GEL Student Handbook

BERNARD M. GORDON
MIT Engineering Leadership
PROGRAM

Developing Tomorrow’s Engineering Leaders
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Capabilities of Effective Engineering Leaders

1. Core Personal Values and Character:
   - Iniative (IN)
   - Decision Making in the Face of Uncertainty (DM)
   - Responsibility, Urgency, and Will to Deliver (RU)
   - Resourcefulness and Flexibility (RF)
   - Ethical, Integrity, and Courage (EA)
   - Trust, Loyalty, and Team-Building (TL)
   - Equity and Diversity (ED)
   - Self-Awareness, Self-Reflection, and Self-Improvement (SA)
   - Vision and Intention in Life (VI)

2. Relating:
   - Inquiring and Dialoguing (ID)
   - Structured Communication (SC)
   - Negotiation, Compromise, and Conflict Resolution (NC)
   - Advocacy (AD)
   - Diverse Connections and Grouping (DC)
   - Constructive Interaction; Providing and Receiving Feedback (CI)

3. Making Sense of Context:
   - Awareness of the Societal and Natural Context (AS)
   - Awareness of the Needs of the Customer or Beneficiary (AN)
   - Enterprise and Business Context Awareness (EA)
   - Appreciating New Technology (AT)
   - Systems Thinking (ST)

4. Visioning:
   - Identifying the Issue, Problem, or Paradox (II)
   - Thinking Creatively, and Depicting Possibilities (TC)
   - Defining the Solution (DS)
   - Architected the Solution Concept (AC)

5. Delivering on the Vision:
   - Aligning Organizations Toward a Vision (AO)
   - Planning and Managing a Project to Completion (PM)
   - Exercising Project/Solution Judgment and Critical Reasoning (CR)
   - Invention (IV)
   - Innovation (NO)
   - Deploying and Operating the Solution (DO)

6. Technical Knowledge and Reasoning
Checklist for Initial Success as a GEL:

GEL can have a huge impact on your development as an Engineering Leader, but to achieve that you must participate fully! That includes the following:

✔ Read this handbook thoroughly. If you have questions, consult with your team coach. (There will be a quiz on this material.)

✔ Understand the program completion requirements for both GEL1 and GEL2 programs. Keep yourself on track for completion, failing to do so will likely result in you being asked to leave or defer the program.

✔ Complete your initial Personal Leadership Development Plan (PLDP)

✔ Understand your Engineering Practice Requirement (EPR) and think about your topic options.

✔ Fully invest yourself in the program, and commit to focusing on your personal and professional leadership development, while maintaining a commitment to your teammates and others.
About GEL

The Bernard M. Gordon-MIT Engineering Leadership Program develops tomorrow’s engineering leaders. Each year, more than 150 MIT undergraduates learn about engineering leadership through our innovative, experiential, and theoretical coursework, and practice and reflection exercises. Our approach is cohort-based, highly interactive, and continually shaped by input from students, educators, and industry.

Vision
To create an enduring program at MIT that effectively develops next-generation technical leaders equipped with the capabilities and character they need to address complex, real-world engineering scenarios.

Mission
Develop MIT engineering students to be more inclined and able to effectively contribute to real-world engineering projects.

Provide a blend of education and practice opportunities to facilitate the development of leadership capabilities and character.

Increase the focus of engineering education nationwide on leadership in Engineering Innovation, Invention, and Implementation (EI3).

Approach
Our approach blends Engineering Scenario Practice, Engineering Leadership Concepts & Theory, and Reflection and Values Development.

History
Launched in 2008 through a $20 million gift (with a matching requirement--please use the search term ‘Gordon’) by The Bernard M. Gordon Foundation - the largest gift ever made to MIT’s School of Engineering for curriculum development - the Gordon-MIT Engineering Leadership Program is creating a national model for preparing the engineering leaders of the 21st century.

Immediately following its inception, the GEL Program began gathering input from industrial and academic partners to design a novel program and curriculum. As the program was formed, a series of workshops, held at MIT, brought together program stakeholders with diverse views of engineering leadership. This group included: alumni, students, faculty, industry leaders, military leaders, community leaders and those from other leadership programs at MIT. GEL’s foundational document, the Capabilities of Effective Engineering Leaders, emerged as a consensus of this group.

With continued support from original benefactor, Bernard M. Gordon (MIT Alum, B.S. ’48, M.S. ’49), additional generous donors, and MIT’s School of Engineering, the GEL Program has grown to reach over 150 MIT undergraduate students each academic year. GEL has now expanded to include a professional education component for working engineering leaders. GEL continues to innovate and refine its curriculum as it strives toward its mission and vision.
**Engineering Scenario Practice:** Developing engineering leadership capabilities requires practice, reflection, and refinement. While underlying theory is important and is covered in other aspects of the program, GEL's Engineering Leadership Lab (ELL) provides a "practice field" that serves as the core of our students' leadership development experience.

In weekly ELLs, students engage in immersive activities that are designed to challenge their assumptions and develop their leadership skills. They have the opportunity to lead their peers as they grow and learn in their teams. Each ELL focuses on one or more of the *Capabilities of Effective Engineering Leaders*. Practicing engineers often serve as role-players and share real-world experiences to stimulate discussion.

**Engineering Leadership Concepts & Theory:** GELs are exposed to the fundamentals of leadership theory. As the program progresses, they learn specific tools and frameworks that are relevant to topics such as ethical decision-making, project engineering, and systems thinking.

**Reflection and Values Development:** Reflection is integral to GEL program. Both inside and outside of class, students are guided through reflection and self-assessment on their own performance and ways to improve. We encourage (and challenge) GELs to embrace the development of their own personal core values.

**Goals of the GEL1 year**

- Enable students to become engineering leaders by providing opportunities to develop character and practice the *Capabilities of Effective Engineering Leaders*.
- Prepare students to become productive and effective contributors in industry through multidisciplinary teamwork on activities.
- Foster the development of students' self-efficacy through experiential learning.
- Expose students to candid evaluation while challenging them to undertake constructive personal reflection while developing integrity and character.
- Sharpen students' communication and presentation skills.

**Goals of the GEL2 year**

- Connect challenging students to become better engineering leaders by immersing them in the practical application of the *Capabilities of Effective Engineering Leaders*.
- Connect encouraging the development of self-efficacy through experiential learning and leadership.
- Practice project engineering, organizational development, negotiation, conflict resolution, peer leadership, and other critical team-oriented skills.
- Offer students the opportunity to participate in an organization where they have the potential to influence and enact change.
- Build skills in evaluating peers candidly, responding constructively to feedback, and utilizing personal reflection for growth.
- Sharpen students' advanced communication and presentation skills.
- Develop and hone leadership skills “on the playing field” by playing a direct and immersive role in leading the program for the GEL1 students.
Bernard M. Gordon is considered "the father of high-speed, analog-to-digital conversion." He and his teams at Epsco Incorporated, Analogic Corporation, and NeuroLogica Corporation, have been responsible for dozens of engineering achievements, securing many hundreds of patents worldwide.

For his profound contributions to his profession and society, Bernie received the National Medal of Technology from President Ronald Reagan in 1986 and was elected to the National Academy of Engineering in 1991.

His concern for the education of engineering leaders led to the establishment of the Bernard M. Gordon-MIT Engineering Leadership Program. He holds B.S. and M.S. degrees from MIT and numerous honorary doctorate degrees in engineering and science.

Awards and honors

- 1971 - Outstanding Living Engineer Award from the Engineering Societies of New England.
- 1972 - Elected an Institute of Electrical and Electronics Engineers Fellow.
- 1986 - Received the National Medal of Technology from President Ronald Reagan.
- 1991 - Elected to the National Academy of Engineering.
- 1992 - Received the Benjamin Franklin Award for Innovation in Engineering and Technology from the Franklin Institute.

Publications

- Gordon, Bernard (14 October 1981). "Education for electronics leadership"
The Gordon Engineering Leadership Program’s main offices are located in building 35, Fourth Floor, Rm. 433

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Program Overview

The Bernard M. Gordon-MIT Engineering Leadership Program develops next-generation technical leaders with the character, values, attitudes, and skills to understand and address engineering problems.

In GEL Year One (GEL1), students are exposed to the fundamentals of engineering leadership theory and they engage in carefully crafted group activities to develop, practice, and hone their leadership skills in an engineering context. During GEL1, students have the opportunity to practice both team membership and team leadership as they undertake exercises and simulations related to engineering industry contexts.

In GEL Year Two (GEL2), students further develop the leadership skills they were exposed to and practiced in GEL1. Importantly, GEL2 students are key stakeholders in the overall program; they assist in advancing GEL, as well as with the planning and delivery of exercises for the Engineering Leadership Labs. The GEL2 cohort makes up a unique student-led organization within GEL.

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<tr>
<th>Summer</th>
<th>Fall</th>
<th>IAP</th>
<th>Spring</th>
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<tr>
<td><strong>GEL1</strong>&lt;br&gt;(Junior or Senior Year)</td>
<td><strong>Engineering Leadership Lab (6.912/16.651) 3 units</strong>&lt;br&gt;<strong>Engineering Leadership Lab (6.911/16.650) 3 units</strong>&lt;br&gt;<strong>Engineering, Innovation &amp; Design (6.902/16.662) 6 units</strong>*&lt;br&gt;<strong>Eng. Practice Requirement Essay (EPR1)</strong>&lt;br&gt;<strong>Personal Leadership Development Plan (PLDP)</strong></td>
<td></td>
<td><strong>Engineering Leadership Lab (6.912/16.651) 3 units</strong>&lt;br&gt;<strong>Engineering Leadership Lab (6.911/16.650) 3 units</strong>&lt;br&gt;<strong>Eng. Practice Requirement Interview (EPR2)</strong>&lt;br&gt;<strong>Personal Leadership Development Plan (PLDP)</strong></td>
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<tr>
<td><strong>GEL2</strong>&lt;br&gt;(Senior Year or M.ENG Year)</td>
<td><strong>InternshipPlus</strong></td>
<td><strong>Engineering Leadership Lab (Team &amp; Lab Leader Role) (6.913/16.667) 6 units</strong>&lt;br&gt;<strong>Project Engineering</strong>*&lt;br&gt;<strong>6.914/16.669: Project Engineering</strong>&lt;br&gt;<strong>Advanced Leadership Elective</strong>**&lt;br&gt;<strong>10.01 (1.082, 2.900, 6.904, 22.014); 10.806 (2.96, 6.93, 16.653); 11.011; 15.301; 15.310; 15.320; 15.665; 15.668, 21G.019; WGS.150</strong></td>
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**GEL Core Courses:**
- 6.911/16.650: Engineering Leadership Lab (For GEL1s)
- 6.913/16.667: Engineering Leadership Lab (For GEL2s)
- 6.912/16.651: Engineering Leadership
- 6.902/16.662: Engineering, Innovation and Design
- 6.914/16.669: Project Engineering

**Approved Alternate Courses:**
- None

**Approved Alternate Courses:**
- None

**Approved Alternate Courses:**
- 2.729J – D-Lab: Design for Scale (Fall)
- 2.722J – D-Lab: Design (Spring)
- 1.011 (not available in AY 2019-20)
- 10.01 (1.082, 2.900, 6.904, 22.014); 10.806 (2.96, 6.93, 16.653); 11.011; 15.301; 15.310; 15.320; 15.665; 15.668, 21G.019; WGS.150
Personal Leadership Development Plan (PLDP) – for GEL1s and GEL2s

An integral part of the reflection component of GEL, the Personal Leadership Development Plan (PLDP) assignment guides students through self-reflection on their strengths and weaknesses regarding the Capabilities of Effective Engineering Leaders. The PLDP is designed to foster personal development as GELs identify areas of focus as they practice leadership. Both GEL1s and GEL2s complete two PLDPs during the academic year.

ASSIGNMENT OVERVIEW
GEL1s first complete a baseline PLDP soon after they enter the program via a template provided in EL class (6.912). All capabilities are listed and students can select a range (not yet possess, introductory, intermediate, and advanced levels) and type in their rationale behind the range. GELs will submit two milestone entries per academic year; however, students are encouraged to add notes to their PLDPs between submissions.

During their time in GEL, students' understanding of the capabilities and of themselves will evolve. That's why GELs revisit their baseline PLDP throughout the year, adding to or refining their responses as necessary. At the conclusion of GEL Year 1, students submit a year-end PLDP entry. GEL2s repeat this process in their second year of the program.

DELIVERABLES
- GEL1 Fall Semester (PLDP1) submission
- GEL1 Spring Semester (PLDP2) submission
- GEL2 Fall Semester (PLDP3) submission
- GEL2 Spring Semester (PLDP4) submission
About GEL Year One

GEL supplements MIT’s technical education with the leadership skills that prepare young engineers for productive and effective careers at engineering companies. In GEL1, students complete two short courses in which they learn leadership frameworks and models and practice these skills through simulations and other assignments.

In weekly Engineering Leadership Labs, students gain experience both being a team member and a team leader, working on hands-on activities that introduce industry contexts. These experiences, combined with reflection opportunities like the Personal Leadership Development Plan and the Engineering Practice Requirement, enable students to improve and grow.

GEL has partnered with industry members and others to offer mentors to GEL students. These mentors are available to advise and assist students in their development as engineering leaders, both in the program and on outside projects (optional for interested students).

### REQUIREMENTS FOR A GEL1 CERTIFICATE

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<th>Requirement</th>
<th>Description</th>
<th>Class Time</th>
<th>Units/Credit</th>
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<tr>
<td>6.902 / 16.662 / 2.723: Engineering Innovation and Design</td>
<td>Presents an iterative design process that is applicable to many different domains. Activities include: designing a voice recognition application, crafting an effective and engaging presentation. (Either semester)</td>
<td>2 hours lecture, 1 hour recitation</td>
<td>6 units</td>
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| *Note* Approved Alternates:  
2.729[J] – D-lab: Design for Scale (Fall Semester) 12 units  
2.722[J] - D-Lab: Design (Spring Semester) 12 units | | |
| 6.911 / 16.650: Engineering Leadership Lab (ELL) | Exposes students to engineering leadership frameworks and models in an interactive, experiential, team-based environment. Activities include: design-build projects, role-plays, simulations, and performance assessment by/of other students. (Both semesters) | 2 hours per week | 6 units total (3 per semester) |
| 6.912 / 16.651: Engineering Leadership | Introduces models, theories, and methods of engineering leadership in the contexts of conceiving, designing, implementing and operating products and systems. Discusses the appropriate times and reasons to use particular models to deliver engineering success. (Both semesters) | 1.5 hours per week | 6 units total (3 per semester) |

Successful completion of GEL1 will satisfy 12-units towards the “Leadership of Teams and Organizations” requirement for the Entrepreneurship & Innovation Minor (E&I Minor) offered through MIT’s Innovation Initiative (MITii)

**Engineering Practice Requirement Essay (EPR1)**  
All GELs must reflect on an experience working on a project team in an engineering context. Students identify a project they are already involved in to meet the criteria. Through a structured reflection assignment, students practice writing a project post-mortem.  
Required for completion

**Personal Leadership Development Plan (PLDP)**  
This assignment is designed to increase familiarity with the Capabilities of Effective Engineering Leaders and encourage reflection regarding personal and professional development. Students rate their competency level for each capability on an ongoing basis.  
Year-long assignment

**Mentorship**  
The GEL Program will host a mid-fall mentoring event where students can meet and be connected with engineers and engineering leaders with industry experience.  
Recommended / Optional

*Note – GEL-1 Students are encouraged to supplement their leadership development experience, by exploring any of the approved leadership electives. A brief course description of each can be found in Appendix 3*
Engineering Practice Requirement Essay (EPR1) – for GEL1s

Engineering Practice Requirement Essay (EPR1)

The GEL1 EPR Essay assignment celebrates GELs’ experiences on engineering projects. It is a writing assignment that:

- Prompts GELs to engage in a realistic team-based engineering project (or, to identify one from their recent past)
- Elicits reflection upon their experiences on the project, and
- Introduces them to an engineering Project Post-Mortem report format – they’ll be diagnosing what worked well, and what didn’t work well during the project, specifically considering teamwork and leadership factors.
- Students will then provide recommendations for how the project could be run more effectively next time.

By realistic, it is meant that the selected project should be of sufficient scale and level of completeness that the student’s experience approximates an authentic engineering process of conceiving, designing, implementing and operating a product (or, processes, material, molecule, system, service or system!).

GELs will either reflect and write a Post-Mortem on an upcoming engineering project they plan to participate in during GEL Year 1, or they may choose to reflect on a project from the recent past (completed no earlier than the spring or summer prior to their joining GEL). See further guidelines below on project selection and signing.

EPR Essay Deliverables

1. EPR Sign-Up

GELs will register their EPR project topic and choose the GEL Year 1 semester (Fall or Spring) in which they’ll deliver the essay. The brief sign-up form will be provided in EL class (6.912/16.651) and is due early in the Fall semester. Topic sign-up must include:

- A one-paragraph project description and explanation of how their selected project is an “engineering project” with a “realistic scale.” Examples of acceptable and unacceptable project topics are available for reference here.
- A choice of semester, Fall or Spring, in which they’ll commit to submitting their Project Post-Mortem essay. Fall and Spring term due date slots are limited to approximately half of the GEL class per term – slots are available first-come/first-serve in the order in which students sign up!

If a GEL chooses to reflect on a project from the recent past, they must sign up to deliver their Post-Mortem essay in the Fall term. Otherwise, students may select either term and are expected to write a Post-Mortem essay on an upcoming project that will reach completion or be very near completion by the time the Post-Mortem is submitted.
All GELs should be able to identify a suitable project for their EPR Essay – while we prefer students to select their own unique project based on their areas of interest and involvement (i.e., student project teams, jobs/internships, other MIT classes, etc.), as a backup plan, any GEL may choose to use their EID (Engineering Innovation & Design) team project as their EPR Essay topic. The EPR Sign-Up form will be reviewed and approved by the GEL Staff before the student writes or submits the Post-Mortem essay. The EPR Sign-Up form will be reviewed and approved by the GEL Staff before the student writes or submits the Post-Mortem essay.

2. The Post-Mortem Essay

Generating a Project Post-Mortem is a common industry practice involving reflection and assessment of what went well and what did not go well during a project while providing recommendations for the future. It’s a mechanism for capturing and conveying lessons-learned so that subsequent projects run more effectively than past ones. In GEL Year 1, the goal of this assignment is similar to that of a traditional Post-Mortem – if you pause and reflect, what can you take away from your involvement in an engineering project that will make you even more effective at leading your next project?

Once GELs have identified and received approval for their project topics (i.e., the EPR Sign-Up), they’ll write and submit a project Post-Mortem essay as part of EL class that includes the following:

- Thoughful reflection and discussion that addresses the topics outlined in the EPR Essay Post-Mortem Rubric
- Approximately 5-7 pages (1500-2100 words) of written text

Students will be graded according to completeness (i.e., coverage of the topics in the rubric), but more importantly, on the quality and depth of their analysis of what went well and what did not go well on their project. A successful Post-Mortem essay will synthesize key lessons-learned from the reflective analysis of the project experience.
About GEL Year Two

In GEL2, students continue developing as leaders while also working closely in a student-led organization and collaborating with instructional staff to plan and deliver activities to GEL1s. In the summer before GEL2 year, students complete an InternshipPlus while participating in structured reflection on leadership capabilities. During GEL2, students complete two short courses in which they learn about tools for project management as well as the challenges of managing people.

GEL2s take a very different role in their second year in the ELLs; some may actively coach a team of GEL1s, observing and offering feedback, while others hold positions in the student leadership organization. The reflection experiences that began in the GEL1 year continue, culminating with a final presentation regarding development in the Capabilities of Effective Engineering Leaders. Participating in mentorship is highly recommended, and specially selected mentors help prepare GEL2s to transition into fruitful careers in industry.

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<th>REQUIREMENTS FOR A GEL2 CERTIFICATE</th>
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<tr>
<td>Requirement</td>
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<tr>
<td>6.913 / 16.667: Engineering Leadership Lab (ELL)*</td>
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<td>6.914 / 16.669: Project Engineering</td>
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<tr>
<td>Engineering Leadership Elective*</td>
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<tr>
<td>InternshipPlus or Impactship</td>
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<tr>
<td>Engineering Practice Requirement Interview (EPR2)</td>
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<tr>
<td>Personal Leadership Development Plan (PLDP)</td>
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<td>Final Presentation</td>
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<td>Mentorship</td>
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*Note - Students can take any one of the following approved leadership electives to satisfy the GEL2 Program requirements. A brief course description of each can be found in Appendix 3*
The EPR2 Interview assignment asks GEL2s to explore the reality of industry-scale engineering projects through the experiences of a seasoned engineering leader. To complete the assignment, GEL2s will:

- Identify an experienced engineering leader whose career inspires them, whose experience includes extensive engineering project oversight, and who is willing to be interviewed. This person can be anyone who meets the criteria described below.

- Conduct the interview – the focus should be on engineering project leadership – beyond that, other topics can be explored informally as the GEL2 and interviewee desire. Core topics for the GEL2 to pose to the interviewee are as follows:
  - Please describe some of the engineering projects that you have led, and why they were successful or not.
  - Describe what has made you effective as an engineering project leader.
  - What are your strengths and weaknesses as an engineering project leader? Do you have a formal or informal plan to strengthen your weaknesses? How have you overcome past weaknesses?
  - Which capabilities are most important to you as an effective engineering project leader?
  - What are your recommendations/advice/guidelines to engineers who are leading, or about to lead, an engineering project?

- Generate a summary report that includes the interviewee’s answers to the questions above, as well as thorough analysis of their answers and guidelines:

The selected interviewee should have substantial engineering project leadership experience – if needed, the GEL staff are able to assist GEL2s to identify possible interviewees. Great interviewee candidates have led teams of engineers on projects with specific, large-scale deliverables – such as: product development endeavors, major software releases, civil/infrastructure engineering projects, aerospace, electronics, biological, biomedical or pharmaceutical product development efforts, etc. There’s no restriction on the type of engineering discipline involved; we simply ask that GEL2s interview someone who has led teams involved in value creation, constrained by schedule, budget, and performance requirements, with a real deliverable. Managers or executives who have led engineering projects during their career are certainly viable interviewee candidates. Examples of candidates that do not fit the intent of the assignment are those who’ve spent their career entirely outside of the engineering projects realm, such as those with experience limited to non-engineering consulting services, policy, or marketing strategy, or those who have engineering degrees but have not practiced engineering, or immediate family members - though, those may certainly be interesting people with great careers!
EPR2 Interview: Deliverables

1. EPR2 Sign-Up

GEL2s will register their EPR Interview and choose the GEL Year 2 semester (fall or spring) in which they’ll deliver the report. The brief sign-up form (via the course Stellar site) is due early in the Fall Semester, and entails:

- A one-paragraph description of whom they plan to interview, briefly summarizing the interviewee’s background and how it includes engineering project leadership. If the student has not yet identified a specific interviewee when the sign-up is due, they have the option of describing the type of person they seek to interview.
- A choice of semester, fall or spring, in which they’ll commit to submitting their interview report.

2. EPR Interview Report

- This 5-10 page (1500-3000 words) report (to be submitted via course Stellar site) should include:
  - A description of the engineering project leader’s background (information provided in the sign-up can be re-used)
  - The interviewee’s answers to the questions above
  - A thoughtful analysis and reflection on those answers – in other words, discuss implications for when and how to apply the interviewee’s advice, and a discussion of what the advice means to you
  - A discussion of how the GEL Capabilities of Effective Engineering Leaders and other aspects of the GEL Program connect to Engineering Project Leadership as it was described by the interviewee – discuss any themes from the interview that build on or refine your understanding of the GEL capabilities
  - A summary section that concisely lists what the interviewee feels are the key engineering project leadership guidelines
  - A “path forward” discussion of how you might implement those guidelines in your next experience as an engineering project leader

Your interview report will be graded based on the following considerations:

1. Suitability of the interviewee (i.e., an engineering project leader)
2. Quality and substance of the report (thoughful, complete, 5-10 pages / 1500-3000 words, more than merely a transcript of the interview – it must contain your own reflection, interpretation, and synthesis of concepts)
3. Inclusion of a key engineering project leadership guidelines
4. Inclusion of a discussion of how the Capabilities of Effective Engineering Leaders relate to the Leader and to the Guidelines presented
5. Inclusion of a “path forward” discussion about your own future experiences
InternshipPlus - for GEL2s

What is InternshipPlus?
InternshipPlus is a means of transforming an ordinary engineering internship experience into a guided leadership development experience. InternshipPlus is a requirement for students rising into the GEL2 class.

- **How does it work?** Rising GEL2s seek and find their own summer engineering or other approved internship (sometimes with the help and consultation of the GEL staff). Then, students plan how they’ll use the summer experience as an opportunity to practice some of the *Capabilities of Effective Engineering Leaders* that GEL is founded upon.

- **What does this mean?** Once at your internship, it may mean stepping up to take on more responsibility; gaining attendance to key strategic meetings that interns may not normally attend; leading a small team on a project; seeking out relationships with key leaders within the company; building a network for your professional future – in essence, you should consider the *Capabilities* and explore ways to practice them.

In InternshipPlus, GEL challenges you to take ownership over transforming what could be a “job” into a **personal development experience**. Once at your internship, you will see other interns around you punching in and out each day, simply doing the tasks assigned to them – InternshipPlus asks you to do much more.

The Assignment:
As part of InternshipPlus, you’ll submit an “Initial Report” and “Final Report”. These straightforward reports are designed to guide you through the process of expanding the leadership practice opportunities at your internship. Due dates will be announced soon – the initial report will be due after you’ve been at the internship for a few weeks. Both reports are submitted via the course Stellar site.

You’re strongly encouraged to engage with your supervisor about InternshipPlus. Supervisors can help provide you with leadership opportunities, as well as take part in providing feedback about your leadership development. You’ll be asked about supervisor engagement in a survey about InternshipPlus.

We’re All in This Together…
Community is a big part of InternshipPlus. Though you’ll be geographically separated, you and your GEL2 peers will discuss your experiences over the course of the summer, taking opportunities to share lessons-learned, tips and suggestions. We’ll employ two vehicles to help us share these ideas. **You are asked to participate in:**

An Online Forum – a moderated forum (via Slack), will go live a couple of weeks before the end of the Spring semester (https://gel2-20XX.slack.com/#internship_plus). Let’s share our stories, pictures, observations, progress, and ask each other challenging questions.

Teleconferences – GEL will host two teleconferences per team (via Google Hangouts), one in early July, and one in late August. Your team will come together briefly in these virtual meetings to discuss the major themes you’re encountering in your internships. You are required to participate in both sessions.

It’s Simple – and it’s What You Make of It…
InternshipPlus is your canvas to paint on. It’s not meant to be complex. One GEL even suggested considering InternshipPlus to be like a giant summer-long ELL – that view may work for some; just remember that this is **your** experience; create it and shape in a way that helps you develop as an engineering leader!
GEL2 Final Assignment

GEL2 Final Assignment

Refleccon is an integral part of the GEL program and we hope it is something that will be a habit throughout your career. We encourage you to thoroughly look at your performance and development, asking yourself questions like: Did I interact with my team in the most productive way? Do I have a systems perspective regarding my company and project?

Now it’s me to consider the following: Did I truly earn my GEL2 completion certificate? Have I capitalized on the GEL opportunity to develop and grow as a leader?

For your final assignment, please:

1. Make a final PLDP entry, reviewing your previous submissions and reflecting honestly on your development regarding the Capabilities of Effective Engineering Leaders
2. Present a summary of your progress and development (see instructions below) to the GEL staff in April or May

The Presentation

Present highlights of your development for at least 3-5 Capabilities where you have seen the most improvement.

Start by considering which experiences (some may be in the program, some may not) have contributed to your growth and development in these capabilities. Explain how these experiences have allowed you to build skills and understanding. (For example: How did your InternshipPlus experience enable you to move from “Not yet possess” to “Intermediate” in Advocacy?)

Select any aspect of the GEL experience you found to be significant regarding your development.

Explain what you learned and how this knowledge might help you in the future.

A few things you should know:

- You will prepare and submit presentation materials (meaning slides or related content). The experience will be no longer than 30 minutes, including presentation content and questions from the GEL Staff. The presentation itself should be around 15-20 minutes and will be video recorded for you to review.
- The tone should be professional. While a PowerPoint presentation is not specifically required, you should give thought to providing adequate visual materials for clarification as needed.
- Include materials like assessment cards, peer evaluations, feedback from your supervisor, feedback from class projects, and other artifacts to help illustrate your points.
- Your reflection should be honest and genuine; you are not expected to have reached the Advanced Level of all of the Capabilities, perhaps one Capability at most.
- Don’t spend a lot of me time collecting artifacts to incorporate into your presentation. Instead, focus on reflection.
- Try to concentrate on development that occurred during engineering-related experiences.
Ground Rules and Guidelines for Success

Professional Conduct -
Timely Interactions -

Advising – Staff members are available upon request to advise students regarding program requirements and other matters. GEL2s are required to meet with instructors once per semester.

Mentorship – Mentorship is an excellent opportunity for GELs to receive guidance on careers, academic decisions, personal growth and development as engineering leaders. Electing to be paired with an industry mentor is an optional but recommended facet of the GEL program (open to both GEL1s and GEL2s). Early in the Fall Semester, GEL staff will reach out to students about mentorship program participation. If paired with a mentor, GELs are expected to be courteous and responsible about meeting with their mentor (however frequently you agree to meet).

Course Stellar site – GELs use the appropriate course Stellar site to submit key GEL assignments and track their academic progress through the program.

Program Conflicts – GEL is a cohort-based leadership development experience made up of a specific set of required short courses. If a GEL knows that a scheduling conflict will jeopardize his or her ability to enroll in one of the required courses, they should immediately raise this issue with their GEL program staff. Exceptions are not typically granted. Students should not wait until after the start of a term to raise questions about conflicts for that term.

Grading Policies – GELs should refer to the specific syllabi from each of the GEL engineering leadership labs, short courses or engineering leadership elective to ascertain grading policies for each course. GELs should raise any questions about grading policies with the individual course instructor(s). Overall grading and course-completion expectations and timelines can be found in Appendix 2 of this handbook.

Attendance – GELs should refer to the specific syllabi from each of the GEL engineering leadership labs, short courses or engineering leadership electives to know the attendance policies for each course. As GEL is a cohort and team-based development experience, attendance is very important to students’ success in GEL.

ELL (6.911/16.650 / 6.913/16.667) Attendance – as the Engineering Leadership Lab is an interactive, team-based experience, absences are detrimental both to individual students and to the success of their teams. GELs must make every effort to attend all ELLs. In the event of exceptional circumstances, GELs send an email to: ell-absent@mit.edu and CC their team coach (GEL1s) or Section Leader (GEL2s) as soon as you have knowledge of a conflict, but no later than the Tuesday prior to the ELL to be missed.

Feedback and Reflection – performance assessment feedback is a critical aspect of the GEL program’s leadership development approach. GELs are routinely assessed during Engineering Leadership Labs and must submit a self-reflection any time they receive an assessment. GELs will submit their reflections via the course Stellar site. Given the uniqueness of this feedback-based approach compared to other classes at MIT, GELs are encouraged to discuss the feedback process with their team coach, student leadership, or program staff.

The GEL Student Leadership Organization – participants who have been accepted into the GEL2 cohort will become part of the program’s Student Leadership Organization. The GEL2s hold leadership positions and play a major role in the execution of the overall program.
Assessment Cards & Debriefing

Assessment (Yellow) Card: All GELs will be assessed while in a leadership role. The primary evaluation will focus on select Capabilities of Effective Engineering Leaders. It will also list leadership capabilities to sustain or improve upon. Students may be evaluated in all or some of these leadership capabilities during a leadership opportunity. An evaluated capability will receive one of the following: A number assessment from 1 to 5, and an overall assessment of either an: E – Excellent / S – Satisfactory / N – Needs Improvement.

Yellow Card Reflection: A self-reflection of each evaluated GEL student after they are in a leadership role. Upon completion of the leadership role, each GEL student will complete a Leadership Reflection and submit it via the ELL Course Stellar site.* This is a moment for reflection; to think about what did and did not go well and which capabilities you feel you can improve upon in the future. The yellow card represents a vital component of your experience in GEL: It is your opportunity for candid, honest reflection.

*Timely reflection is essential to individual development; to receive full credit, Yellow Card reflections must be submitted within 5 days of the ELL. Yellow Cards submitted after the 5th day will incur a significant grade reduction. Yellow card submitted > 10 days from the ELL or evaluated event will not be accepted without prior notification, and approval from the course instructional team.

The Capabilities of Effective Engineering Leaders are used to assess students while in a leadership role. These capabilities can be observed and are assessed by a trained observer while using an “Assessment Card.” At the end of the assessed period, the observer and student will discuss the leader’s performance and highlight both positive and negative aspects. The assessor will review the assessment card with the student and provide an overall assessment grade.

Core Personal Values and Character: Reflecting upon existing beliefs, embracing a growth mindset, and further evolving one’s sense of responsibility and personal values in order to build the foundations for character and leadership effectiveness. For effective engineering leaders, these foundations include:

- **Initiative (IN)** – Ability and willingness to assess risk and to take initiative; to create a vision and launch a course of action, including in situations characterized by minimal help or direction from others.
- **Decision Making in the Face of Uncertainty (DM)** – Ability and willingness to make decisions based on the information at hand, factoring in risks, uncertainty, and potentially conflicting objectives.
- **Responsibility, Urgency, and Will to Deliver (RU)** – Determination to accomplish one’s objectives, and those of the team, pragmatically and in the face of constraints, obstacles, and errors by oneself and others. Commitment to the absolute responsibility to persevere and deliver on me, pursuing necessary follow-up. Ability to focus on the tasks at hand with passion, discipline, and intensity.
- **Resourcefulness and Flexibility (RF)** – Ability and willingness to approach problems, tasks, and situations making ingenious use of the resources of the situation and group, and to manage the use of me. A willingness to accept and respond to change, embrace various views, be adaptable, and maintain and take alternative courses of action when necessary.
- **Ethical Action, Integrity, and Courage (EI)** – Adherence to ethical standards and principles. Demonstrating the courage to act ethically and with integrity. Comming to practice in accordance with the norms of professional responsibility and one’s responsibility to society.
- **Trust, Loyalty, and Team-Building (TL)** – 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 and to make the people around you successful.
Relating: developing key relationships and networks within and across organizations, including listening to others to understand their views and advocating for your position. For effective engineering leaders, capabilities in this area specialize to:

- **Inquiring and Dialoguing (ID)** – Listening to others with the intention of genuinely understanding their thoughts and feelings. Constructing effective dialogue. Recognizing the ideas of others may be better than yours. Listening to and being willing to learn from everybody.
- **Structured Communications (SC)** – Being able to create a strategy and structure to formal communications; presenting information orally, in written form, and graphical form to both engineers and non-engineers in a clear and concise manner.
- **Advocacy (AD)** – The ability to clearly explain one’s own point of view or approach, advocate a position, and explain how one reached their interpretation and conclusion. Proactively assessing the extent to which you are understood. Being able to do so with and without technical backgrounds, and from different cultures.
- **Negotiation, Compromise, and Conflict Resolution (NC)** – Appreciating the need to identify potential disagreements, tensions or conflicts, and being able to negotiate to find mutually acceptable solutions.
- **Diverse Connections and Grouping (DC)** – Appreciating, engaging, and connecting widely with those with different skills, cultures, and experiences. Building a sense of group within direct participants, and building extended networks of those that can help achieve the goals and technical solutions.
- **Constructive Interaction; Providing and Receiving Feedback (CI)** – Understanding and respecting the unique needs and characteristics of individuals and the group. Recognizing what individuals with different backgrounds can bring to an organization. Coaching, teaching, and providing and receiving evaluation and feedback, while exhibiting elements of gracious professionalism.

Debriefing: A debriefing is a professional discussion which focuses on GEL student performance set against an established standard for the capabilities being evaluated. Debriefings maximize learning benefits by GELs, to learn from each other and the overall situation. Debriefs are most effective when the discussion is dynamic, candid, insightful, and focused. Everyone can and should participate if they have an insight, observation or question that will help the GEL leader or team identify areas of improvement or maintain strengths. Maximum participation fosters the best discussion.

A debrief is NOT a critique. A debrief is NOT a means of “grading” success or failure. Ideally, debriefs should be conducted immediately following an exercise so that the information and experience is fresh in the minds of the participants. GEL2s should encourage GEL students to give honest opinions and use open-ended/leading questions to guide the discussion of leader and team performance.

**Sample Debrief Structure**

Review of objectives and intent: Learning Objectives- (what was supposed to happen, were the learning objectives met)

Summary of recent events (what happened): Planning, Preparation, Execution

Discussion of key events/themes/issues: What did the team do well? How can the team improve?
APPENDICES
Appendix 1: Selected FAQs

- How can I share more about the GEL experience?
- How does one become a GEL? How do I advance to the second year of GEL?
- How do I encourage others to participate in GEL?
- What are the requirements of the GEL Year One and GEL Year Two programs?
- What do I receive as a result of participating in GEL?
- How do GELs support each other and the overall GEL community?
- Where do GEL alums work?

Q. How can I share more about the GEL experience?

Encourage others to visit our booth and talk to current students and staff at:
- Career Fairs
- Sophomore Year Experience (SYE) Fair
- Information Sessions (typically held during the spring semester; check our website for dates)

Watch these videos:
- GEL Program Video
- Emily Hupf '14: Why You Should Apply to GEL
- Ariadne Smith '11: Why GEL is Valuable
- Nora Micheva '11: How GEL Enhanced My MIT Experience

Read this blog:
- Stanley Gill '14 Admissions Blog

Q. How does one apply to become a GEL? How do I advance to the second year of GEL?

For GEL1, prospective students will fill out an online application and complete an in-person interview. GEL’s admission season is typically early in the spring semester, check the website for deadlines and announcements.

For GEL2, the student (GEL1) must demonstrate a commitment to developing themselves while supporting their team and its leadership. The first year of GEL serves as a “year-long interview” in which student leadership, and program staff observe and assess your leadership potential. Additionally, the process involves a brief online application and self-evaluation, and in many cases a one-on-one interview with program staff.

Q. How do I encourage others to participate in GEL?

Encourage others to consider joining GEL if they strive to enhance their leadership ability in engineering or technical contexts. All students join GEL at differing levels of leadership experience – this creates a wonderfully diverse cohort where students grow from each other’s feedback, energy and enthusiasm. Whether they’re an emerged leader or a novice leader, aspiring and current GELs share a passion for continued leadership development – GEL provides the instruction, practice, feedback and structure they’ll need to enhance their engineering leadership ability.
Q. What are the requirements of the GEL Year One and GEL Year Two programs?

Learn more about GEL1 Requirements and GEL2 Requirements.

Q. What do I receive as a result of participating in GEL?

In addition to receiving academic credit, you’ll receive a Certificate of Engineering Leadership (for successful completion of the GEL1 program) or a Certificate of Advanced Engineering Leadership (successful completion of the GEL2 program). These certificates are increasingly coveted by industry and are a strong addition to your resume. Students will be recognized at a formal completion ceremony.

Q. How do GELs support each other and the overall GEL community?

Before and after graduating, GELs are a vibrant community. Here is just a small sample of the ways that GELs contribute:

- GELs play a vital role in recruitment and outreach during the GEL admissions season
- GELs organize and host events
- GELs fundraise for initiatives
- GELs take the responsibility for building and enhancing the GEL student community

Our alums are particularly active; here are just a few ways they give back to the program:

- GEL alums return to visit Engineering Leadership Labs
- GEL alums mentor current GELs
- GELs alums help make career connections for current GELs
Q. Where do GEL alums and interns work?

GEL Alums and current student-interns can be found actively working and leading successful teams throughout private and government industry. The GEL Program prides itself on maintaining a strong mutually-beneficial relationship with our Alums in industry in order to continuously enhance our undergraduate, graduate and professional education programs. Many outside companies specifically seek out GEL students in their recruiting activities.
Appendix 2: General Program Completion Criteria and Expectations

Performance Expectations –
GEL Students are expected to earn a “B” or higher in all GEL related coursework. Students are encouraged to complete all relevant GEL courses under standard (A,B,C,D,F) grading. Due to the teamwork nature of GEL and the emphasis on small-team building, taking GEL courses under alternative (other than regular) grading methods is discouraged and requires prior approval. Students electing to use their Junior-Senior P/D/F Option should first notify the appropriate GEL course instructor in writing. If approved, students taking a course under alternative grading methods are expected to earn a “B” or higher on all deliverables and coursework in order to earn their GEL1/GEL2 completion certificate.

Requirement Completion Timeline –
GEL Students are expected to remain on-track to complete GEL program coursework and to be a part of a GEL class cohort. Students who fall behind are asked to work directly with GEL instructional staff to establish a recovery plan. If a student falls behind and is unwilling or non-responsive regarding getting back on track, they will be asked to leave the GEL program. “Students may not remain in 6.911/6.913 (ELL) if they are not on-track to complete their GEL1 or GEL2 completion certificate.

In-line with the values of courtesy, respect, and professionalism championed by the GEL program, students are asked to reach out to the instructional staff before dropping a GEL class. Similarly, admitted GEL students are expected to register for GEL classes during the registration period along with the rest of their cohort. Admitted GEL students who withdraw from a GEL course without notice after “Reg. Day” may be asked to leave the program.

Unless approved in advance by GEL Staff, students are expected to complete all required coursework within two (GEL1) or four (GEL2) consecutive academic semesters in order to earn their completion certificate.

GEL2 Application and Advancement prerequisites
Students who have/will successfully earn their GEL1 completion certificate are encouraged to explore and apply for the Advanced (GEL2) program. Favorable consideration will be given to those students who have or will successfully complete all of the GEL year-one requirements. Students desiring to apply for the GEL2 program should make early-efforts to seek a summer internship opportunity that will satisfy the InternshipPlus* completion requirement. Failure to secure a qualifying internship will likely have a negative impact on their application.

* for details regarding InternshipPlus, visit http://gelp.mit.edu/students/about-gel-year-two, InternshipPlus.
Appendix 3: Approved Engineering Leadership Electives

9.00 Introduction to Psychological Science
Prereq: None
Units: 4-0-8

A survey of the scientific study of human nature, including how the mind works, and how the brain supports the mind. Topics include the mental and neural bases of perception, emotion, learning, memory, cognition, child development, personality, psychopathology, and social interaction. Consideration of how such knowledge relates to debates about nature and nurture, free will, consciousness, human differences, self, and society.

10.01 - Ethics for Engineers (Offered under: 1.082, 2.900, 6.904, 10.01, 22.014)
Engineering School-Wide Elective Subject.
Prereq: None
Units: 2-0-4

Integrates classical readings that provide an overview of ethics with a survey of case studies that focus on ethical problems arising in the practice of engineering. Readings taken from a variety of sources, such as Aristotle, Machiavelli, Bacon, Hobbes, Locke, the Founding Fathers, and the Bible. Case studies include written analyses and films that address engineering disasters, biotechnology, court cases, ethical codes, and the ultimate scope and aims of engineering.

10.806 - Management in Engineering (Offered under: 2.96, 6.930, 10.806, 16.653)
Engineering School-Wide Elective Subject.
Prereq: None
Units: 3-1-8

Introduction and overview of engineering management. Financial principles, management of innovation, technical strategy and best management practices. Case study method of instruction emphasizes participation in class discussion. Focus is on the development of individual skills and management tools. Restricted to juniors and seniors.

11.011 - The Art and Science of Negotiation
Prereq: None
Units: 3-0-9

Introduction to negotiation theory and practice. Applications in government, business, and nonprofit settings are examined. Combines a "hands-on" personal skill-building orientation with a look at perennial theory. Strategy, communication, ethics, and institutional influences are examined as they shape the ability of actors to analyze problems, negotiate agreements, and resolve disputes in social, organizational, and political circumstances characterized by interdependent interests.
15.301 - Managerial Psychology Laboratory
Prereq: None
Units: 3-3-9

Surveys individual and social psychology and organization theory interpreted in the context of the managerial environment. Laboratory involves projects of an applied nature in behavioral science. Emphasizes use of behavioral science research methods to test hypotheses concerning decision-making, group behavior, and organizational behavior. Instruction and practice in communication includes report writing, team projects, and oral and visual presentation. 12 units may be applied to the General Institute Laboratory Requirement. Shares lectures with 15.310.

15.310 - Managerial Psychology
Prereq: None
Units: 2-1-6

Surveys social psychology and organization theory as interpreted in the context of the managerial environment. Covers a number of diverse topics, including motivation and reward systems, social influence, groups and teams, leadership, power, organizational design and culture, and networks and communication patterns. Similar in content to 15.311; shares lectures with 15.301. Preference to non-Course 15 students.

15.320 - Strategic Organizational Design
Prereq: None
Units: 3-0-6

Focuses on effective organizational design in both traditional and innovative organizations, with special emphasis on innovative organizational forms that can provide strategic advantage. Topics include when to use functional, divisional, or matrix organizations; how IT creates new organizational possibilities; examples of innovative organizational possibilities, such as democratic decision-making, crowd-based organizations, internal resource markets, and other forms of collective intelligence. Team projects include inventing new possibilities for real organizations.

15.665 - Power and Negotiation
Prereq: Permission of instructor
Units: 3-0-6

Provides understanding of the theory and processes of negotiation as practiced in a variety of settings. Designed for relevance to the broad spectrum of bargaining problems faced by the manager and professional. Allows students an opportunity to develop negotiation skills experientially and to understand negotiation in useful analytical frameworks. Emphasizes simulations, exercises, role playing, and cases.
15.668 - People and Organizations
Prereq: None
Units: 3-0-6

Examines the historical evolution and current human and organizational contexts in which scientists, engineers and other professionals work. Outlines major challenges facing the management profession. Uses interactive exercises, simulations and problems to develop critical skills in negotiations, teamwork, and leadership. Focuses on practical application of these skills in a professional context. Introduces concepts and tools to analyze work and leadership experiences in internships, school activities, and fieldwork. Preference to Management minors and other undergraduates not majoring in Management Science.

21G.019 - Communicating Across Cultures
Prereq: None
Units: 3-0-9

Examines a range of communication styles and techniques resulting from different cultural norms and traditions. Begins with a general theoretical framework and then moves into case studies. Topics include understanding the relationship between communication and culture, differences in verbal and non-verbal communication styles, barriers to intercultural communication, modes of specific cross-cultural communication activities (argumentation, negotiations, conflict resolution) and intercultural adjustment. Case studies explore specific ways of communicating in Asian and European cultures. Graduate students are expected to complete additional assignments. Taught in English. Enrollment limited.
Appendix 4: Capabilities of Effective Engineering Leaders

Version 3.7, July 2019

Engineers design and build things that meet the needs of customers, beneficiaries, and ultimately, society. These activities can only be accomplished by the concerted action of many people aligned and rallied by effective leadership. The Bernard M. Gordon-MIT Engineering Leadership Program (GEL) is dedicated to empowering MIT students to make the most of their talents and to help them set and achieve personal goals related to these activities. Such goals include making an impact upon, leading, and founding teams and organizations that tackle and solve the types of market and societal problems that can be addressed (at least in part) by technical solutions.

This document serves to guide the curricular and programmatic design of GEL. Fundamentally, GEL seeks to educate and develop the character of outstanding MIT students as the potential future leaders of engineering practice and technological development. Our program centers on the following definition:

*Engineering Leadership is the technical leadership of change: the innovative conception, design, and implementation of new products/processes/materials/molecules/software/systems that meet the needs of customers and society, as enabled by the invention of key technologies and as brought to fruition by teams of people working together.*

We start with the assumption that many students entering university possess leadership potential. At the same time, we observe that with a primary focus on engineering science, existing engineering curricula often do not adequately emphasize the development of engineering leadership. In this program, our educational task is to provide opportunities for all engineering students to further develop the values, character, and capabilities that underpin effective engineering leadership.

Our engineering leadership educational framework encompasses three developmental realms:

- **Personal development** in areas of values, responsibility, and character;
- **Skills development** in areas that enable critical to delivering engineering success, categorized as: communicating and relating with others, making sense of context, creating and conveying visions, and implementing and delivering upon visions;
- **Development of technical knowledge and reasoning** in one (or more) engineering domain.

In order to address those realms, the curricular scope of the Capabilities of Effective Engineering Leaders framework draws from multiple sources. The framework’s development was initiated and shaped during a series of consensus-building workshops held at MIT during the winter and spring of 2008. The workshops brought together program stakeholders with diverse perspectives on engineering leadership: alumni, students, faculty, industry leaders, military leaders, community leaders, and educators from other leadership programs at MIT. Following from workshop participants’ inputs, the framework’s details were further refined and substantiated by two primary literatures: leadership scholarship and engineering curricular reform efforts. Among leadership scholarship literature, the framework draws from both sub-literatures on personal development and on skills development. Meanwhile, the categorical organization of the framework leverages a scheme similar to the MIT Sloan School of Management’s Four Capabilities Model, as specialized for the case of engineering leadership. Following its initial release, this document has further evolved through several subsequent stakeholder engagements with engineering leaders from industry.
Our program operates on the belief that students’ capacity for engineering leadership is best developed by linking learning, practice, feedback, and reflection in a meaningful and systematic way. Program educational elements consequently include:

- Coursework that provides analytical concepts and frameworks for understanding engineering teamwork and leadership;
- Engineering teamwork and leadership practice opportunities (both on- and off-campus);
- Opportunities to gain feedback from peers, faculty, and experienced engineering mentors on lessons-learned from teamwork and leadership activities; also, opportunities to reflect upon and discuss this feedback with peers, faculty, and mentors.

In some greater detail, the components of the *Capabilities of Effective Engineering Leaders* are presented below. These components nest within contemporary published engineering curricula: for each item, bracketed numeric notes (e.g., “[2.4.1]”) indicate related topic(s) within the CDIO Engineering Curriculum[^10] and parenthetical alphabetic notes (e.g., “(a)”) indicate related topic(s) from among ABET Accreditation Criteria[^11].

1. **Core Personal Values and Character**: Reflecting upon existing beliefs, embracing a growth mindset, and further evolving one’s sense of responsibility and personal values in order to build the foundations for character and leadership effectiveness. For effective engineering leaders, these foundations include:

   - **Initiative** – Ability and willingness to assess risk and to take iniative; to create a vision and launch a course of action, including in situations characterized by minimal help or direction from others. [2.4.1]
   - **Decision Making in the Face of Uncertainty** – Ability and willingness to make decisions based on the information at hand, factoring in risks, uncertainty, and potentially conflicting objectives. [2.4.1]
   - **Responsibility, Urgency, and Will to Deliver** – Determination to accomplish one’s objectives, and those of the team, pragmatically and in the face of constraints, obstacles, and errors by oneself and others. Commitment to the absolute responsibility to persevere and deliver on commitments, pursuing necessary follow-up. Ability to focus on the tasks at hand with passion, discipline, and intensity. [2.4.2]
   - **Resourcefulness and Flexibility** – Ability and willingness to approach problems, tasks, and situations making ingenious use of the resources of the situation and group, and to manage the use of me. A willingness to accept and respond to change, embrace various views, be adaptable, and maintain and take alternative courses of action when necessary. [2.4.2]
   - **Ethical Action, Integrity, and Courage** – Adherence to ethical standards and principles. Demonstrating the courage to act ethically and with integrity. Comming to practice in accordance with norms of professional responsibility and one’s responsibility to society. [2.5.1](f)
   - **Trust, Loyalty, and Team-Building** – 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 and to make the people around you successful. [2.5.6]
   - **Equity and Diversity** – Commitment to treat others as equals, regardless of status or background, and to embrace diversity in organizations. [2.5.5]
• **Self-Awareness, Self-Reflection, and Self-Improvement** – Awareness of one’s own strengths and weaknesses, personal, interpersonal, and professional skills. [2.4.5] Being prepared to continue learning, and proactively planning for one’s continuing education, self-improvement, and future career. [2.4.6, 2.5.3, 2.5.4] (i)

• **Vision and Intention in Life** – Determining a pathway to one’s eventual contribution to and impact on society. Envisioning how engineering plays a role in one’s intentions. Commitment to a personal vision and to inspiring others. [2.5.3]

2. **Relating**: developing key relationships and networks within and across organizations, including listening to others to understand their views and advocating for your position. For effective engineering leaders, capabilities in this area specialize to:

• **Inquiring and Dialoguing** – Listening to others with the intention of genuinely understanding their thoughts and feelings. Constructing effective dialogue. Recognizing the ideas of others may be better than yours. Listening to and being willing to learn from everybody. [3.2.7]

• **Structured Communications** – Being able to create a strategy and structure to formal communications; presenting information orally, in written form, and graphical form to both engineers and non-engineers in a clear and concise manner. [3.2, 3.3] (g)

• **Negotiation, Compromise, and Conflict Resolution** – Appreciating the need to identify potential disagreements, tensions or conflicts, and being able to negotiate to find mutually acceptable solutions. [3.2.8]

• **Advocacy** – The ability to clearly explain one’s own point of view or approach, advocate a position, and explain how one reached their interpretation and conclusion. Proactively assessing the extent to which you are understood. Being able to do so to those with and without technical backgrounds, and from different cultures. [3.2.9]

• **Diverse Connections and Grouping** – Appreciating, engaging, and connecting widely with those with different skills, cultures, and experiences. Building a sense of group within direct participants, and building extended networks of those that can help achieve the goals and technical solution. [3.2.10]

• **Constructive Interaction; Providing and Receiving Feedback** – Understanding and respecting the unique needs and characteristics of individuals and the group. Recognizing what individuals with different backgrounds can bring to an organization. Coaching, teaching, and providing and receiving evaluation and feedback, while exhibiting elements of gracious professionalism. [3.1] (d)
3. **Making Sense of Context**: making sense of the world around oneself and coming to understand the context in which the leader is operating. Making mental maps of complex environments, and explaining them to others clearly and straightforwardly. For effective engineering leaders, capabilities in this area specialize to:

- **Awareness of the Societal and Natural Context** – Being aware of and understanding the world’s problems, challenges, and opportunities, and the historical and contemporary role of engineering in addressing them. Understanding the natural context and the need for sustainability. Being able to identify opportunities for new (or previously not implemented) engineering solutions and systems to address these needs. [4.1] (j, h)

- **Awareness of the Needs of the Customer or Beneficiary** – Understanding the specific needs of those who will benefit from the envisioned engineering solution: the customers who will buy it, the users who will use it, the beneficiaries who will directly or indirectly benefit from it. [4.3.1]

- **Enterprise and Business Context Awareness** – Understanding the goals and culture of the enterprise in which one works; the shared beliefs, goals and strategies of the enterprise; and the norms for working successfully and bringing forth change. Literacy in broader business concepts and analysis, and in particular, engineering project finance. [4.2]

- **Appreciating New Technology** – Understanding the emergence and implications of new science and technology. In the context of engineering projects or programs, understanding how new technologies might enable or enhance new solutions and systems. [4.2.6]

- **Systems Thinking** – Thinking holistically. Possessing an ability to view complexity, focus on critical features, identify interrelationships and emergent qualities, and create abstractions and models that simplify comprehension. [2.3]

4. **Visioning**: creating purposeful, compelling and transformational images of the future, and identifying what could and should be. For effective engineering leaders, capabilities in this area specialize to:

- **Identifying the Issue, Problem, or Paradox** – Synthesizing an understanding of situations, inclusive of problems, needs or opportunities. Clarifying the central issues, framing the problem to be solved, or identifying the underlying paradox to be examined. [4.3.1]

- **Thinking Creatively and Depicting Possibilities** – Understanding how to create new ideas and approaches. Creating and conveying visions for new technical products, systems and new engineering-based enterprises that deliver new capabilities. [2.4.3]

- **Defining the Solution** – Establishing a vision for the solution and setting achievable goals for performance (including quality), budget, and schedule. This solution vision is guided by the views of the customer and other key stakeholders, reflects the possibilities of technology, considers the full range of alternative approaches, meets regulatory and policy constraints, and considers competitive forces. [4.3.1]

- **Architecting the Solution Concept** – Selecting and architected the concept for the technical solution, which might be novel or evolutionary. Defining the specificaons, interfaces and key elements of the solution so that realization can be effective. [4.3.2, 4.3.3]
5. **Delivering on the Vision**: leading transformation by designing and executing processes and approaches to delivering on the vision; moving from abstraction to implementation. This transformation (e.g., “geng engineering done”) is the conversion of inventive ideas and innovative concepts into realized, deliverable solutions. For effective engineering leaders, capabilities in this area specialize to:

- **Aligning Organizations Toward a Vision** – Strengthening an organization by recruiting key players with complementary and superior skills, tailoring an organization’s operating processes and systems, formulating roles and responsibilities, and setting expectations toward achieving project/program/product vision(s). Facilitating group decision-making. Assessing organizational and individual performance. Observing, reflecting, and building upon the leadership qualities of others. Developing approaches to leverage competence outside of one’s immediate area in an extended organization. Understanding how to manage organizational change. [4.2.4] In certain cases, creating a new engineering-based entrepreneurial enterprise. [4.2.3]

- **Planning and Managing a Project to Completion** – Choosing a development strategy (waterfall, spiral, agile, etc.) and devising primary and alternate plans of action to achieve the goals and deliver on them. Identifying and removing obstacles. Controlling the project to the plan. Identifying when the project is off plan and re-planning appropriately. Managing and apporportioning the resources of the team to achieve the desired outcome within the human, material, financial, and technological resources available. Controlling and managing program margins, risk, configuration, and documentation. Understanding the financing and the economics of the project. [4.3.4]

- **Exercising Project/Solution Judgment and Critical Reasoning** – Questioning, critically evaluating, and applying judgment to solutions proposed by others. Corroborating inputs. Evaluating evidence and identifying the validity of key assumptions. Applying critical thinking. [2.4.4] Understanding alternatives that may be developed or are being developed by others, including competitors. Taking into account the evolution of existing systems when proposing new systems.

- **Invention** – Imagining possibilities based on emerging technology or science, and conceiving a practical device, material, process or way of working that enables or enhances a new good or service. Adhering to and leveraging intellectual property regimes. [4.4] (c)

- **Innovation** – Designing and introducing new goods and services to the marketplace. Based on goals and solution concept, identifying, advocating for and amassing the required resources. Designing a solution with the appropriate balance of existing and new technology, reuse and new development, while maintaining flexibility and adaptability. Considering current and future competition. Considering sustainability in the design and implementation. Validating the effectiveness of the outcomes. [4.4] (c)

- **Deploying and Operating the Solution** – Ensuring successful outcomes of engineering endeavors through solution verification (e.g., modeling, simulation, testing), roll-out (e.g., production, deployment), feedback collection (e.g., monitoring), and refinement. Considering quality, variability, and robustness when carrying out implementation plans. Deploying and operating the solution (e.g., product / process / material / molecule / sware / system) effectively in a manner such that the needs of the customer and society are repeatably and reliably met. [4.5, 4.6]
6. **Technical Knowledge and Reasoning**: Essential to the effective execution of engineering leadership is a deep working knowledge of a technology or discipline. While normally developed in the standard curricular course of study, this knowledge is no less essential for an engineering leader. It includes an ability to understand, decompose and recombine different elements of a technical problem through application of a deep understanding of technical knowledge [1.0] (a), engineering reasoning and problem solving [2.1] (e), and the approaches to inquiry and experimentation that may be necessary to develop or refine a new technology needed for a product, process or system. [2.2] (b)
References

1 For critical reviews of existing engineering curricula and discussion on efforts to introduce leadership development, see:


2 The values and character development component of our program leverages experiential learning, feedback, and reflection, similar to the learning framework described by Keith et al. (2009), tailored for the non-military university context:


3 The skills development component of our program centers on building a skill set for effective engineering practitioners and leaders, as presented by ABET (2000) and Crawley et al. (2001). This component of the program aligns with the “skills approach” to leadership, as described by Northouse (2010):


4 Development of technical knowledge and reasoning is assumed to take place within existing engineering curricula.

5 For general overviews, see:


6 See Reference 1, above.

7 See Reference 2, above. For overviews of the Growth Mindset and Adult Development theories that underlie this approach, see Heslin and Keang (2017) and Lewis et al. (2005), respectively:


8 See Reference 3, above.

9 The MIT Sloan 4-Capability Model is described by Ancona et al. (2007):


10 The CDIO Syllabus Version 1.0 (Crawley, 2001) was the source used during concept and development of this document. Since CDIO v.1.0 was released, an updated version (Version 2.0) has been published within Crawley et al. (2014):


11 The ABET 2000-2001 Engineering Criteria (ABET, 2000) was the source used during development of this document. Since ABET (2000), updates have been released by ABET. The second citation, below, provides a link to the latest version:

