The Gordon Engineering Leadership Program at Northeastern University

The NAE Bernard M. Gordon Prize 2015 Lecture
October 4, 2015

2015 Bernard M. Gordon Prize for Innovation in Engineering and Technology Education
“For developing an innovative method to provide graduate engineers with the necessary personal skills to become effective engineering leaders.”

2015 Prize Winners:
Prof. Simon Pitts
Prof. Michael Silevitch

GIEL Team Members:
Prof. Steven Klosterman
Prof. Steven McGonagle
Snowfall was only 108.6 inches
Concentrates on the knowledge, skills, and attitudes that reside at the intersection of engineering and leadership
The trade balance in advanced technology manufactured products, many of them invented in the United States, turned negative in 2001 and has widened in the decade since.

Start-Ups and mature companies are failing
There are significant “Gaps” ...between the needs of practicing engineering leaders and the output of conventional engineering education

Implementation Skills

• Performance, quality, cost & timing
• “Front loading”
• Engineer for the “real” environment
• Required rigor and robustness
• Program management
• Designing for manufacture
• Designing to avoid failure modes
There are significant “Gaps” … between the needs of practicing engineering leaders and the output of conventional engineering education.

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- Performance, quality, cost & timing
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**Interpersonal Skills**
- Leadership & Followership skills
- Influencing & motivating skills
- Communication skills
- Team skills
- Interdisciplinary decision skills
- Organizational & social awareness
- Connecting across cultures
- Willingness to engage with others
- Persistence
There are significant “**Gaps**” … between the needs of *practicing engineering leaders* and the output of *conventional engineering education*

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<tr>
<th>Implementation Skills</th>
<th>Interpersonal Skills</th>
<th>Breadth of Focus</th>
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<tbody>
<tr>
<td>• Performance, quality, cost &amp; timing</td>
<td>• Leadership &amp; Followership skills</td>
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<td>• “Front loading”</td>
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<td>• Market &amp; Customer focus</td>
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<td>• Engineer for the “real” environment</td>
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<td>• Competitiveness</td>
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<td>• Required rigor and robustness</td>
<td>• Team skills</td>
<td>• Enterprise understanding</td>
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<td>• Program management</td>
<td>• Interdisciplinary decision skills</td>
<td>• Business acumen</td>
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<td>• Designing for manufacture</td>
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<td>• Narrow Discipline focus</td>
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To create an elite cadre of engineering leaders who stand out from their peers in their ability to innovate, invent, and implement engineering projects from concept to market success.

These leaders will demonstrate an exceptional ability to lead engineering teams by providing purpose, direction, and motivation to influence others to achieve their collective goals.
The Graduate Engineering Leadership Program

Market, Customer, and Stakeholder Focus

Leadership Capabilities
Leadership Labs
Product Development
Scientific Foundations
Challenge Project

Engineering Leadership Seminars, 3-Way Mentoring and Cross Cohort Sharing

Experiential Learning to Enhance Knowledge, Skills, and Attitudes
**Year 1** Graduate Engineering Leadership Program

**Fall**
- Engineering Leadership
  - Leadership Classes
  - Leadership Labs
  - Product Development Classes

- Scientific Foundations of Engineering

**Spring**
- Challenge Project

**Summer**

**Year 2** Additional Technical Courses resulting in Masters Degree

- Technical Course 1
- Technical Course 2
- Technical Course 3
- Technical Course n
The foundational elements are integrated into every aspect of the curriculum.
Experiential learning

Learning by doing – Integrating Theory and Practice
This concept is integrated in two key areas:

- **Lead Labs** – by immediately practicing the skills they have been exposed to in a simulated real world context the students learn and master the “how” as well as improve their understanding of “when” to use the skill
- **Challenge Project** – by completing the project for the sponsor company in an authentic real world environment, with all the idiosyncrasies and unpredictability that results, their learning experience is enriched.
The curriculum focuses on 14 Leadership Capabilities (derived from research and experience) as essential qualities for successful engineers.
Leadership Laboratories enhance the mastery of topics introduced in classes. Candidates explore topics through practical experience such as self-assessment, interactive role-playing, and case studies.
"This was perhaps the best leadership and team building experience I ever had. It was a unique opportunity to see a team form and develop before my eyes as we learned individual team members’ strengths and weaknesses. At each obstacle we determined which team members would be best at solving various elements of complex challenges and how to get the whole team across the finish line."

Emily Anesta, MIT Lincoln Laboratory
Classroom based Lead Labs follow each engineering leadership class:

- Highly interactive
- Often designated teams/team leaders
- Task oriented
- Engineering workplace scenarios
- Role playing, case studies
- After action review/ direct feedback

Build mastery of topics introduced in classes through practical experience

Sample Topics

- Leadership framework - Values
- Group and team development
- How to present
- Leadership presence - Be, Know, Do
- Decision making
- Followership
- Standards and accountability
- Negotiation/dialog/inquiry
- Ethics in workplace and beyond
- Conflict resolution
- Risk management
Introduces engineering leadership in the context of the end-to-end product development process and reinforces that choices made early in the lifecycle have the most leverage and greatest impact.
Product Development Process

Planning → Concept Development → System Level Design → Detailed Design → Testing and Refinement → Production and Ramp

Mission Statement → Concept Review → System Spec Review → Critical Design Review → Production Approval

Partnership and influence concurrency across the process

Marketing and product specification → Engineering and design → Manufacturing and production
Students learn to:
- Unearth and refine customer needs
- Develop specifications, schedules and cost models
- Initiate, evaluate, plan, execute, test, validate, and complete a project
- Effectively lead teams in an extended enterprise
- Understand business and financial drivers

Topics
- Product development methods
- Organization structure and teams
- Planning and technology
- Market and customer needs
- Product specifications
- Cost, schedule
- Concept development
- Product architecture
- Program management
- Industrial design
- Finance for engineers
- Robust design
- Design for Manufacturing
- Validation, test, release
- Production/supply chain
- Service
- Quality and reliability
- Customer relations
- System design
- System engineering
Provides a foundation to enable interaction across different engineering disciplines. Candidates also gain confidence in their ability to tackle and learn new fields without being intimidated.
Supports the “T” shaped engineer model: (depth in at least one discipline and system and breadth to lead and collaborate across disciplines, systems and functions)

Provides students with the first principles of the main engineering disciplines that they are likely to face when leading cross-functional teams. Enables them to make informed decisions and ask the right questions when faced with information from outside their personal domain of expertise.

Strengthens ability to leverage scientific analysis to understand problems and lead resolution, often under time pressure.
For the Sponsor – a product or process of value and impact is developed on behalf of the organization

For the Student – an opportunity to apply knowledge and develop confidence under real-world time, business, performance, and quality pressures
The Challenge Project concentrates on a technology development and delivery challenge from the student’s sponsor company.

It is the analog of the thesis experience focused on providing Project Based Learning in three primary areas:
- Market Value
- Technology Development / Technical Depth
- Leadership

The Challenge Project is a key win–win element of the Leadership Program. It produces a market worthy impact for the sponsor while facilitating mastery of classroom topics in an authentic context for the student. He/she delivers a project with a degree of difficulty above his/her prior capability.

Bo Zhou and Dan Wells – Entegris
Shawn Cousins  
**EMC**  
Application Performance Profiler Proxy

Laura Mikinos  
**NEC Energy**  
SBIR to design a trailer mounted solar thermal power generator

Jessica Patel  
**Raytheon IDS**  
Adding robustness to an automated design process

Jason Harland  
**EMC**  
Firmware validation and emulation suite to support hardware validation

Lauren Brown  
**WEAC FDA**  
Developed a priority based process for the analysis of high risk medical devices

Abdul-Karim Barrie  
**Entergy- Pilgrim Nuclear Station**  
Developed Feed water heater level transmitters for nuclear power systems

Sheldon Green  
**Raytheon IDS**  
Using Model Driven Systems Design to Enable Product Development

Nobuhito Suzuki  
**Mitsubishi Heavy Industries**  
Developed a new systemized global program management capability
Desiccant vs. Vapor-compression

Desiccant systems are more efficient than vapor-compression systems due to their ability to remove the Latent heat.
The curriculum continually reinforces engineering in context: leading teams to engineer products and processes that satisfy the collective needs of the market, customers, and their organization’s stakeholders.
The 12 Month Engineering Leadership graduate certificate may be pursued as a standalone or combined with any Masters or PhD program.

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<th>Professional Master of Science</th>
<th>Traditional Master of Science</th>
<th>Doctor of Philosophy</th>
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<td>Computer Systems Engineering</td>
<td>Bioengineering</td>
<td>Bioengineering</td>
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<td>Energy Systems</td>
<td>Chemical Engineering</td>
<td>Chemical Engineering</td>
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<td>Engineering Management</td>
<td>Civil Engineering</td>
<td>Civil Engineering</td>
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<tr>
<td>Information Systems</td>
<td>Electrical &amp; Computer Engineering</td>
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<td>Sustainable Building Systems</td>
<td>Electrical &amp; Computer Engineering</td>
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<tr>
<td>Telecommunication Systems Management</td>
<td>Industrial Engineering</td>
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<td></td>
<td>Mechanical Engineering</td>
<td>Information Assurance</td>
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<td>Operations Research</td>
<td>Interdisciplinary</td>
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<td>Network Science</td>
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How would you rate the program in contributing to your overall character and leadership development?

- Most important experience yet in improving Leadership capability: 52%
- Essential to Development: 38%
- Important but not essential: 10%
- Little or no impact: 0%

To what extent has the program contributed to your advancement?

- Not likely without GEL: 7%
- Major impact: 61%
- Important but not essential: 27%
- Little or no impact: 4%

NAE Survey data
The Leadership program delivers its mission of enhancing knowledge, skills, and attitudes on both sides of the Venn diagram:

**Improving the ability to lead diverse teams of engineers** with different personalities, cultures, discipline expertise, worldviews, motivation levels, and sensitivities.

**Improving the capability to technically lead projects** by integrating the engineers (and the non-engineers) on the team to move projects from the concept stage through to commercial success.
We are closing the “Gaps” and accelerating the contribution and careers of engineers
The Gordon Engineering Leadership Program

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