

Industry Supported Dual-Master's Degree Program

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Abstract:

In the fall 2003, Loyola Marymount University (LMU) will initiate a new, dual-degree Systems Engineering Leadership Program (SELP) to fulfill the graduate educational needs of industry and government in Southern California. The SELP is based on the collaborative development of an integrated curriculum among LMU's college of engineering, business and local industry. It is designed around the constituents' needs and confers two degrees: M.S. in systems engineering and MBA. The systems engineering leadership emphasis resulted from suggestions by local industry and the Air Force. The constituents and their needs have been established and translated into a set of educational objectives and program outcomes. Since very few universities offer dual-degrees in systems engineering and business, the SELP fills an important need for an integrated engineering/business curriculum.

I. Introduction

Today the United States has a major shortage of engineers and scientists capable of leading and managing complex technical projects. One example is the U.S. Air Force whose Secretary, Hon. James Roche, has testified before the U.S. Congress [1] that one of the reasons for the large cost overruns and schedule slips on major acquisitions is the lack of systems engineering and management capability. In discussions between LMU's President and industry leaders from Southern California's high-technology organizations, the need for well-rounded systems engineers who understand business was established [2]. As a result, the University President chartered an LMU-industry partnership for a new graduate program, entitled the Systems Engineering Leadership Program (SELP).

The SELP will confer two degrees upon its graduates: an MS in Systems Engineering and an MBA. Based on the needs of its constituents, the SELP's goal is to provide the education needed for working engineers and scientists to take leadership roles in complex, multi-disciplinary projects. The emphasis is on meeting all customer requirements in the broadest sense – including the quality, technical, schedule, financial, legal/environmental, ethical, international, and customer satisfaction aspects. Our graduates will be able to integrate across technical and business disciplines to creatively design affordable solutions to a wide variety of problems. The program's techniques will lead to shorter product development cycles and lower life-cycle costs.

LMU's commitment to ethics will be built into the SELP with an integrated approach to developing and practicing ethical strategies in solving problems and integrating/managing projects.

The purpose of this paper is to describe the collaboration between LMU and industry, the cooperation within LMU, and the planning that led to the new program. The benchmarking of other comparable programs, our proposed curriculum, and the sources and qualifications of prospective students are discussed.

II. Benchmarking Successful Programs

A number of university graduate programs, integrating engineering and business were examined, and their systems engineering content determined. While many universities offer systems engineering graduate studies, only four universities offer interdisciplinary, dual-degree programs between engineering and business (see **Table I**). The Iowa/Iowa State program [3] offers a dual-degree in systems engineering and business and is also the only part-time program that allows students to maintain their full-time jobs in industry. It is also a cohort program where the same group of students take the same courses together throughout the program. It is operated like an executive MBA program without course sharing with the regular university engineering and business graduate classes. The other three universities in **Table I** offer dual-degree programs oriented toward manufacturing.

Table I. Comparison of LMU's SELP with Comparable Dual-Degree Programs.

University	Location	Program Name	No. Students	Full/Part Time. Cohort?	Semester Units Req'd.
Iowa/Iowa St. [3]	Cedar Rapids, IO*	Exec. Engin. Dual Master's	31	Part Time. Cohort.	60
MIT [4]	Cambridge, MA	Leaders in Mfg.	48	Full Time. Cohort.	60 plus Thesis
Michigan [5]	Ann Arbor, MI	Tauber Mfg. Institute	8	Full Time. Non-Cohort	66 Minimum
Cal Poly [6]	San Luis Obispo, CA	Engin. Mgt. Program	~6	Full-Time. Non-Cohort.	65 Sem. Equiv.
LMU	Los Angeles CA	SELP	TBD	Part-Time. Non-Cohort.	66

*classes meet at one central location (Cedar Rapids) instead of on either university campus

LMU is establishing a program currently non-existent in Southern California. It will closely approximate the Iowa/Iowa State program; however, it will be a non-cohort program. The SELP has been created at the request of and supported by regional industry to provide much needed graduate education in systems engineering and business. It will draw from over 50,000 working engineers and scientists in the Los Angeles' South Bay. In addition, the SELP curriculum has been coordinated with the needs of the Los Angeles Air Force Base in nearby El Segundo [7-9].

While other Southern California universities offer education in systems engineering, the SELP extends its education into areas where business and management skills are essential. The program's graduates will be prepared to take on leadership roles in major technical firms and enhance their careers in management.

The goals of our SELP program are very similar to those of the benchmarked programs. At the top-level all the programs provide a solid business education via the MBA and a broad

engineering education via a master's degree with a selected emphasis in engineering management. The Iowa/Iowa State program is the only comparable program in the U.S. with a curriculum emphasizing systems engineering and business. The MIT, Michigan and Cal Poly programs emphasize manufacturing management in the engineering curriculum.

The benchmarking work has shown that our SELP program has the following unique attributes: (1) dual-masters' degrees in systems engineering and business, (2) part-time, evening classes, to serve working students, (3) flexibility of core classes being part of ongoing university academic programs in both engineering and business, (4) leadership, lean/affordability, and ethics skills development integrated throughout the curriculum. While there are 35 U.S. universities offering programs in systems engineering and an additional 31 offering systems engineering as a combined technical major [10], very few have integrated a business-content into their program. In Southern California, there are no programs integrating systems engineering and business into graduate degree programs.

Several common characteristics have emerged from benchmarking the four successful dual-degree programs (**Table I**): (1) close collaboration with industry in understanding and serving its needs, (2) university intradisciplinary cooperation, strongly encouraged by the Deans of the participating colleges, (3) faculty jointly working to integrate the curriculum and class content, (4) co-directors representing both engineering and business, and (5) having an industry advisory board. The LMU program incorporates all five characteristics as described in the following sections.

III. Planning New Program

In planning the SELP, LMU has considered the following:

- Admission requirements
- Existing accreditation requirements
- Class scheduling
- Industry Advisory Board

Students in the SELP must be admitted to and meet the requirements for both the engineering and business colleges. All students must have a bachelor's degree in science or engineering from an ABET [11] accredited program. Admission will be based on appropriate work experience of at least three years and three letters of recommendation. The MBA program requires the GMAT for admission. An approach will be implemented to coordinate the admissions process between the colleges and give the applicants one point of contact that covers both colleges.

The SELP students will be expected to meet the course requirements in the existing, accredited MBA program [12]. The SELP will coordinate the MBA courses to match the simultaneous engineering coursework. Some MBA courses will need modification to include interdisciplinary material, but no new MBA courses are needed to meet the constituents' goals. Graduate engineering programs do not have to meet any accreditation requirements.

To meet the needs of working industry employees, the SELP program will be part time with evening courses for student convenience – a practice consistent with the meeting times of the current MBA and graduate engineering classes.

An Industry Advisory Board will be formed for the SELP to assure meeting industry's needs at the program's outset and as it evolves in the years to come. The Board will maintain strong industry collaboration and will assist in recruiting students, part-time instructors, guest speakers and class projects. The Board will also help in assessing the effectiveness of the program.

IV. Curriculum

The curriculum was developed based on an infrastructure of outcomes assessment as defined by ABET [11]. Our methodology was the same as that utilized in the assessment of LMU's undergraduate mechanical engineering program [13]. To develop the curriculum, the needs of industry and the Air Force in Southern California were surveyed. The needs of our other constituents (students, faculty, and LMU) were added. The needs were determined by interviewing different constituents and asking the question: "What are the most important attributes for a masters' degree in systems engineering?" After all of the needs were collected, the list was grouped into ten items of constituents' needs (shown in **Table II**). Then the needs were grouped into three general categories that could be identified by educational objectives. Hence, this process linked the constituents' needs with our three educational objectives - the capabilities that graduates were expected to have during the first few years after graduation [14] (**Table II**).

The program outcomes were established such that they linked to the previously established educational objectives. These outcomes were consistent with the qualities of systems engineers [15] and were equivalent to ABET's program requirements [11].

The requirements of the proposed LMU program are entirely consistent with those of the comparable dual-degree programs in **Table I**. The program outcomes were unique to LMU and generally were similar to those of the Iowa/Iowa State dual-degree program.

To develop the curriculum of the SELP, we started with the educational objectives (**Table II**) and established a set of courses that would both fulfill the objectives and meet the MS and MBA degree requirements. In addition, it must be possible to complete the two degrees in about 3 years to meet the needs of industry.

Table II. Linking of Constituents' Needs to Educational Objectives & Program Outcomes.

Constituents' Needs	Educational Objectives	Program Outcomes
i. Integration	1. Ability to professionally integrate systems engineering, business and management	a. Systems & project mgt.
ii. Engineering, business, mgt.		b. Supply chain management
iii. Quality, cost & scheduling		c. Interdisciplinary teams
		d. Affordable products
iv. Systems thinking	2. Capability in creative problem solving for developing new & existing products	e. Systems architecture/design
v. Lean methods		f. Lean & reliable processes
vi. Innovation		g. Producibility, maintenance
vii. Career enhancement	3. Ability to lead teams, communicate and implement a vision	h. Leadership
viii. Customer-focus		i. Requirements development
ix. Communication		j. Ethical and legal issues
x. Teambuilding		k. Human factors

Table III presents the 22 courses (the Integrative Project being a two-semester course), equivalent to 66 semester-units, satisfying these criteria. In order to complete the two degrees in a reasonable time, the MBA program agreed, as a major area of emphasis, to give credit for several of the engineering courses (**Table III**).

Table III. Educational Objectives vs. Suggested Courses.

Educational Objectives	Suggested Courses																					
	Engineering												Business									
	Quality Systems*	Statistics*	New Product Dev.	Systems Engin.*	Systems Mgt.*	Lean Systems*	Ops. Analysis*	Engin. Economy*^	Project Mgt.*	Adv. Project Mgt.*	Asv. Syst Engin.*	Integr. Project*^	Bus. Law & Ethics	Mgt. Accounting	Bus. Economics	Org. Behavior	Marketing Mgt.	Financial Mgt.	Mgt. Info. Systems	Mgt. Strategies	Electives	
1. Integration			√	√	√				√	√	√	√	√	√	√	√	√	√	√	√	√	
2. Creative sol'ns.	√	√	√	√	√	√	√	√	√	√	√	√	√	√			√	√			√	
3. Leadership			√	√	√				√	√	√	√				√		√				
* MBA (dual-degree) credit ^ New course (to be added)																						

Based on the example of LMU's existing MBA/JD dual-degree program [16], the MBA program will accept for credit several engineering courses having significant financial, economics, management, business and/or marketing content. In a like manner, the engineering program will accept for credit some MBA courses having an emphasis in statistics, operations and/or project management. Of the 22 courses required for the two degrees (**Table III**), eight courses plus the integrative project will receive credit toward both degrees.

In developing the SELP curriculum, we leveraged our previous collaboration between the engineering and business colleges in its Engineering and Production Management (EAPM) program [17], which grants a master's degree and emphasizes manufacturing management. Several EAPM courses, e.g., Quality Systems, New Product Development and Systems Engineering, will support the SELP curriculum with little or no modification. Other courses will have to be modified in order to meet the outcomes of the program.

Our SELP program will use both full-time and part-time faculty to teach the dual-degree curriculum. The dual-degree courses are part of the ongoing business or engineering graduate programs and are assembled in a manner that provides the desired dual-degree content.

Our SELP program will emphasize the following unique program outcomes (in **Table II**) as strengths: leadership, lean/affordability thinking, and ethics. These outcomes will be integrated throughout the curriculum. The strong ethics component [18] is a unique feature of our program.

V. Conclusions

LMU has developed a Systems Engineering Leadership Program. It offers dual degrees: MS in Systems Engineering and MBA. Prior to establishing this program, the SELP was benchmarked against four other dual-degree programs at universities across the nation. There is only one program in the U.S. directly comparable to our program. The SELP program consists of 22 courses (66 semester units) that can be completed in 3 years. The SELP is a part-time (evening) program for full-time working professionals. The curriculum was designed around the needs of our constituents – industry, government, students, faculty and university. An Industry Advisory Board will assure that the 'voice of the constituents' is heard in order to guide and assess the program. Our educational objectives and program outcomes have been established so that the course content can be constructed and the effectiveness of the program evaluated. The key outcomes are leadership, systems thinking, lean/affordability and ethics, and these will be emphasized and integrated throughout the curriculum. The curriculum will blend both systems engineering and business into its courses.

The SELP will attract students who are entering or headed for leadership positions in their organizations. There is an increasing and unfulfilled need for graduates with a knowledge of both systems engineering and business. Our graduates will have expanded career options open to them within their institutions.

Acknowledgements

*“Proceedings of the 2003 American Society for Engineering Education Annual Conference & Exposition
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The authors acknowledge the support of TRW Inc., the TRW Foundation, and Loyola Marymount University for funding for the work described here.

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