course	Focus on the application of sustainability methods learned through this program. The students are to select research topics and conduct research and write a detailed report. During this part of this course, the students define the problem/hypothesis, and gather data from literature searches and/or client organization, if applicable
SEM 610 B Capstone Course	This continuation course may focus on methodology, data analysis, results, modeling/simulation, conclusions and recommendations related to the project selected. Students are required to present their research in both written and oral form to students and faculty and if applicable to client organization.

Table 1: Description of Courses in the Program

Program Assessment:

The assessment of this program at the course and program levels is established at the program approval time. As a part of the program approval, a detailed curriculum mapping is prepared as shown in Table 3. For example, each of the program learning outcome is mapped to the courses as to the degree of learning namely, “introduced” or “developed” or “mastered.” For example, “Understand the importance of sustainability concepts” is taught and measured in a number of courses in this program as listed below:

Introduced -- SEM 601, SEM 602, SEM 603, SEM 604
 Developed – SEM 605, SEM 606, SEM 607, SEM 608, SEM 609,
 Mastered -- SEM 610A, SEM 610B

Quizzes, exams, assignments, and projects are used to measure students’ learning outcome. Specific rubrics are used to assess the project reports. Quizzes and exams are assessed based on the right and wrong responses provided. For case study analysis, the instructor assigns a case study to each group consisting of a few students. Students are

required to summarize each case and answer all questions posed at the end of each case study in a narrative form as a group paper. Besides this, students are required to perform outside research in order to be able to provide additional information relevant to the case study. Students who use outside sources must acknowledge them in the reference section/. The group project paper requires students to read peer-reviewed articles from scholarly journals and then summarize and synthesize them. In addition, the students should also show what theory was applied to solve the problem in the paper they had reviewed.. In addition, students are required to submit their paper using the American Psychological Association's (APA) standard, published in its 5th Edition of the Publication Manual. This exercise not only helps the student to master the topic in this course, but also serves as the preamble for their follow up capstone course. It also gives students an opportunity to enhance the students' research skills, but also their analytical and writing skills. The instructors accept early drafts to give feedback to the students so that they can improve on their quality of work. The drafts as submitted along with the final paper with instructor comments could indicate the rigor as well as quality of instruction provided in this program. Each course is established with an acceptable target achievement.

Table 4 shows an example layout of course learning outcomes assessment for SEM 602 course. As shown, these individual course learning outcomes are linked to the program learning outcomes through a curriculum mapping process.

Summary

This program, developed with the help of experienced academics and industry practitioners, has resulted in a program that integrates fundamentals with relevant applications, offers significant opportunity to study sustainability, exposes students extensively to current issues and practitioners, allows to be readily updated due to modular structure, and addresses the needs of the marketplace. Finally, the use of novel delivery methods makes this degree accessible to geographically diverse learners, including working adults.

References

1. World Commission on Environment and Development, "[Our Common Future, Report of the World Commission on Environment and Development](#)", 1987.
2. <http://www.epa.gov/sustainability/basicinfo.htm>
3. http://eon.businesswire.com/portal/site/eon/permalink/?ndmViewId=news_view&newsId=20071003105337&newsLang=en
4. http://www.usatoday.com/news/education/2009-08-02-sustainability-degrees_N.htm
5. <http://www.nu.edu/OurUniversity/TheUniversity.html>

Program-specific Qualification	Course Numbers											
	SEM 601	SEM 602	SEM 603	SEM 604	SEM 605	SEM 606	SEM 607	SEM 608	SEM 609	SEM 610A	SEM 610B	
Sustainability Concepts	FE											
Enterprise Excellence		FB /FE										
Innovation			FB /A/ AJ									
Life Cycle and Risk Analysis				FE/ AJ								
Energy Management					FE/ AJ							
Environmental Management						FE/ AJ						
Watershed Management							AJ					
Sustainable Buildings								FE/ AJ				
Supply Chain and Business									FB /AJ			
Capstone Process										FE/ AJ/ A	FE/ AJ/ A	

FB– Full Time Faculty - School of Business and Management;
FE– Full Time Faculty - School of Engineering and Technology
AJ- Adjunct Faculty A – Associate Faculty

Table 2: Course Specific Faculty Qualifications

Course #	SEM 601	SEM 602	SEM 603	SEM 604	SEM 605	SEM 606	SEM 607	SEM 608	SEM 609	SEM 610A	SEM 610B
PLO #											
1	I	I	I	I	D	D	D	D	M	M	M
2	I	I	I	I	D	D	D	D	M	M	M
3			I	I	D	D	D	D	D	M	M
4	I	I	I	I	D	D	D	D	D	M	M
5					I	I	I	D	D	M	M
6				I	D	D	D	D	D	M	M
7			I	I	I	D	D	D		M	M
8	I	I	D	D	D	D	M	M	M		

“I” - introduced, “D” - developed, “M” - mastered

Table 3: Curriculum Mapping Layout

SEM 602 Enterprise Excellence									
Course Learning Outcomes		Means of Assessment							
		Mid-term Exams	Final Exam	Writing Assignments	Research Paper	Oral Presentation	Graded Homework	Graded Participation	Case Analysis
1.	Set standards for enterprise excellence	X	X	X				X	
2.	Make decisions regarding compliance with environmental/sustainable standards using statistical techniques	X	X	X				X	
3.	Analyze the impact of past management policies and processes through hypothesis testing	X	X	X				X	
4.	Evaluate the likely outcome of proposed policy or management actions through hypothesis testing	X	X	X				X	

Table 4: Example Layout of Course Learning Outcomes Assessment