AC 2007-2283: MIGRATION FROM A LEADERSHIP HONORS PROGRAM TO AN ENGINEERING LEADERSHIP MINOR

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Migration from a Leadership Honors Program to an Engineering Leadership Minor

Abstract

This paper presents a new Engineering Leadership Minor developed for all engineering majors at Lehigh University. This minor program utilizes the experience of engineering faculty, liberal arts faculty, and alumni who have achieved positions of leadership. The evolution from an existing leadership honors program in a specific major (Information and Systems Engineering (I&SE)) to a more general leadership minor is discussed. The original program was limited to students in the I&SE major with a high GPA and was taught in a one-credit seminar format. The curriculum involved both leadership aspects and major-related projects in a hands-on environment. The new program is broader in scope, including courses from arts and humanities and engineering, and is open to all engineers. It includes application of leadership principles through team-based projects at local companies and provides better economy of scale for faculty. At the same time, it provides many more students with an opportunity for leadership training.

Leadership Honors Program

The Information and Systems Engineering Leadership Program (ISELP)[1] was an honors program developed for students in the Information and Systems Engineering degree program. The motivation for the program came from alumni in leadership positions advocating that a formal leadership program would provide theory and practice in leadership and better prepare students for leadership roles in their careers. ISELP was developed at the same time as the I&SE degree with the intention of attracting highly qualified students to the university and providing them with a broader education than the typical engineering student. ISELP began in 2002 and is presently being phased out as students in the program graduate. Students were accepted into the program at two different times: prior to freshman year or at the beginning of sophomore year. Since Lehigh University has a common freshman year, students entering at the beginning of freshman year could not register for specific leadership courses. Instead, they attended an evening workshop each semester about basic leadership skills and program requirements and were invited to participate in other extracurricular activities.

During the sophomore, junior, and senior years, students registered for a one-credit seminar course. Because it was an honors program, these seminars were above the normal load and did not count towards the I&SE degree. In addition the students attended evening workshops and participated in other aspects of the program[1]. Other key features of ISELP included:

- **Instruction in leadership theory and leadership skill development.** ISELP students begin learning about foundational leadership theories and developing specific skills as first year students. A series of workshops are conducted throughout the program. Examples of workshop topics include leadership styles, leadership skills assessments, effective communication and problem solving skills. Students practice their leadership skills by assisting with workshops offered to new students who join the program.
- **Use of leadership assessment tools.** ISELP students learn to assess leadership styles using various assessment tools. They first assess their own leadership practices as well as

their skill strengths and weaknesses. Later, as they gain experience, they assess the leadership practices of their peers and provide feedback for improvement. They formulate a plan to improve their own leadership skills and meet individually with their industry and faculty mentors to critique and improve according to their plan. Later in the program, they assess the success and/or progress of their plan.

- **Individual interaction with industrial and faculty mentors.** Throughout the four years, ISELP students interact closely with a team of mentors consisting of faculty, industry experts, and research engineers. Close interaction with mentors and industrial projects in systems engineering and information technology ensures that the students can apply what they learn in the classroom to real-world problems. Mentors also help students assess their leadership capabilities and plan activities to improve their leadership skills.

- **Preparation and presentation of case problems.** Students interact with each other and industry experts to solve industry problems. This prepares them for life in the workplace. They develop case problems based on their industrial experiences. Finally, they present the case problems to the classes below them. This allows them to sharpen their leadership skills as they direct student teams, lead discussions, and assist with problem solving sessions.

- **Networking with industry partners, faculty, and peers.** ISELP students have the opportunity to network with industry partners, faculty, and other ISELP students at social mixers and program sponsored seminars. Students are invited to ESC open houses to talk to potential project sponsors and employers about their projects and experiences. Students also have the opportunity to meet with and recruit perspective students interested in the program.

- **Use of Enterprise System Center (ESC) Collaboratory and meeting facilities.** ISELP students have access to the ESC's newly renovated facility. ESC is a center at Lehigh University committed to enriching students' education while working to make its clients in industry more efficient and increasingly competitive. Students have access to meeting space, computers, and the Collaboratory. The Collaboratory provides distance learning and virtual meeting systems for students to discuss projects with industry partners who remain at their site. Industry seminar speakers address the class face-to-face or virtually in the ESCs Collaboratory.

- **Opportunity to practice skills in projects, seminars and classes.** The students progress in leadership roles until as seniors they are leading projects teams of underclass students. Since the program is an honors program, not all students have access to the program. Students not in the program also have the desire to enhance their leadership skills. Therefore, students in the ISELP assist with leadership seminars and classes for other students in the Department of Industrial and Systems Engineering.

Experience with the Honors Program

Students who completed the ISELP were highly satisfied with their experience as determined via anonymous evaluation forms and informal interactions. They formed a cohesive group and helped each other in their other classes and with problems on their jobs. They learned about leadership styles and practiced what they learned on teams in other courses and on internships. They formed close relationships with mentors and faculty. However, after 5 years of experience with the ISELP it became apparent that there were ways the program could be improved.

First and foremost, since the program was linked to the I&SE degree, the pool of applicants was not as large as planned. Downturns in computer related industries fueled a reduction in enrollments in the I&SE degree. This reduced the number of students in the selection pool. Originally, it was hoped that ISELP would attract highly qualified freshmen to the university. While there were many inquiries about the program, students viewed application to the ISELP as a commitment to majoring in I&SE. There was some truth in this view. Students were required to remain in the I&SE degree program if they were to continue participation in ISELP; however, they could remain in I&SE even if they chose to withdraw from ISELP. Some students expressed interest in joining ISELP but were deterred when they learned that the program was only for I&SE majors.

Second, because ISELP was an honors program, a large number of students who could benefit from leadership training were ineligible because of their GPA. Historical data showed that students in the middle of the class tended to do quite well years after graduation, often advancing into positions of leadership. These data were gathered from alumni interaction, alumni surveys, and alumni association contacts. This particular group of students would have significantly benefited from formal leadership training and experience.

Third, the one-credit seminars provided students less structured time than was needed to practice their leadership skills. Workshops and seminars could teach skills. However, more time was needed to practice what they learned.

Finally, the one credit seminars did not allow sufficient contact hours to meet the other goals of the program. Preparation of case studies and presentation to younger students took a significant amount of time. The cycle of developing a case study in the junior year and presenting it to sophomores during the senior year did not provide a good avenue for leadership practice. Too much time was spent on the problem development and not enough on leadership.

Leadership Programs at Major Universities

A review was conducted of leadership programs at major universities to determine alternative structures. Table 1 shows a summary of the programs based on the web pages for each program[2]. Programs were analyzed to determine common themes. The last column in Table 1c lists the number of programs in which a theme appears. The themes are ordered according to the frequency of appearance in all the programs.

Programs have various mixtures of core and elective courses. Some require projects, retreats, or community service. Credit requirements range from 10 to 32 credits with 15-18 credits being the most common. Only three programs require a minimum GPA. Finally, a summary of broad themes is listed for each program. A discussion of how Lehigh University's Engineering Leadership Minor compares to the other programs is included in the next section.

The themes in Table 1 were determined by analyzing the focus of the programs. The lack of a bullet in a cell does not mean that the theme is not covered somewhere in the program. Instead, it means that it was not objective or feature of the program as listed in the literature. The most

common theme was the **Study of Leadership Theories**, which was listed as a theme in 12 programs. **Leadership in Organizations/ Applications of Leadership** was listed in 9 programs. **Development of Leadership Skills** and **Observation/Participation in a Leadership Setting** were listed in 9 programs. An **ethics course** was required by 7 programs. A **Leadership Project, Personal Leadership/Goal Setting,** and **Communications in Leadership** were listed in 4 programs. The remaining themes were listed in 3 or less programs

Development of the Engineering Leadership Minor

For all of the previously stated reasons, ISELP was evaluated to improve its deficiencies. Input was solicited from alumni in leadership positions in local and international companies, employers of students, the department advisory board and other university staff and programs. For example, senior executives from IBM Business Consulting Services; FMI, a company that bottles many household products; and the Lehigh University Class of '74 Officers, who have maintained a close relationship with the ISE department and are in leadership positions for their class and companies. These groups have visited campus for multiple work sessions related to this program. They have provided guidance and advice on the structure and content of this program. In addition, they have indicated an interest in ongoing participation by their executives and consultants in various capacities to provide content to the program and real world connectivity. From these discussions, the following competencies emerged as objectives for the leadership minor:

- Dealing with ambiguity
  - Decision making when outcomes are uncertain
  - How to apply data / tools to solve unstructured problems
- Knowledge of self and others (including understanding your customer)
- Teamwork
- Verbal and written communication skills
- Leading change – sponsoring / participating in change
- Mentoring/coaching
- Breakthrough thinking
- Customer insight
- Ethics / morals
- Diversity / globalization
- Core values
- Storytelling (retention of key details)
- Use of technology

Lehigh University recognized the importance of student leadership about the time ISELP was started and created a position of Assistant Dean of Students with an Office of Student Leadership Development. This Assistant Dean was responsible to create, coordinate and monitor leadership activities on campus, primarily outside the classroom. The Assistant Dean was asked to participate in the development of the minor, and in particular, a new course about leadership development. This course was developed and taught 3 times to gage student interest in the topic of leadership and gather feedback about the format of topics covered. This new core course was developed and piloted several times in parallel and separate to the ISELP seminars. In its current form, it is a 3-credit course called Leadership Development. The development of this leadership

course and minor was unique at Lehigh University as it was the first time the Assistant Dean of Students assisted with the development and delivery of an academic course on a reoccurring basis. In the pilot offerings the Assistant Dean assumed a large portion of the lecture responsibility and workshop coordination. She intends to continue this role in future offerings. Her participation in the development of the minor and team teaching of a core course required the removal of longstanding barriers at Lehigh University.

Features of the Engineering Leadership Minor

By combining the best practices of other universities with experience from the ISELP and the Leadership Development pilot course, the Engineering Leadership Minor was developed. Existing courses were used wherever possible to reduce the requirement for new resources. At Lehigh University a minor is usually 15-16 credits, requiring 4 or 5 courses. Furthermore, engineering curricula tend to have fewer electives than other majors (6 credits of free electives for most engineering programs), so it was decided to make the minor 5 courses, resulting in a total of 15 or 16 credit hours. Lehigh University also has a rule that only one course in a minor can be required course in the major. This limited the use of common required courses for all engineering students. As many elective courses in the major as needed, such as technical electives or humanities electives can be applied towards a minor. By using existing courses that were not required, but counted towards other degree requirements, engineering students would minimize the use of their scarce free elective credits. Note that the minor is open to all students at Lehigh University who meets the prerequisite of Calculus 1 and a calculus-based course in probability. However, it was developed with the engineering student in mind.

The minor in leadership provides students with the background and practice to become more effective leaders. The minor consists of 5 courses that explore different competencies of leadership:
1. An ethics elective provides a basic framework for the understanding of ethical human interaction and behavior. While engineers study ethics in engineering courses, many of the courses on this list are from the College of Arts and Sciences. The main reason for using courses from the College of Arts and Sciences is that they will satisfy the Humanities and Social Science electives for engineers.
2. IE 226 (Engineering Economy and Decision Analysis) or CEE 202 (CEE Planning and Engineering Economics) provides quantitative decision making skills and the exploration of uncertainty.
3. IE 334 (Organizational Planning and Control) provides an understanding of how business organizations function, both effectively and ineffectively.
4. IE 382 (Leadership Development) provides a background in a range of topics that pertain to leadership skills.
5. IE 281 (Leadership Project) provides an opportunity to use the skills learned throughout the program in a team-based, industrial/community service project.

In an engineering curriculum, the ethics course will also count as an HSS (Humanities or Social Science) Elective. IE 226, IE 281, IE 334, and IE 382 could count as technical electives, depending on the program. Courses that do not count as a technical elective could be classified as a free elective. For example, a student in Industrial Engineering could take the minor and only

use 3 credits of free elective for IE 281. A student in Mechanical Engineering could satisfy the minor by taking an ethics course as an HSS elective, IE 226 and IE 334 would be technical electives, and IE 382 and IE 281 would be free electives.

IE 281 (Leadership Project) will be implemented using resources/projects from the Enterprise Systems Center (ESC). ESC is a center at Lehigh University committed to enriching students' education while working to make its clients in industry more efficient and increasingly competitive. ESC has provided senior projects for IE and I&SE students for many years. The leadership project course will allow them to facilitate interaction between their companies and a broader range of students on projects that might not be acceptable for senior capstone design, but still provide leadership practice and value to the company.

Comparing the themes in the Engineering Leadership Minor to the programs in Table 1, Lehigh University's program contains most of the themes commonly found in other programs. **Study of Leadership Theories** is covered in IE 382. **Leadership in Organizations/ Applications of Leadership** is covered in IE 334, IE 382, and IE 281. **Development of Leadership Skills** is covered in IE 382 and IE 281. **Observation/Participation in a Leadership Setting** is covered in IE 334 and IE 281. An **ethics course is required**. **Leadership Project Requirement** is covered in IE 281. **Personal Leadership/Goal Setting** are covered in IE 382 and IE 281.

Implementation of the Engineering Leadership Minor

Students have expressed a strong desire to participate in the Engineering Leadership Minor. Engineering students who were not I&SE majors and did not have access to the ISELP are excited for the opportunity to learn and practice leadership in a coordinated program. While all courses except IE 281 have been offered for at least 3 years, the Engineering Leadership Minor will officially begin in the fall of 2007. Students are expected to graduate with the minor in Spring of 2008.

Table 1a - Comparison of Leadership Programs at Top National Universities

	Rice University	Vanderbilt University	Tufts University	University of Southern California	University of Illinois, Urbana	Penn State University	University of Florida
Program Areas of Interest							
University's National Ranking*	17	18	27	30	42	48	50
Program Name	Leadership Rice	Minor in Managerial Studies: Leadership and Organization	Minor in Entrepreneurial Leadership	Critical Approaches to Leadership Minor	Minor in Leadership	Engineering Leadership Development Minor	Interdisciplinary Minor in Leadership
Total Credit Hours Required	10-15		15-18	20	16-21	18	15
Credit Hours (Core Courses)	10+		12-15	12		12	6
Credit Hours (Electives)			3-6	8		6	9
Minimum GPA Requirement							●
Minimum Minor GPA Requirement							●
Common Themes							
Study of Leadership Theories	●	●			●	●	
Leadership in Organizations/ Applications of Leadership		●			●	●	●
Development of Leadership Skills	●		●		●		●
Observation/Participation in a Leadership Setting							
Ethics Course Required	●						●
Leadership Project Requirement	●		●			●	
Personal Leadership/Goal Setting							
Communications in Leadership	●						●
Study of Leadership Behavior Across Cultures/World Leadership							
Business Planning/ Entrepreneurial Leadership	●		●			●	
Community Service Requirement							
Social Responsibility							
Self Assessments							
Retreat Required							

*National Ranking based on US News and World Report's Best Colleges 2006, Listings to 120

Table 1b - Comparison of Leadership Programs at Top National Universities

	Northwestern University	Worcester Polytechnic Institute	University of Miami	University of Delaware	University of Minnesota	Indiana University	Virginia Tech
Program Areas of Interest							
University's National Ranking*		53	55	66	74	74	78
Program Name		Organizational Leadership Minor	Leadership Minor	Minor in Leadership	Leadership Minor	Leadership Minor	Business Leadership Minor
Total Credit Hours Required			15-18	18	16	15	18
Credit Hours (Core Courses)			9	9	11	8	9
Credit Hours (Electives)			3-9	9	5	7	6+3 (activity)
Minimum GPA Requirement							
Minimum Minor GPA Requirement							
Common Themes							
Study of Leadership Theories			●	●		●	●
Leadership in Organizations/ Applications of Leadership	●			●		●	●
Development of Leadership Skills			●	●			
Observation/Participation in a Leadership Setting	●				●	●	●
Ethics Course Required			●				●
Leadership Project Requirement	●						
Personal Leadership/Goal Setting			●		●	●	
Communications in Leadership							
Study of Leadership Behavior Across Cultures/World Leadership		●			●		
Business Planning/ Entrepreneurial Leadership							
Community Service Requirement					●		
Social Responsibility				●			●
Self Assessments	●		●				
Retreat Required	●						

*National Ranking based on US News and World Report's Best Colleges 2006, Listings to 120

Table 1c - Comparison of Leadership Programs at Top National Universities

	University of Missouri	University of Kansas	Northeastern University	Washington State University	Central Michigan University	Kansas State University	Total Occurrences
Program Areas of Interest							
University's National Ranking*	85	97	115	120	not ranked	not ranked	
Program Name	Minor in Leadership and Public Service	Leadership Studies Minor	Leadership Studies Minor	Leadership Minor	Leadership Minor	Interdisciplinary Minor in Leadership Studies	
Total Credit Hours Required	15	19 +	32	18	24-27	18	
Credit Hours (Core Courses)	9	10	16	9	12-15	9	
Credit Hours (Electives)	6	9	16	9	12	9	
Minimum GPA Requirement	●			●			
Minimum Minor GPA Requirement				●			
Common Themes							
Study of Leadership Theories		●	●		●	●	12
Leadership in Organizations/ Applications of Leadership					●		9
Development of Leadership Skills		●				●	8
Observation/Participation in a Leadership Setting	●	●	●			●	8
Ethics Course Required		●	●			●	7
Leadership Project Requirement							4
Personal Leadership/Goal Setting	●						4
Communications in Leadership		●			●		4
Study of Leadership Behavior Across Cultures/World Leadership						●	3
Business Planning/ Entrepreneurial Leadership							3
Community Service Requirement	●	●					3
Social Responsibility							2
Self Assessments							2
Retreat Required							1

*National Ranking based on US News and World Report's Best Colleges 2006, Listings to 120

Bibliography

1.   Tonkay, G.L., Zimmers, E.W., and Williams, A.N., "Information and Systems Engineering Leadership Program (ISELP): A New Honors Program Concept at Lehigh University," *Proceedings of the 2004 American Society for Engineering Education Annual Conference & Exposition*, American Society for Engineering Education, 2004.
2.   Data for Table 1 was obtained from the web pages of the individual universities.