

## **AC 2009-1639: HARNESSING INDUSTRY COLLABORATION IN DEVELOPING GRADUATE-DEGREE PROGRAMS**

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Dr. Howard Evans was appointed founding Dean of the School of Engineering and Technology, National University, in October, 2003. He received B.S. degrees in Physics and Chemical Engineering from Brigham Young University, and a Ph.D. in Chemical Engineering Science from the California Institute of Technology.

Dr. Evans has over 20 years of executive and senior technical management experience at 3M Company and IBM Corporation, primarily leading multidisciplinary, global technical organizations responsible for R&D; new business and market development; manufacturing engineering; quality; environmental, health and safety; and others.

Before joining National University he acquired 12+ years of voluntary involvement with higher education, including adjunct teaching and research in engineering at the University of Colorado and formal advisory involvement in both science and engineering at the University of Texas. Other past professional and academic activities include being a founding member and officer in the Central Texas Electronics Association; past chairman of IBM's Materials Shared University Research Committee; Ph.D. Recruiting Coordinator for IBM's Systems Technology Division; and executive sponsor for 3M division's student programs. He has published and presented widely in areas of surface science, electronic materials and processes, project management, and industry/university relations. He holds 4 patents and has received awards for excellence in technical innovation (IBM), technical authorship (IBM), teaching (University of Colorado), and scholarship (National Science Foundation).

## **Harnessing Industry Collaboration in Developing Graduate Degree Programs**

### **Abstract**

An unique engineering management degree programs developed by harnessing industry collaboration are described. This paper summarizes the step-by-step approach adopted in developing two specializations namely enterprise architecture and lean six sigma. The paper concludes by pointing out that these two programs developed offer significant opportunity for choice of specialization; exposes students extensively to current issues and practitioners; and which addresses needs of the marketplace.

### **Introduction**

Today's competitive global environment requires professionals with expertise in specific specialized areas. Some of the expertise comes exclusively from industries. It is common to see collaboration among industries and universities on research areas. However, it is unusual to see academic programs developed in conjunction with the industries. The need for enhanced integration of basic fundamentals along with the application concepts, demanded by specialized fields, can be accomplished by bringing together viewpoints from experienced academics and expert practitioners. Over the past few years, developments in higher education have brought collaboration between the university and the private sector more and more common. The industry approach to professional development is based on the needs of acquiring, developing, and retaining a skilled and competent workforce. Universities, in turn, may benefit from the knowledge, ideas, and practices of real life outside the academy. Research findings showed that graduates greatly value the experience of learning in the workplace<sup>1</sup>. Kameoka et al<sup>2</sup> through their research have identified a strong need to create a dynamic venturing between businesses and universities by supporting suitable education programs in order to develop needed talents. Gunasekara<sup>3</sup> points out that the roles of universities have evolved over the last twenty years from simply performing teaching and research role to enablers of regional economic development. This requires the need for close cooperation between universities and industries in the development of academic programs.

This paper highlights the university-industry collaboration in the development of a unique graduate degree program with specializations in enterprise architecture and lean six sigma. Some initial insights gained from this collaboration are presented and possible principles on which to base future development are suggested. This paper summarizes the step-by-step approach adopted in developing a unique, relevant, and accessible master's program in engineering management based on a modular concept with specializations in enterprise architecture and lean six sigma specializations.

### **Description of National University and Its Student Body**

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 7<sup>th</sup> nationally and 2<sup>nd</sup> 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. Students can complete programs in this format much faster than they would 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.

### **Curriculum Design**

Positions of leadership in firms pursuing technologically-based competitive strategies call for graduates who are well educated and trained in specialized fields. Although an undergraduate degree in engineering can secure entry-level opportunities in engineering, the graduate level educations are preferred in the competitive global environment. According to JobWeb.com, while bachelor's engineering may be desired by employers, master's engineering degrees are preferred<sup>4</sup>. To a larger extent, graduate students of engineering are usually better equipped to obtain choice positions that provide both a higher salary and access to a broader network of opportunities. At many U.S. universities, the engineering graduate degrees can be completed in one year. Typically, these degree programs emphasize coursework, and advanced training in an area of technical specialty. Typical graduate engineering curriculum consists of a set of core courses which address critical competencies needed to enhance technical skills, followed by course technical electives in a concentration area. However, most of the programs are developed without any direct involvement or collaboration of an external industry. As a result, the specialized programs are not effective.

Curricula structured around traditional disciplines can be easily developed without any industry involvement. However, trans-disciplinary programs in specialized fields can be enhanced by harnessing industry collaboration. By bringing together viewpoints from expert practitioners from outside academia, the program developed would become relevant and applicable to the needs of the industry. Typically, this requires collaboration with industry members whose credentials and experience add immense value to the program. Unlike physicians, engineers are taught in an environment different from the one in which they practice. To make the degree more relevant, curricula have to be designed with the industry requirements. In addition, these specialization courses can be taught by the collaborating industry. Through collaboration, the model of knowledge acquisition in the specialized area is made easier and relevant.

Using this approach, a Master of Engineering Management Degree Program (M.S.) with specializations in enterprise architecture and lean six sigma were developed. The process adopted is listed below.

### **Program Description:**

#### Master's Degree in Engineering Management with Specialization in Enterprise Architecture

The Master of Engineering Management Degree Program (M.S.) with specialization in Enterprise Architecture is designed to bring the benefits of modern technology and high quality graduate-level instruction to engineers who may be interested in furthering their skills in this area. This program is designed to prepare technically qualified individuals for a responsible management role in the management of Enterprise Architecture and, unlike traditional MBA programs, the M.S. program emphasizes management skills that are specifically required and encourages students to build on their technical backgrounds and experience. The specialization courses relevant to this program are offered by FEAC Institute<sup>5</sup>.

The FEAC Institute was founded in 2002 and is the first organization to provide certification in enterprise architecture. They have graduated over 850 enterprise architects in their two programs, the Federal Enterprise Architecture Framework and the Department of Defense Architecture Framework. This program is the most academically rigorous in the field and the students include all government organizations and the Department of Defense and its contractors. The latter include such organizations as Lockheed Martin, Northrop Grumman, Raytheon, SAIC, MITRE, TITAN, BAE Systems and many more.

The FEAC Institute<sup>5</sup> is an independent, framework, methodology, and tool agnostic organization that focuses on pragmatic Enterprise Architecture, hands-on education, and training leading to formal certification. Their faculty and instructors are experienced at the highest levels of government and across agencies in enterprise architecture and come from governmental, educational institutions and systems integrators supporting the government. The FEAC Institute has centers in Washington DC and on the West Coast. Key to the success of enterprise architecture are understanding the culture of the organization, budgeting and developing a realistic statement of work, selling it internally, monitoring and performing the work within budget and scope, tying enterprise architecture to the CPIC, Exhibits 300 & 53, and security and mapping it to the five FEA Reference models. The Institute's primary programs cover all of these issues in a pragmatic manner whereby students engage in real enterprise architecture projects within government agencies and present that work to a faculty panel as part of the certification process. Students take an enterprise architecture comprehensive written certification examination that qualifies them as a Certified Enterprise Architect (CEA) with specialty in the FEA or DoDAF. Once certified, the students become Fellows of the Institute and participate in a number of invited seminars and other FEAC sponsored events. This degree emphasizes Enterprise Architecture with two specializations namely DoDAF [Department of Defense Architecture Framework] certification program or FEA(F) [Federal Enterprise Architecture (Framework)] Certification Program Courses) program.

## Master's Degree in Engineering Management with specialization in Lean Six Sigma

This degree program provides specialization in lean six sigma programs (Green belt and Black belt certifications). This specialization was developed in collaboration with the Management Sciences Division of VSE Corporation<sup>6</sup>. VSE Corporation is a broadly diversified company that is focused on creating, sustaining, and improving the systems, equipment, and processes of government through core competencies in legacy systems sustainment, obsolescence management, prototyping, reverse engineering, technology insertion, supply chain management, foreign military sales, management consulting, and process improvement. Its faculty and instructors are experienced at the highest levels of government and across agencies in Lean Six Sigma training programs including Green Belt and Black Belt certifications. Over 1,400 alumni have been trained under VSE Corporation's Lean Six Sigma programs and hence are well experienced in academic training.

### **Program Development:**

Having established the link to two industrial partners for the development of academic programs, a step by step process was adopted to develop these two programs. Fundamental courses have been developed to ensure a solid understanding of basic principles and concepts, and corresponding application courses have been designed to reinforce the fundamentals. In addition, the courses provide exposure and experience in addressing issues and problems. It is important to recognize that this program is expected to attract students interested in becoming scholar-practitioners working in the field of specialization. Hence, it is important that the approach to education adopted is learner-centered, participative, experiential, case/problem-focused, and team-based. As long as these criteria are met, it is certain that the goal of this program to educate professionals with the capacity to transform theory into practice in collaborative and empowering ways can be achieved. As a part of the program development, the following issues were considered including the following:

- Program learning outcomes
- Course learning outcomes
- Course mapping with program and course learning outcomes
- Course and program assessment processes

### Degree Requirements

To receive a Master of Science in Engineering Management, students must complete 54 quarter units involving twelve courses. A total of 13.5 quarter units of graduate credit may be granted for equivalent graduate work completed at an another institution, as it applies to this degree, and provided the units were not used in earning another advanced degree. Since this program is defined for various areas of specialization, there are specific requirements for the type of courses to be taken.

### Program Prerequisites

Candidates for the program must possess a Bachelor's degree in engineering, engineering technology, or physical sciences or a closely related area from an accredited university. Interested students from other disciplines can be admitted to the program; however, they are required to complete additional preparatory courses. Non-degreed students are not allowed to enter this program. For those who have a general non-science and non-engineering degree, admission would be determined based on relevant experience and a set of program prerequisites. The curriculum has been divided into three modules: core module, specialization module, and electives module. Courses included under each module are listed below.

#### Core Courses:

The core module consists of six courses that ensure a thorough grounding in the fundamental basics of engineering management. These courses are mandatory courses that are required in both field of specialization. (A two course sequence for Masters Project is included in this core module.) The students then move to in-depth study of their chosen area of specialization.

Students in the program have to start with the following core courses; however, it is recommended to take the courses in the order specified below.

ENM 600 - Introduction to Engineering Management  
ENM 601 - Engineering Project Management  
ENM 602 - Management of Risk, Contracts, and Legal Issues  
ENM 603 - Managing Projects in Operation Management

#### Area of Specialization Courses: Enterprise Architecture:

This module consists of four courses in the enterprise area of specialization. These courses are taught by the FEAC Institute<sup>5</sup>. The faculty, teaching and assessment processes and, importantly, evaluations were in concert with National University academic requirements.

Successful completion of all four courses in either certification program is required as part of the Enterprise Architecture specialization in the MS Engineering Management Program. The courses including the following:

#### DoDAF [DEPARTMENT OF DEFENSE ARCHITECTURE FRAMEWORK] CERTIFICATION PROGRAM COURSES

DAF 601: Architecture Framework Basics  
DAF 602: Core and Supporting Products  
DAF 603: Enterprise Architecture Planning  
DAF 604: Advanced Architecture Modeling and Analysis

#### FEA(F) [FEDERAL ENTERPRISE ARCHITECTURE (FRAMEWORK)] CERTIFICATION PROGRAM COURSES

EEA601: Enterprise Architecture Concepts and Theory

EEA602: Enterprise Architecture Planning  
EEA603: Enterprise Architecture Implementation  
EEA604: Enterprise Architecture Integration

These courses are taught during 236 contact hours of instruction. This involves 96 hours of face-to-face instruction and 140 hours of online interaction on the FEAC Virtual University, which is based on the Moodle Learning Management System. Students actively participate online in number of interactive forums and online presentations, as well as submit a number of detailed assignments and pass a final examination in each of the four courses in the respective programs. The faculty members teaching in this program are experts in their chosen fields. In addition, the faculty members are approved in accordance with National University's teaching faculty requirements based on academic and experience credentials.

Area of Specialization Courses: Lean Six Sigma:

Lean Six Sigma academic training program prepares personnel to become professionals in implementation of Lean Six Sigma for achieving Enterprise Excellence. The program covers all of the topics of the Green Belt and Black Belt certifications. The curriculum provides hands-on learning of the processes, tools and techniques of Lean Six Sigma. The class room exercises and project work develops an enterprise level Value Stream Map, identify and prioritize improvement opportunities, and develops an Enterprise Excellence implementation strategy. The class room exercises also focus on the programmatic tools and techniques for listening to the Voice of the Customer integrating Six Sigma, Lean Enterprise and Integrated Product and Process Development. Concepts taught include methodology for using the Production Preparation Process (3P) for designing and developing, effective and efficient processes, products and services.

Successful completion of below mentioned four courses (LSS 601, LSS 602, LSS 603, and LSS 604) is required as part of the Lean Six Sigma specialization in the MS Engineering Management Program. The courses include the following:

GREEN BELT PROGRAM COURSES

LSS 601: Fundamentals of Process Analysis and Optimization  
LSS 602: Operational Efficiency and Cost Effectiveness

BLACK BELT PROGRAM COURSES

LSS 603: Fundamentals of Leading and Managing Continuous Measurable Improvement  
LSS 604: Advanced Topics in Process Analysis

GREEN BELT AND BLACK BELT CERTIFICATION COURSE:

LSS 605: Six Sigma Project Practicum

Thus, the combined Green Belt and Black Belt program courses are equivalent to 160 hours of instruction. LSS 605 is required only to obtain the Black Belt and Green Belt certifications in conjunction with the Green Belt and Black Belt program courses. These courses are taught

by three well known experts in their fields who are approved adjunct faculty members at National University.

#### Program Electives Courses:

Then the students move to the electives module in which they are required to select two courses of their choice from a list of six. This modular structure produces a flexible curriculum design where adding or dropping a particular specialty can be done at any time in response to changing needs in the marketplace. Also, the list of elective courses can be constantly modified based on the need of current practitioners. Some of these courses are more relevant to a given discipline than to others, and hence students are encouraged to consult with their lead faculty to help determine if they are relevant to their specific needs.

ENM 604 - Quality Management

ENM 605 - Infrastructure Management

ENM 606 - R & D and Innovation Processes

IEM 605 - Operations Research

SCL 605 - Logistics Technology Management

PME 601- Planning, Performing and Controlling Projects

PME 602- Managing Engineering Competencies and Skills

#### Capstone Courses

After completing all the required courses, the students are asked to register for their capstone courses. Capstone courses are intensive experiences in critical analysis, and they are designed to broaden students' perspectives beyond their discipline and provide them with an opportunity to integrate the knowledge obtained from their various courses into their area of specialization. In these two courses, the students are to select research topics under the guidance of the instructor and conduct research and analyze a problem in-depth and write a detailed report. Working in teams or as individuals under the guidance of their assigned faculty advisor, the students are to examine complex issues.

ENM 607A Engineering Management Capstone Course

ENM 607B Engineering Management Capstone Course

#### **Program Experience:**

The Enterprise Architecture program was started in 2007 whereas the lean six sigma started in 2008. Since the inception of this program, thirty eight students have registered in the enterprise architecture and five in the lean six sigma. All of these students are already working in their desired industry. These experienced students have a high degree of self, and other, awareness. Informal discussions with the students at various times revealed a number of interesting insights about the program. They claimed that this modular curriculum design, which allows them to select an area of specialization in addition to two elective courses, challenges them to reflect on their own qualities and competencies in relation to the educational experience, and to move toward greater personal and professional development in



their chosen area at the competitive global marketplace. This curriculum is also able to increase the students' capacities as reflective practitioners. Students, who are highly aware of their roles in their professions, are able to assess and improve their effectiveness through this approach.

The pedagogical approach followed in this program engages students as active participants in their own learning, in interaction with others, in response to real world problems, and in ways that parallel the process of fieldwork. Students are able to learn in concert with others who are supportive and yet different. Faculty members seek input from students with varying viewpoints or backgrounds so as to challenge them to articulate – and further consider - their perspectives. The curriculum used follows a team-based, problem-focused approach, so that the students experience working in a diverse, small group environment that brings a variety of views and expertise to bear on real world situations, similar to those that they will face in practice. Methods of instruction follow the participative, interactive and experiential approach. Case study analyses, both individual and team-based, are utilized extensively to apply concepts and strategies to real world situations. Structured exercises in skill training, role-plays, and simulations are also applied in translating theory into practice in a non-threatening manner. A variety of media is used in the teaching aspects of the program to bring reality and freshness to presentations. Examples include case study analysis, video presentations from institutes such as Project Management Institute, and special guest lectures by experts in select topics and field visits. The use of the Internet, in addition to traditional sources, is integrated into students' activities in gathering and assessing information. Also, this collaboration incorporates National University's model of incorporating talented professionals employed full time in the field of study. This exposes students to more “real world” types of issues and enables them to broaden their networks of professional contacts. Throughout the academic process, students are asked to maintain individual learning journals to capture and reflect on their experiences and identify the important learning relevant to their field of interest.

Some of the challenging issues include keeping track of assessment requirements to ensure that the program achieves them. Assessment coordination between two institutions poses a challenge since the systems adopted are quite different. Two different online systems between FEAC and National University do pose a challenge to students. In addition, tuition fees required by the two different institutions are different, thus requiring some unique administrative process alignments.

### **Summary**

This unique engineering management program developed by harnessing industry collaboration offers significant opportunity for choice of specialization; exposes students extensively to current issues and practitioners; and addresses needs of the marketplace. In addition, this program allows students to obtain industry approved certification as a part of the degree. Continual exchange of ideas between students, teachers, and practitioners make this program effective. Finally, the use of both ‘on site’ and online delivery methods makes this degree accessible to geographically diverse learners, including working adults.

### **Bibliography**

1. G. Crebert, M.Bates, B. Bell, C.J.Patrick & V. Cragolini, "Developing generic skills at university, during work placement and in employment: graduates' perceptions", [Higher Education Research & Development](#). Vol. 23, No. 2, May 2004, p. 147-165.
2. A. Kameoka, S.W. Collins, L. Meng & M. Hashimoto, "Emerging MOT education in Japan", Presented at the Engineering Management Conference, 2003. IEMC '03. *Managing Technologically Driven Organizations: The Human Side of Innovation and Change*, 2-4 Nov. 2003, p 296-300.
3. Gunasekara, Chrys S. (2004) *The Third Role of Australian Universities in Human Capital Formation*. *Journal of Higher Education Policy and Management*, 26(3). pp. 329-343.
4. <http://www.jobweb.com> accessed on March 17, 2009
5. <http://www.feacoinstitute.org/ea-certification/> accessed on March 17, 2009
6. <http://www.vsecorp.com/services/management/leansixsigma.htm> accessed on March 17, 2009