

The Engineering Leadership Program: *A co-curricular learning environment by and for students*

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Introduction

In recent years, there is a growing recognition among educators of the imperative to educate engineering students in life and leadership skills that complement technical competence, to prepare them adequately for the current global workplace. This was a theme that emerged from the 2005 Symposium at Tufts University on engineering education in the 21st century, had already been articulated in *The Balanced Engineer: Entering the New Millennium*, and one that is emphasized in the National Academy of Engineering's *Engineer of 2020* report.^{1,2,3}

The College of Engineering at Iowa State University created the Engineering Leadership Program (ELP) based on the "Engineer of 2020"¹ vision articulated by the National Academy of Engineering which emphasizes the civic responsibility of engineers. It is a four year pilot program for a values-based learning community of engineering students committed to making a difference in the world. The program goal is to create an environment where future leaders can develop and engage in public life making social contributions above and beyond their traditional engineering roles⁴. Started in Fall 2006, within three years there is already some evidence that enabling students to practice leadership and altruism during college is an effective way to develop those students as leaders of tomorrow. This paper describes the ELP experience at Iowa State, beginning with an overview of the program, some highlights about its implementation, its successes thus far, and some future goals.

Program Overview

The ELP at Iowa State University is a 4-year program which supports the leadership development of engineering students by adding meaningful co-curricular learning opportunities to their classroom experience. Student leadership in program development and implementation is a key element of the program.⁵ Students have been at the leading edge of program design and implementation from the very begin-

ning and proved extremely worthy of the challenge to design, implement, assess and modify program elements iteratively through a participatory process with peers and educators. The program uses a leadership model to guide the scholars in their development. The leadership Model is described in the Program Highlights section of the paper. Individual leadership development after the first year is tracked using a personalized electronic portfolio system⁶. Reflection and self-awareness are emphasized as crucial to leadership development. This is described in greater detail in the section **Individualized development plans for scholars**. The program is divided into two main phases: year 1 and years 2+. The following sections will address how the scholars are chosen, followed by descriptions of the two phases of the program.

Scholar Selection

Potential ELP scholars apply directly to the program expressing their motivation and readiness to engage. The selection is by a committee through blind evaluation of the applicant portfolios that include academic excellence, extracurricular activities, leadership experiences, and passion for leadership development as demonstrated by their written responses to a series of questions. The number of applicants each year has been about 150 from which 15-17 students are selected. The selection committee includes individuals from the following categories: students, staff, faculty, alumni and professionals from the corporate world. Every year, an ELP scholar team leads the process and assumes responsibility for maintaining timeliness and integrity. The current seventy plus ELP scholars are distributed across all majors in engineering and over 40 per cent of them are women.

Year 1

The first year is devoted to creating a sense of community and shared purpose through a series of structured activities: a teambuilding retreat at an off-campus venue, a weekly credit bearing seminar that exposes scholars to top-

Abstract

This article describes the Engineering Leadership Program at Iowa State University, a pilot educational program for leadership development of undergraduate engineering students, designed and built with student ownership and leadership. A client focused leadership model, articulated through an iterative year long group exercise, with anticipated learning outcomes, and competencies that help students achieve them, guides program activities and individual leadership development plans of the students. As the pilot phase nears completion, efforts are underway to create an effective strategy for assessing learning outcomes while maintaining the opportunity for individualized leadership development pathways. Discussions are also ongoing about integrating components of the ELP into the curriculum, to have broader student impact.

ics such as leadership theory, practical tips for leadership development, effective communication, and ethics. Scholars are required to submit a reflection journal every week which are reviewed and discussed one-on-one with an upper class teaching assistant. They are paired with a peer and faculty mentor. Scholars have a common reading project and book discussion. They are required to participate in monthly networking events, and, during the second semester, they participate in a service learning project selected by the group from ideas submitted by the members.

Years 2+

The primary focus of a scholar after the first year is to identify and envision a long term leadership learning project to work on for the remainder of their time on campus and beyond. It is designed by the scholars to fit their personal passions and learning goals, with attention to the key values of altruism and community impact.

Leadership learning experiences/projects allow scholars to:

1. Gain in-depth expertise in an area of interest to the scholar within the context of leadership
2. Make a substantial contribution to an area of professional and/or personal interest
3. Develop and enhance the competencies outlined in the ELP leadership model.

Scholars submit their project ideas in a proposal format in response to a formal request for proposals, which are reviewed by a team that includes program leadership as well as external reviewers. The first round of proposals contained ideas ranging from improving communications skills of engineering students on campus, infusing a sustainability focus in the engineering curriculum, to addressing the global issues of water safety, conservation and access. Scholars are challenged to work through issues of succession planning for project leadership and long term sustainability of the projects.

In addition to the project, scholars track their personal leadership development through an electronic portfolio system⁶. They continue to engage in some peer led community activities such as common readings and seminars and reflections, as well as annual off-campus retreats that help them to stay connected.

Scholars are also encouraged to seek out exceptional leadership learning opportunities. In the past scholars have presented with a fac-

ulty member at an *Engineers for a Sustainable World* conference, presented at the *Frontiers in Education Conference*, and participated in an appropriate technology class-which included designing and implementing projects in a Malian village.

Program Highlights

The ELP has been a successful pilot program for leadership education for engineers during its existence thus far, based on preliminary data that includes scholar feedback, level of student engagement, and career pursuits. The individuals involved believe that this success can be largely attributed to three key aspects of the program:

1. Competency based leadership model
2. Strong student leadership
3. Individualized leadership development plans for scholars

The following subsections will address each of these points in more detail.

Leadership Model

The ELP is guided by a Leadership Model that was developed through an iterative group process involving students, staff and faculty from the college and university. The leadership model provides guidelines for scholar development through a set of learning outcomes aligned with ABET⁷, and articulates supporting competencies and key actions⁸ on which scholars can base their leadership portfolios⁶. The program chose this approach due to the success of academic programs at Iowa State University in using competency based student portfolios to assess learning and program outcomes⁹.

The eight learning outcomes of the Leadership Model include five ABET outcomes, and an additional three that the group identified as critical to leadership

The learning outcomes identified in the model are:

1. An ability to function on interdisciplinary teams
2. An understanding of professional and ethical responsibility
3. An ability to communicate effectively
4. The broad education necessary to understand the impact of engineering solutions is a global and societal context
5. A recognition of the need for, and the ability to engage in, life-long learning
6. An ability to create a vision, articulate it,

and inspire others to share and implement it

7. An ability to effectively influence and innovate to deliver results
8. Recognition of the need for actively encouraging diversity and creating an inclusive environment

In order to achieve these learning outcomes, students have to develop a set of 19 competencies that are grouped into four categories as shown in the table below:

Strong student leadership

From its inception, the ELP has always had a strong student voice in its leadership team. The student leadership team has ownership of program design and implementation as well as future vision and program sustainability. This has resulted in a sometimes imperfect, but very flexible and exciting program. The ongoing challenges of effective teamwork, peer accountability, community building and communication continue to provide the context for hands-on, in-depth leadership learning. The high level of scholar engagement and ownership, coupled with, and possibly motivating academic achievement, validates the student driven approach of the ELP.

Individualized development plans for scholars

Scholars have significant control of their own development after the first year in the program. The leadership model competencies guide them in developing their individual leadership learning portfolios that they maintain on-line as they progress through years 2-4 in the program. Scholars track their learning and

development through

1. listing activities such as courses, research activities, conference participation, extracurricular activities which are relevant to their personal development goals
2. uploading evidence to validate their competency development, and
3. writing reflections to demonstrate/validate their progress in specific competencies.

The portfolios are reviewed by peer scholars and by faculty and external reviewers. Discussions are under way to design a consistent set of criteria that allows tracking of leadership development without being overly burdensome on the scholars and the reviewers. The most important goal is to empower scholars with the flexibility to design a personally meaningful and relevant leadership development process tied to their passions.

Program Outcomes

The ELP measures its effectiveness in two ways: the impact it is making on the university as a whole as well as the impact on its scholars. The following sections will describe those impacts.

Curricular Impact

The ELP has been working with various departments and colleges on campus to seek out and support existing and new courses and programs that align with the program's goals. Such courses, so far, include *Voices of Public Policy, Science, Technology and Public Policy*, and, *Ethical Responsibilities of a Practicing En-*

Leadership Characteristics	Engaging Others
Initiative Integrity Analysis and Judgment Communication Energy and Drive	Building a Successful Team Developing Others Coaching Teamwork Leading Through Vision and Values
Awareness and Growth	Demonstrating Excellence
Engineering Knowledge General Knowledge Cultural Adaptability Continuous Learning	Quality Orientation Customer Focus Innovation Professional Impact Planning

Table 1.

gineer. The ELP is partnering with the department of political science on creating a formal policy certificate for students in science and engineering. The ELP is also working with another new certificate program on campus titled Community Leadership and Public Service. The College of Business at the university is piloting a similar program for select undergraduates in their college.

Scholar Impact

The ELP determines scholar impact through two primary methods. One is obtaining feedback from and assessing the scholars and the second is in observing what students who participate in the program do in college and beyond.

At the current time, program feedback is collected through surveys throughout the academic year, and end of the year focus groups, conducted by evaluators external to ELP. In addition, cohort representatives collect feedback from their peers and share that with the administrative leadership. The ELP leadership team also invites individual scholars to share their concerns and ideas with them through office hours and regular brainstorming meetings. In addition, there is ongoing discussion at the current time among students and educators to come up with a way to measure learning outcomes from this co-curricular ELP model, without placing excessive burden on the scholars or reviewers.

While the program is still in its developmental stage, the ELP scholars and recent graduates already appear to be distinguishing themselves in terms of their initiative and community awareness. One scholar, at the end of just one year on campus, traveled to a village in Mali Africa, as a member of an Appropriate Technology Design class. The following year, four ELP scholars were among the 9 selected for the class via a rigorous process of application, recommendations and interviews. A recent graduate is working for the Peace Corps in Nicaragua. Two recent graduates have teamed up in creating a new organization, EOS International: Emerging Opportunities for Sustainability, focused on appropriate technology in the developing world¹⁰. A few recent graduates who are pursuing more traditional careers are also engaged actively in community outreach activities through their employers and are on the fast track for corporate leadership.

Faculty Engagement

At the current time, during the pilot phase,

the most significant faculty engagement includes program leadership from the Associate Dean for Academic and Student Affairs in the College whose academic base is in the department of Electrical and Computer Engineering, the faculty director of the program from Materials Science and Engineering, faculty leaders of the assessment component who happen to be from Agricultural and Biological Engineering, a department that leads the college in using individual student on-line portfolios, and faculty mentors for students spanning all the departments in the college. Faculty participate in scholar selection and review of leadership learning projects. Additionally, students seek out faculty advisors for their leadership learning projects. There is an annual dinner and discussion event where all the department chairs participate with great enthusiasm, and often leads to meaningful career opportunities for scholars. Currently, efforts are underway to invite greater ownership from faculty across the college in the interest of increasing the reach of the program and to ensure sustainability and strategic growth.

Conclusion

The ELP is just entering its final year of the pilot phase. In this time, the program has already generated a great deal of interest and attention from current students, alumni, donors and employers. Returning alumni and donors who meet with the ELP scholars have expressed their interest in seeing the reach of the program extended to a wider clientele, extending the opportunity to greater numbers of students and engaging more faculty within the college. Corporate recruiters have sought out the program based on their interaction with scholars who interviewed with them for internships.

As the program matures, the plan is to move towards a financial need based scholarship model for participants and to strengthen the funding opportunities that support scholars in implementing their leadership learning projects and learning experiences. A recent grant to the College from the National Science Foundation is extending successful program elements to a wider student community, beginning with the network of highly successful learning communities in existence in the college. Working groups that include students, faculty and staff from the college and beyond are being created to design measures for learning outcomes achievements of scholars while maintaining their ability to

personalize their pathways to achieving them. Another effort is underway to increase faculty engagement across the college and identify strategies to integrate successful program elements into the curriculum. Past the pilot phase, there is also the plan to share the model widely across institutions interested in deliberate and focused leadership development of their (engineering) students.

The program has consistently attracted high proportion of underrepresented students. The relatively small sample size of the program would not make for statistically significant data, but can also provide pointers for increasing diversity within engineering through meaningful student engagement opportunities.

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Dr. Krishna Athreya – Program Director

Dr. Athreya was appointed as the director of the Engineering Leadership Program at Iowa State University on March 1st, 2006. As director, Dr. Athreya supervises all program activities, including curriculum development, mentoring, diversity training, and a leadership learning community, as well as corporate and public outreach efforts.

Dr. Athreya is co-founder and current president of Engineers for a Sustainable World, a national non-profit organization with chapters and members at dozens of major research institutions across the U.S.

Engineers for a Sustainable World mobilizes both engineers and engineering students to address the challenges of global poverty and sustainability through education, public outreach, and development work both domestically and internationally.

From 1993 to 2000, Dr. Athreya was coordinator of Iowa State's Program for Women in Science and Engineering. She also served as director of Women's Programs in Engineering from 2000 to 2004 at Cornell University in Ithaca, New York, as well as interim director of Cornell's Minority Programs in Engineering from 2001 to 2003. She is currently serving a second term on the American Association for the Advancement of Science's national Committee on Opportunities in Science.

Dr. Athreya received her Ph D in experimental condensed matter physics from Iowa State University in 1986. She has conducted postdoctoral research at the U.S. Department of Energy's Ames Laboratory and has served as a temporary assistant professor in the Department of Astronomy and Physics at Iowa State.



Mike Kalkhoff – Student Director

Mike is a senior majoring in Chemical Engineering. Mike has been involved in ELP as an associate director, a scholar, and as a peer mentor and looks forward to continuing this involvement as Student Director. In the upcoming year Mike is looking forward to getting more involved with Engineers Without Borders where he serves as Director of Fundraising and the Project lead of the Health/Medical Team. This involvement ties directly to his leadership learning project which focuses on improving health care in the developing world. Mike plans on continuing to participate in many intramural sports as well as working at the local hospital. After completing his undergraduate degree in May 2010, Mike plans on going to medical school.

