# Developing Engineering Leaders using Engineering Leadership Capabilities and Leadership Labs

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# The Gordon Engineering Leadership Program Approach to Creating Engineering Leaders: Improving Self and Situational Awareness and Developing Targeted Leadership Capabilities Through a Leadership Framework and Leadership Labs

## 1    Introduction

To succeed in today's hyper-competitive environment, industry and society need an educational process to develop engineering leaders with the capability to lead teams in efficiently and effectively delivering projects and products for their stakeholders. Yet a significant gap exists between this need and the output of the traditional engineering education system. This results in a lack of competitiveness for commercial entities, causes failed projects and failed companies and prevents technologies and innovations from transitioning from the laboratory to customers and society.

To bridge this gap innovative integrated approaches that develop not only the technical depth but also the interpersonal agility essential to successfully lead engineering teams are needed[i].

The purpose of this paper is to examine a pedagogical technique employed in developing engineering leaders: the use of self-assessment and a leadership capabilities framework linked to interactive leadership laboratories (LLabs). This is part of a curriculum that also includes the teaching of best practices in effective product development and the scientific principles underlying major engineering disciplines. Experience-based practice and mastery of methods is gained via the Challenge Project, an intense, tightly-scheduled, deliverable-oriented demonstration of human leadership, project and resource management and engineering problem solving.

The Gordon Engineering Leadership Program (GEL), in the graduate school of engineering at Northeastern University, targets the development of the soft skills, organizational awareness and technical agility key to mastering leadership in an engineering environment. The program, launched in 2007 with a gift bestowed by Dr. Bernard Gordon, actively works with industry partners in honing the knowledge, skills and attitudes essential to accelerate the building of a new generation of game-changing engineering leaders. Students, known within the program as Candidates, pursue either Master of Science degrees (completed in 12 to 24 months) in various engineering disciplines or a stand-alone 12-month Certificate. Participants in the program are predominantly sponsored by their current employers or participate through an internship with a company. As of August 2012, 76 Candidates have graduated from the program and 35 Candidates are enrolled in the 2012-2013 cohort.

## 2    Background

The mission of GEL is to create an elite cadre of engineering leaders with exceptional abilities to lead engineering teams by providing purpose, direction and motivation to influence others to achieve collective goals.

Building upon Northeastern University's 100-plus years of experiential learning, the program augments the traditional masters program in engineering by addressing the awareness and the development of attitudes and character needed to lead engineers to successfully deliver products to a marketplace. The intersection of engineering/technical capability and human/leadership efficacy leads to an increased ability to influence, motivate and inspire teams by articulating a vision, developing and executing a plan and making it happen in a real world environment.



Figure 1: The focus of the Gordon Engineering Leadership Program - Educating at the Intersection of Engineering and Leadership

This paper concentrates on the use of experiential learning as part of a deeper dive into the leadership portion of the program including the definition of leadership capabilities, a leadership development framework and examples of how the framework is used, in conjunction with interactive LLabs, to build competence and mastery of leadership skills. Candidates learn to apply these skills in their own industry and work environment.

In prior papers[ii] an overview of the complete structure of the GEL approach has been described, including the assessment of industry's need for improvement in engineering leadership and the current impact and consequence of poorly led engineering projects. The syllabus and approach to the engineering, technical and scientific content was described, including application of

techniques taught in the course to an industry specific Challenge Project. Further, the global risk to the competitiveness of companies if this need is not addressed was presented in 2012[iii].

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

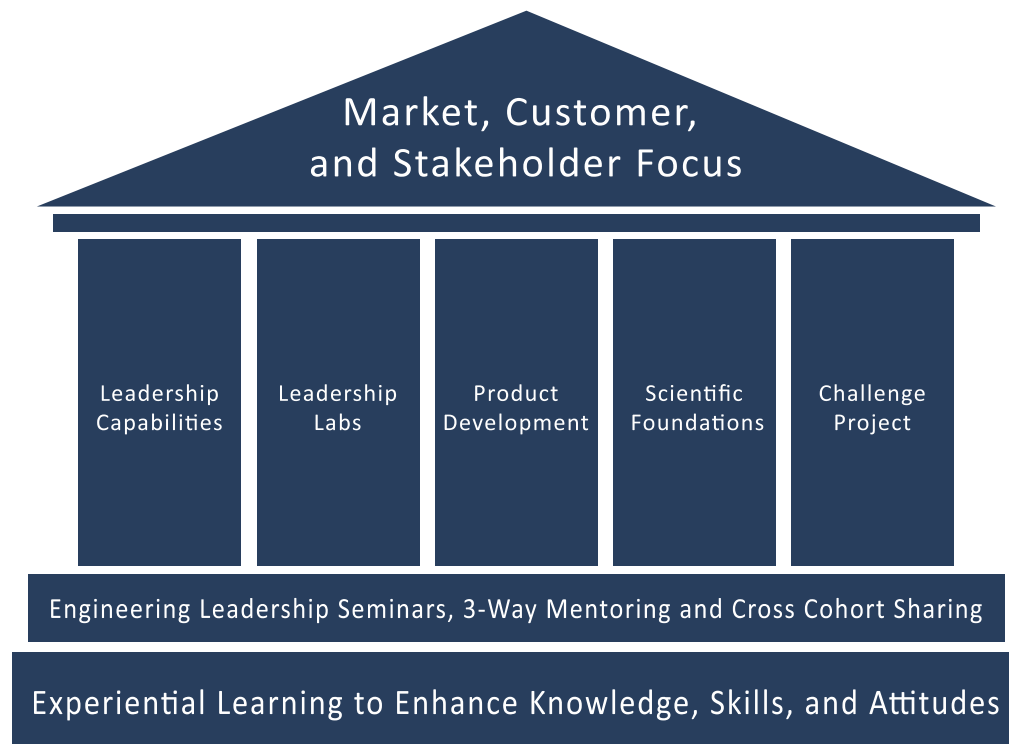Experiential Learning to Enhance Knowledge, Skills, and Attitudes

Figure 2: The Northeastern Gordon Engineering Leadership Program

Briefly, the program structure is presented as a house, with a foundation, roof and pillars.

Four elements serve as the foundation and are integrated into every aspect of the curriculum

- Experiential Learning to enhance Knowledge, Skills and Attitudes
- Distinguished speakers from industry that discuss and model leadership
- 3-Way mentoring including one mentor each from the program, industry partner and Candidates' technical area
- Cross-cohort sharing, where Candidates learn from each other

Five pillars represent the core elements of the curriculum:

- Leadership Capabilities

- Leadership Laboratories
- Product Development
- Scientific Foundations
- Challenge Project

The foundational elements and the five key pillars of the house all develop the human and technical capabilities of engineering leadership focused on achieving the common goals of satisfying market, customer and stakeholder needs.

## 3    Self-Team-Stakeholder Pyramid Approach

Figure 3: The Engineering Leadership Pyramid

GEL uses coursework, team activities and labs in the introduction and mastery of the theory and practice of leadership within the framework of a capability pyramid. This approach is similar to the US Army model[iv], a recognized best practice in leadership training, progressively building levels of fundamental, tactical, operational and strategic skills. The three levels are:

- *Self and Situational Leadership Awareness:* The program begins with readings, discussion and exercises designed to improve self-awareness, develop appropriate confidence and attitudes, and gain an appreciation for the importance of values, integrity, credibility and personal character essential to be an effective leader. Through reflection

and self-assessment, the Gordon Candidates begin to understand their own strengths and weaknesses, preferred styles, biases and potential blind spots. Customized development plans and regular mentoring sessions serve to increase the Candidates' ability to perceive and effectively deal with the range of personalities they face within diverse teams. For example, conflicts created by the contrasting personal styles of individual team members can be mitigated with appropriate empathy, coaching and direction.

- *Knowledge, Skills and Attitudes to Successfully Lead Engineering Teams:* The next level targets the development and mastery of best practices in the techniques of setting expectations, organizing and leading a team. Skills such as diagnosing and understanding team dynamics, goal setting, establishing clear end points, and methods to improve negotiation, decision making, conflict resolution and providing feedback are taught and mastered. Role playing exercises give the Candidates a safe environment to learn, practice and receive feedback in order to hone these skills in mock team situations.

- *Realizing Vision, Mission and Stakeholder Goals:* Finally, the role and responsibility of the leader to understand and communicate their organization's vision and strategy are explored. Methods that emphasize the leader's responsibility to know, understand, visualize, align and articulate the task and purpose of their team enable them to achieve a collective goal in the service of the big picture. A high performing team that does not provide genuine value to their stakeholders is wasteful at best.

## 4    The Gordon Engineering Leadership Program Engineering Leadership Capabilities

The GEL leadership capabilities are derived from the Sloan-MIT Leadership model as described in the articles "In Praise of the Incomplete Leader"[v] and "Capabilities of Effective Engineering Leaders"[vi], combined with proven techniques on developing leadership competencies used by the U.S. military as described in the U.S. Army Field Manual and other references. [iv,vii,viii,ix]

Building upon these best practices, while adapting them and testing concepts in interviews and feedback sessions with industry stakeholders and advisors, GEL has identified 14 key capabilities essential to becoming an effective engineering leader:

1. *Initiative:* Assess risk and take the initiative, to create a vision and course of action.
2. *Decision Making:* Make decisions with information at hand factoring in risk; maintain and take alternative action when necessary.
3. *Responsibility and Urgency to Deliver:* Determination to accomplish the mission in the face of constraints or obstacles; commitment to absolute responsibility to deliver on time, pursuing necessary follow-up.
4. *Resourcefulness – Get it Done:* Focus on the tasks at hand with passion, discipline, intensity and flexibility.

5. *Ethical Actions and Integrity:* Adherence to ethical standards and principles and the courage to act ethically and with integrity.
6. *Trust and Loyalty:* Commitment to actions that will instill trust and to the principle that loyalty to the team yields loyalty to the leader and vision. Working to empower those around you to make the people around you successful.
7. *Courage:* Face difficult/high-risk actions head-on.
8. *Vision:* Creating compelling images of the future, identifying what could and should be for new products, systems and enterprises.
9. *Realizing the Vision:* Designing processes and approaches to move from abstraction to invention, innovation and implementation. Lead an organization to plan and deliver a project exercising solution judgment and critical reasoning.
10. *Inquiry:* Listen to others with intention of genuinely understanding their thoughts and feelings; recognize their ideas may be better than yours.
11. *Interpersonal Skills:* Respect needs of individuals and the group; recognition of others' strengths; coaching, gracious professionalism.
12. *Communicating and Advocacy:* Clearly able to explain point of view, approach to those with differing backgrounds and cultures; assess extent to which you are understood.
13. *Connect – Across Disciplines, Skills and Cultures:* Appreciate, engage, and connect with those who have different perspectives.
14. *Negotiating and Compromise:* Appreciating the need to identify potential disagreement or conflict, negotiate to find mutually acceptable solutions.

Some capabilities, such as "Responsibility" and Urgency to Deliver", are core in developing the proper attitude to drive programs to conclusion. Others, like "Inquiry" tied to empathetic listening skill development, enable the Candidates to develop the proper skills to better lead in diverse and stressful environments. "Vision" compels Candidates to think about the overarching goals and objectives their team is trying to achieve. "Decision Making", "Communicating and Advocacy" and "Negotiation and Compromise" cover techniques to effectively facilitate group problem solving.

## 5   Creating Self Awareness

To begin, the Candidates participate in a series of assessment and reflection exercises designed to reveal the inner core of their own values and belief systems. Through these sessions the Candidates begin to understand the language and theory in unearthing, categorizing and describing personality traits, behavior styles, strengths and weaknesses and how they influence how people interact with each other.

First, the Candidates undertake a Myers-Briggs Type Indicator (MBTI)[x] self-assessment as a means for revealing their behavioral preferences in how they perceive the world and make

decisions. The results are discussed and analyzed in a review session, facilitated by a certified administrator, and most Candidates find their MBTI designation to be consistent with how they view themselves. They are also now sensitized to look for and recognize behavioral and personality traits in their teams.

Next, the 14 leadership capabilities are introduced to Candidates using a radar or polar plot, known within the program as the "spider chart." The spider chart and descriptions of the capabilities are given to the Candidates on a card and revisited throughout the program as a method for Candidates to visualize their relative areas of strengths or weaknesses for each capability on a scale of 0-10; 10 being world-class, 0 being virtually inept.
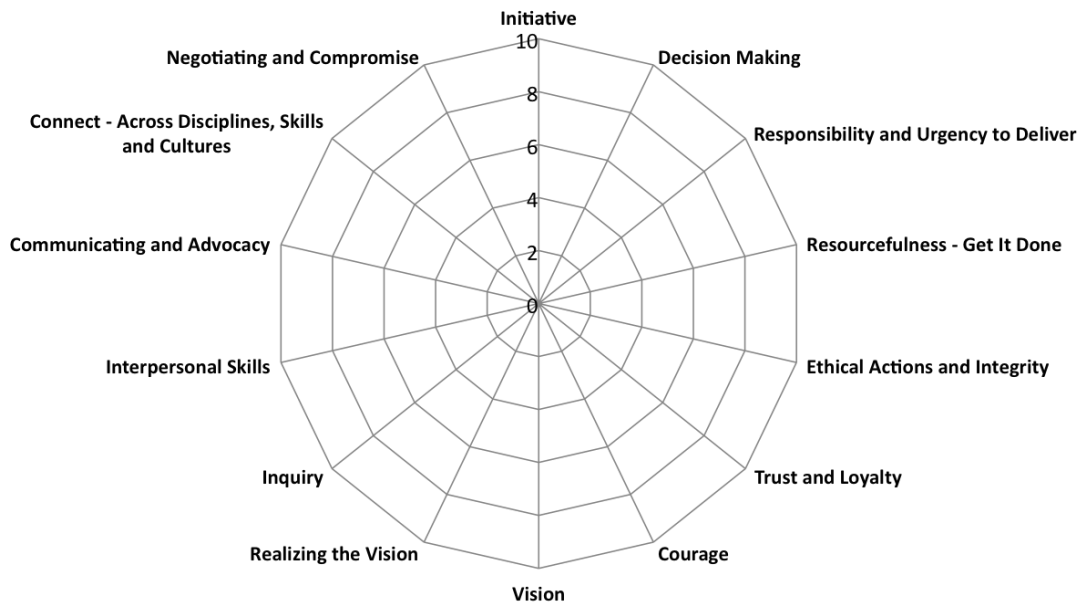
Figure 4: Leadership Capability Spider Chart

Candidates complete a spider chart self-assessment during the first week of class. This provides a baseline for future reference and serves as a method to create individual and customized leadership development plans. The spider chart exercise is repeated later in the course augmented by additional feedback obtained from their peers, subordinates and supervisors in a comprehensive 360-degree review.

Finally, Candidates are tasked to contemplate and create a deeply self-reflective "personal mission statement" (Covey)[xi]. This statement of values, life's priorities and goals, considers

things like the importance of family, work-life balance, the role of personal character in making choices and the power that comes from living one's life with purpose, integrity, and courage. This introspection serves as a "this is how I hope to live my life" manifesto and is encouraged to be periodically reviewed and revised as life changes such as promotions, job changes, family situations or crisis present themselves. Candidates' feedback has indicated that is one of the more unexpected, challenging, painful and yet, ultimately rewarding and valuable exercises in the program. Most plan to continue to review and update their personal mission statement beyond graduation, integrating it into their way of assessing their lives.

Throughout the program, additional assessment tools and opportunities for reflection are introduced, including those dealing with understanding communication and conflict resolution styles. Candidates are required to submit a weekly status report in which, in addition to progress against goals, they reflect on their learning, the highs and the lows.

## 6    The Leadership Framework

Concurrent with the first self-assessment is an introduction to "The Leadership Framework." Candidates answer two questions, "What is a leader?" and "What does a leader do?" A facilitated discussion begins to reveal a schema covering core values, leadership knowledge, capabilities and attitudes, culminating in a group-derived definition of "leadership".

A partial example of how the framework, typically drawn on a whiteboard at the front of the class, is used to facilitate classroom discussion in shown (Figure 5: Leadership Capabilities Framework).

Figure 5: Leadership Capabilities Framework

From this exercise, Candidates offer up terms that, in their own experience, seem to have some connection with leadership. Typically dozens of words randomly generated from the class are collected and categorized into one of three buckets: Values, Leadership Capabilities, or Management Skills. In the ensuing dialogue, Candidates begin to appreciate how solid values, established from one's behavior, beliefs, feelings and personality, matched with the desire and commitment to consistently embrace and live by those values, can become a source of strength.

Taken from the Leadership Framework lesson plan, the key points and learning objectives for this module include:

- Values are deeply held beliefs about right/wrong, good/bad.
- Personal values are implicitly related to choice; they guide decisions by allowing for an individual's choices to be compared to each choice's associated values.
- Leadership attributes/attitudes are internal and defining qualities we possess, develop and exercise in our activities and interaction with others.
- Leadership is: influencing others by providing purpose, direction and motivation to accomplish a task while improving the organization and its people.
- Distinguishing the difference between leadership and management: Leadership deals with people and behavior; management with the science of organizing and planning programs, budgets and systems.

After having discussed, learned about and practiced many leadership capabilities, we follow with a contextual discussion and understanding of respective organizational cultures and climates. This enables increased self and situational awareness, which we then further codify by having candidates complete a personal SWOT (strengths, weaknesses, opportunities and threats) analysis.

## 7    Leadership Laboratories (LLabs)

Key to turning concepts and theory discussed in the leadership classroom into skills the Candidates can practice and master is the use of highly interactive LLabs to supplement each lecture. LLabs are designed to be immersive, highly experiential and to create high energy, deliberately placing the Candidates outside their comfort zones but in a safe, non-threatening environment. During LLabs, Candidates depart the formal classroom setting, forming teams, groups or pairs, depending on the task and learning objectives.

For example, a class on setting standards, goals and expectations, which explores the culture, climate and accepted rules of behavior of the organization and expectations as explained to a new team member, is followed by a LLab where Candidates are paired up to conduct an activity:

- Using scenarios, Candidates will practice conducting one-on-one expectation sessions in both a send and receive mode. For example, a new employee meets with their supervisor for the first time. Does the supervisor provide a clear description of what is expected, when and how their work will be evaluated and what will be the measure of success within the team?
- Candidates receive feedback from their partner and from cadre process observers and repeat the session several times with alternating partners.
- The result is that Candidates not only appreciate the need for these initial expectations sessions in the workplace, they can also confidently and competently conduct such a session when required to do so.
- Linked to leadership capabilities, this exercise improves competence and confidence in interpersonal skills, communicating and advocacy, inquiry, connecting across culture and disciplines, trust and loyalty and even establishing and realizing a vision.

Using similar, iterative role-playing each LLab enables Candidates to practice and gain experience in performance-oriented behavior, gaining increased confidence and proficiency in using one or more leadership capabilities in a simulated real-world situation.

While most classes and LLabs focus specifically on one or more of the 14 leadership capabilities, other topics serve to supplement them by providing targeted, peripheral lessons of significant value for an engineering leader. For example, one of these modules is entitled "Followership":

- The concept of followership is that in order to be a good leader one must first be a good follower, and that there are several key follower skills that leaders must possess, is often not even considered by our Candidates. In fact, the term "followership" and its interactive components can often be foreign even to seasoned leaders.
- Beginning with a homework reading "The Ten Rules of Good Followership,"[xii] Candidates report back on their recent observations and experiences, followership tenants, both good and bad are discussed and debated.

A facilitated After Action Review (AAR) closes each LLab, designed to reinforce the skill practiced, and demonstrate the effectiveness of learning through reflection. The AAR involves all participants and uses a series of open-ended questions to explore performance and behaviors:

- "What do you think you did well?"
- "What could you have done to improve?"
- "How did you feel when your team mate said…?"
- "What would you do differently?"
- "What did you learn?"

The AAR effectively drives home learning points by encouraging Candidates to collectively reflect and articulate what behaviors; feelings, experiences and outcomes were observed during the lab.

## 8    Linking Leadership Capabilities to Practice

Engineering leadership is practiced primarily in a business, corporate, research or industrial setting. Therefore, LLabs have been adapted so that case study and role-playing exercises mimic situations likely to arise in the typical work setting. This includes assigning the Candidates to seek out, observe and reflect on incidents and interactions in their own work place. Example areas include:

- Conflict management
- Decision making
- Setting goals/setting expectations
- Dealing with performance issues
- Politics in the workforce
- Dealing with multi-disciplinary, multi-cultural, multi-national team issues

By studying their own companies Candidates gain insight into how they can adapt skills to lead and influence within the unique character of their firm's environment and personality.

Finally, having been broadly exposed to the skills and vocabulary associated with leadership, the focus shifts to the application of those skills in the engineering domain with assignments in

which Candidates analyze specific types of team interactions within their organizations and how leadership or lack thereof, impacts the performance of the teams. Some of these include:

- Interacting with Marketing and other functions to collect customer needs or "voice of the customer" information to feed into the program and how those needs become specifications.
- Integrating manufacturing and service requirements as design goals and the challenge of incorporating the input from those functions at the start of a program.
- Leading teams through the dynamic of the change management, moving goals, and shifting priorities.
- Negotiating priorities and tradeoffs, team decision-making, coping with the tension between cost, quality and schedule pressure.
- Analyzing the company vision and how it is communicated to its members and used to inspire them.
- Understanding the role of quality and how to account for the limitations of technology, sub-systems and systems to work within the envelope of tolerances and noise factors.

On a regular basis, Candidates are asked to seek out and interview experts and leaders within their companies to share what they learn in the class and see how it applies to their business.


## 9    Results To Date

Course feedback, interviews with industry sponsors and measuring the returns of Challenge Projects clearly endorse the methods and validate the growing program.

TRACE (Teacher Rating and Course Evaluation)

The engineering leadership course and LLabs have been ranked, by Candidates, at a 4.9 out of 5 approval rating in each of the last 3 surveys.  Questions relating specifically to lecture and in-class activities contributions to learning were ranked 4.8 and 4.9 respectively, indicating almost unanimous student approval of the program.


Student Feedback

Candidates provided a substantial amount of written feedback on the program in course evaluations.  Selected quotes include:

*"GEL is very different from the various leadership programs that I have been exposed to in my career. First of all, it is not a generic leadership program that has been tailored for an application but instead is a program that was designed with the engineering leader in mind. I*

*believe that its unique blend of technical content and real world studies in leadership is the most practical and effective method of training tomorrow's technical leaders."*

*"The leadership labs and activities set a strong tone for how I should act and behave as a leader. At the end of this program, not only did I learn the class material, but I have grown. I have become more confident and proactive."*

*"What I enjoyed most about GEL is how applicable it was to industry. I have always had a disconnect between the knowledge learned in school and what is needed in industry. School teaches all of the technical theories behind the engineering, but does not focus much on application. I have enjoyed how almost everything I have learned in GEL has related to a real situation I have encountered in my career."*

Industry Feedback

Industry sponsors provide end of year assessments. Selected quotes include:

*"Qualified Engineering Leadership is always in demand at <our company>. GEL greatly accelerates the learning process for new engineers and prepares them for increased responsibility at a very early stage in their engineering career. We gained an experienced engineering leader. In addition, our Candidate worked on a new product that will expand our reach in a highly competitive marketplace."*

*"It affords them an opportunity to run a program under the watchful eyes of their industry sponsor and the professors at GEL. These opportunities help employees learn the necessary skill sets while providing the confidence for them to take the next step in advancing their careers."*

*"Early development of leadership skills helps young engineers to better integrate into a variety of teams. These skills are very important in the type of fast-paced product development environment <in our company>. Students who develop leadership skills by participating in GEL are able to increase their level of contribution earlier in their career and this will ultimately help accelerate their career development."*

*"Dan definitely expanded both his leadership and technical skills. He expanded his leadership skills by taking ownership of larger parts of the project, which involved working with fellow team members, extended team members (including interaction with individuals in other countries), as well as working with people and organizations outside the company. Dan expanded his technical skills in many ways, including identification and development of new measurement technologies that enabled the project to succeed."*

## 10  Summary and Conclusion

A significant gap exists between the needs of today's industry and the output of traditional engineering education in the area of leadership. As a result, engineers entering the workforce do so without a honed set of methods, techniques and experience to enable them to lead teams in successfully producing work that is valuable to their organization. This skill deficit has a direct impact on declining competitiveness in many industries.

The Gordon Engineering Leadership Program at Northeastern University has developed a systemic approach to augment traditional engineering education in teaching these leadership skills to improve the performance and success of projects in delivering products of genuine value to the market, company and society.

GEL is able to build on Northeastern University's 100-plus years of university-industry collaboration to validate the approaches taught in real-world opportunities with partner companies.

The program continues to collect data on the impact being seen by both the companies, in terms of increased productivity and value, and by the graduates, in terms of career growth and opportunities.

Initial feedback from companies and engineers participating in the program confirm that the methods taught by this approach are effective and demonstrating measurable improvement in the abilities of graduates to more efficiently and effectively lead projects to success.

The program is enthusiastic about sharing any of the techniques or approaches with other institutions involved in engineering leadership development.

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