

# Cooperative Education as an Undergraduate Feeder into a Graduate Level Engineering Leadership Program

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**Abstract - The Bernard M. Gordon Center for Subsurface Sensing and Imaging Systems is a multi-university National Science Foundation Engineering Research Center founded in 2000. Its mission is to develop new technologies to detect hidden objects and to use those technologies to meet real world subsurface challenges in areas as diverse as noninvasive breast cancer detection and underground pollution assessment. Part of its mandate is to create the graduate level Gordon Engineering Leadership Program at Northeastern University. This program will train graduates, called Gordon Fellows, who will constitute a cadre of technology drivers adept at envisioning new engineering products and skilled at leading multidisciplinary teams to bring their ideas to market.**

**This paper will discuss the undergraduate feeder program, how it is organized, the student selection criteria, and the way that cooperative education work assignments will be chosen and assessed to foster students with appropriate abilities and interests to become Gordon Fellows.**

*Index Terms* – cooperative education, leadership

## Overview

The Gordon Engineering Leadership Program at Northeastern University is an intensive one-year graduate program that educates participants in the essential skills and knowledge required for them to assume leading roles in technical projects or programs. While it is open to students from any engineering or technical background who qualify and have the necessary interest, a natural progression from undergraduate engineering into the Gordon Leadership Program is obvious. A feeder program to allow undergraduate students to understand and pursue eventual acceptance into it will provide a stream of qualified applicants. By incorporating undergraduate participation into the project requirement of the graduate program, the need for additional help in bringing projects to completion will be met. The graduate students will provide leadership of

undergraduate students and thereby meet one of the program criteria.

Since undergraduate engineering students have a variety of options for course selection, and in the case of Northeastern University, of cooperative education experiences, a well developed “feeder” program is required to identify and inform potential student participants. This will ensure that student “share of mind” is gained among those who might be interested and suited to the graduate study of the Gordon Leadership Program.

The academic program of the Gordon Leadership Program is deliberately multi-disciplinary and emphasizes scientific fundamentals. Undergraduate academic programs are constrained by the need to include a variety of technical and non-technical subjects to meet University and accreditation requirements. However, each student has a number of choices for technical and non-technical elective courses. A selection of courses appropriate to the eventual transition of the student to the graduate Gordon program is available for discussion with students who are identified as potential participants.

Experiential education is a natural component of any course of study that emphasizes real-world technical leadership. The cooperative education program at Northeastern University provides each engineering student three, six-month opportunities for work in a wide variety of technical areas.[1] Those job opportunities that can be identified as having potential for project focus and that will expose the co-op student to project issues and experiences will be flagged as suitable for future Gordon Fellows.

Students who are suitable for and interested in the Gordon Leadership Program are best identified early. It is unrealistic to expect a student in the early years of their college program to be willing to commit to a program of graduate study with a specific emphasis such as the Gordon program, so the emphasis is on education about the program and the opportunity that it presents. For students who are interested enough to consider it, each step in the direction of eventual application to the program is also a step that provides an excellent educational opportunity by itself. Academic courses and cooperative education assignments

are useful and fulfilling no matter what eventual decision the student makes about the Gordon program.

### **The Gordon Engineering Leadership Program at Northeastern University [2]**

The Gordon Program is modeled on the internship training of military leaders [3] and medical personnel [4], two professions that have successfully applied mentored intensive study to the education of their leaders.

The “Challenge Project” is a principal focus of the Gordon Program. The project must meet the dual criteria of being technically feasible and of having market potential; a “real-world” exercise that allows the student to demonstrate the ability to choose, specify, and lead the development of a useful product through all stages from concept to manufacturing-ready. Motivating and leading others to accomplish this goal is necessary, in fact, is one of the principal purposes of the project. This is where a cadre of talented undergraduate participants becomes essential to the success of each graduate student. Participation by undergraduates in the projects of the graduate student is on a voluntary basis, as an undergraduate research opportunity, or as a for-credit directed study, depending on the student’s schedule and other commitments.

Mentoring is a key element of the Gordon Program as well. Each graduate student will be teamed with an experienced project leader with significant industrial experience. In turn, the undergraduate team for each project will benefit from the mentoring of the project leader and indirectly from his or her mentor.

### **Undergraduate Engineering Program**

Cooperative Education is the framework for all engineering undergraduate education at Northeastern University. Beginning with the sophomore year, each student spends six months of each calendar year in classes and six months in a job related to their major. In the five years of undergraduate work, each student has three co-op work terms. In the most desirable case, each work term assignment provides incremental increases in technical challenge and personal responsibility for the student. Full time faculty advisors work with employers to identify jobs that meet the company’s needs and challenge and develop the students. Virtually all of the engineering students in the school participate in cooperative education. Courses are offered, in the case of required and popular elective courses, twice a year so each student sees an identical curriculum. Available job opportunities range from the power generation and distribution industry to medical and biomedical electronics to software at various levels to research in university or industrial laboratories. There are even Northeastern students employed at other universities in research, applied research, and computer infrastructure support. Numerous examples of cooperative education work assignments that incorporate leadership and project opportunities are included in the total number and scope of assignments. Cooperative education faculty members match job opportunities to student skills and interests.

The academic options available that are supportive of future Gordon Fellows are drawn from the departments in which students are enrolled and from the university as a whole. For example, both business and basic science courses are appropriate and can be taken as electives. A comprehensive list of courses and their relevance to the objectives of the program is maintained by the Gordon Engineering Leadership Program and used as a discussion basis between the student and their advisor in developing an academic plan.

The emphasis in the Gordon Program is on leadership. Leadership development of the undergraduate student is accomplished in several ways:

- Course work in management, leadership, entrepreneurship, and psychology
- Active involvement in student groups such as professional societies, honor societies, sports teams, campus activities and so on
- Project activities in support of graduate student projects in the Engineering Leadership program or in undergraduate Capstone projects
- Project-oriented cooperative education assignments; as individual contributors at first and finally as project engineers for students in their final work term

Developing a student’s leadership capabilities is a priority for the program and the academic and co-op faculty that support it.

A departure from the customary engineering undergraduate education process is the emphasis on broad scientific understanding across different disciplines and topics. Rather than an elective suite that focuses totally on in-depth study of a narrow set of topics, future Gordon Fellows are encouraged to engage in broad topics, chemistry, physics, economics, that prepare them to conceptualize and integrate a variety of scientific views.

### **Cooperative Education Tailored to Leadership Skills Development**

As a feeder program for potential graduate education, cooperative education coupled with tailored selection of electives can illuminate the future for a student. The typical undergraduate entering an engineering school has not been exposed to engineering practices, project-based team activities, deadlines and deliverables, checks and double-checks, or any of the realities that the Gordon program emphasizes. By selecting job opportunities for potential participants in the program that are rich in the appropriate technical and project management activities and challenges, the student will see what the future might be if they pursue the Gordon opportunity. The program will, in turn, get a chance to evaluate the student in terms that are related to its requirements.

Jobs for co-op students are developed and maintained by cooperative education faculty with backgrounds from industry. For the Gordon program, each job in the current list and all future jobs are rated for suitability against the following criteria:

- A reasonable level of scientific content
- Multidisciplinary activities and team members

- Project oriented with specific deliverables and deadlines
- Student opportunities for a variety of roles including individual technical contributor and some project management responsibility
- Potential for the employer to sponsor the student for the Engineering Leadership Program

The employers who participate by hiring co-op students that are identified as potential Gordon program participants may have several roles. They may simply employ the students with no particular visibility of their potential inclusion in the program; they may be willing to tailor the assignment to emphasize project involvement and mentor the students for eventual project responsibility; they may be willing to sponsor the student for the Gordon program when they graduate and emphasize preparation of the students for the program in the co-op assignment. Cooperative education and academic faculty work with employers who wish to have more than the minimal involvement in the students' progress to identify and refer candidates for employment who fit the employers' criteria and the Gordon program's as well.

### Measurement and Assessment

Hitting the target requires either exceptionally good aim or a way to make adjustments. We assume the need for evaluation and adjustments to the feeder program. The metrics on which our model of success is built include

- Number of students identified as potential applicants to the Gordon Engineering Leadership Program
- Number of students identified as potential applicants in their sophomore or middle (middle of five) years
- Number of cooperative education assignments available for identified students
- Number of participating employers who are willing to sponsor a student for the graduate leadership program
- Number of students who are identified as potential Gordon program candidates are accepted into the program

The process delay in this set of metrics can reach four years. Careful review and evaluation are required to avoid instability.

Evaluations are conducted in conjunction with each cooperative education work term; the period during which jobs are selected, students interviewed and jobs offered is a natural time to assess the direction of the program. Each Fall and Spring semester, the standing of each student in the feeder program – committed as an applicant or not – is reviewed by co-op faculty and Gordon program leadership. A second review is held after the students return from their co-op work assignments to reflect on how the work experience relates to their academic work and career interests, discuss goals and objective for the next work term and gauge interest in continuing in consideration for the Gordon program.

### ACKNOWLEDGMENT

The authors wish to gratefully acknowledge the generous support of Bernard M. Gordon for establishing the Gordon Engineering Leadership Program, and our students

for showing us, every day, what great potential young people have for learning, growing, and accomplishing extraordinary things.

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