GEL Student Handbook
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1. **The Attitudes of Leadership - Core Personal Values and Character:**
   - Initiative
   - Decision Making in the Face of Uncertainty
   - Responsibility, Urgency and Will to Deliver
   - Resourcefulness, Flexibility and Change
   - Ethical Action, Integrity and Courage
   - Trust and Loyalty
   - Equity and Diversity
   - Vision and Intention in Life
   - Self-Awareness and Self-Improvement

2. **Relating:**
   1. Inquiring and Dialoging
   2. Negotiation, Compromise and Conflict Resolution
   3. Advocacy
   4. Diverse Connections and Grouping
   5. Interpersonal Skills
   6. Structured Communications

3. **Making Sense of Context:**
   7. Awareness of the Societal and Natural Context
   8. Awareness of the Needs of the Customer or Beneficiary
   9. Enterprise Awareness
   10. Appreciating New Technology
   11. Systems Thinking

4. **Visioning:**
   12. Identifying the Issue, Problem or Paradox
   13. Thinking Creatively, and Imagining and Communicating Possibilities
   14. Defining the Solution
   15. Creating the Solution Concept

5. **Delivering on the Vision:**
   - Building and Leading an Organization and Extended Organization
   - Planning and Managing a Project to Completion
   - Exercising Project/Solution Judgment and Critical Reasoning
   - Innovation
   - Invention
   - Implementation and Operation

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

✓ Read this handbook thoroughly, and if you have questions consult with your team leader. (There will be a quiz on this material.)

✓ Be aware of the program completion requirements for both GEL1 and GEL2 programs. Keep yourself on track for completion.

✓ Log onto the GEL Student Website.

✓ Complete your initial Personal Leadership Development Plan (PLDP)

✓ Become familiar with the Engineering Practice Requirement. Start to think about project options.
About GEL

The Bernard M. Gordon-MIT Engineering Leadership Program develops tomorrow’s engineering leaders. Each year, more than 120 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 2007 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 100 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 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 and practice the Capabilities of Effective Engineering Leaders.
- Prepare students to become productive and effective contributors in industry through multi-disciplinary 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.
- Sharpen students’ communication and presentation skills.

Goals of the GEL2 year

- Continue challenging students to become better engineering leaders by immersing them in the practical application of the Capabilities of Effective Engineering Leaders.
- Continue 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.
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 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.

<table>
<thead>
<tr>
<th>SUMMER</th>
<th>FALL</th>
<th>IAP</th>
<th>SPRING</th>
</tr>
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<tbody>
<tr>
<td><strong>GEL1</strong></td>
<td><strong>ESD.05</strong></td>
<td><strong>ESD.050</strong></td>
<td><strong>ESD.05</strong></td>
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<tr>
<td>(Junior or Senior Year)</td>
<td><strong>ESD.054</strong></td>
<td><strong>ESD.054</strong></td>
<td><strong>ESD.054</strong></td>
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<td><strong>ESD.051</strong>&lt;sup&gt;*&lt;/sup&gt;</td>
<td><strong>ESD.050</strong>&lt;sup&gt;**&lt;/sup&gt;</td>
<td><strong>ESD.050</strong></td>
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<td>Eng. Practice Requirement Essay (EPR1)&lt;sup&gt;**&lt;/sup&gt;</td>
<td>Eng. Practice Requirement Interview (EPR2)&lt;sup&gt;**&lt;/sup&gt;</td>
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<tr>
<td></td>
<td>Personal Leadership Development Plan</td>
<td>Personal Leadership Development Plan</td>
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| **GEL2** | **InternshipPlus** | **ESD.052** | **15.668** |
| (Senior Year) | **ESD.050** | **ESD.050**<sup>**</sup> | |
| | **6 units** | **6 units** | **9 units** |

<sup>*</sup> ESD.051 is offered in the Fall and Spring semesters. Students can take it at either time.

<sup>**</sup> Students elect (in early Fall) to submit their EPR deliverables in either the Fall or Spring semester.

**GEL Core Courses:**
- ESD.05 - Engineering Leadership Lab (For GEL1s)
- ESD.050 - Engineering Leadership Lab (For GEL2s)
- ESD.054 - Engineering Leadership
- ESD.051J - Engineering Innovation and Design
- ESD.052 - Project Engineering
- 15.668 - People and Organizations

**Approved Alternate Courses:**
- None
- None
- None
- 2.722J
- 1.011
- 15.301; 15.310; 15.320
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

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Description</th>
<th>Class Time</th>
<th>Units/Credit</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESD.05: Engineering Leadership Lab (ELL)</td>
<td>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/tother students. (Both semesters)</td>
<td>2 hours per week</td>
<td>6 units total (3 per semester)</td>
</tr>
<tr>
<td>ESD.051J: 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) <em>Note</em> Approved Alternate Course: 2.722J - D-Lab: Design</td>
<td>2 hours lecture, 1 hour recitation</td>
<td>6 units</td>
</tr>
<tr>
<td>ESD.054: Engineering Leadership*</td>
<td>Introduces models and theories, such as the Four Capabilities Framework and the Capabilities of Effective Engineering Leaders. Discusses the appropriate times and reasons to use particular models to deliver engineering success. (Both semesters)</td>
<td>1 hour per week</td>
<td>6 units total (3 per semester)</td>
</tr>
<tr>
<td>Engineering Practice Requirement Essay (EPR1)</td>
<td>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.</td>
<td>Required for completion</td>
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</tr>
<tr>
<td>Personal Leadership Development Plan (PLDP)</td>
<td>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.</td>
<td>Year-long assignment</td>
<td></td>
</tr>
<tr>
<td>Mentorship</td>
<td>The GEL Program will periodically host group mentoring events where students can meet and connect with engineers and engineering leaders with industry experience.</td>
<td>Optional</td>
<td></td>
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* This subject is no longer offered over IAP.
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.

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, software, 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 timing.

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 (via the GEL Student Website) is due early in the Fall Semester, and entails:

- 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 on the GEL website.
- 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 ESD.051 (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.
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. It’s a mechanism for capturing and conveying lessons-learned so that future 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 (via the GEL Student Website) a project Post-Mortem essay that includes the following:

- Thoughtful reflection and discussion that addresses the topics outlined in the EPR Essay Post-Mortem Rubric
- Approximately 5-7 pages 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.

### REQUIREMENTS FOR A GEL2 CERTIFICATE

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Description</th>
<th>Class Time</th>
<th>Units/Credit</th>
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<tbody>
<tr>
<td><strong>ESD.050: Engineering Leadership Lab (ELL)</strong>*</td>
<td>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. *GEL2 students work closely with program staff to plan, organize, and deliver lab exercises to GEL1s. (Both semesters)</td>
<td>2 hours per week (GEL2s are required to meet, as needed, outside of lab)</td>
<td>12 units (6 per semester)</td>
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<tr>
<td><strong>ESD.052: Project Engineering</strong></td>
<td>Provides an introduction to basic principles, methods, and tools for project management in a realistic context. Over remainder of term, progresses to an introduction to project management, with emphasis on finance, evaluation, and organization. (IAP + selected dates) <em>Note</em> Approved Alternate Course: 1.011 - Project Evaluation and Management</td>
<td>4-day off-site class</td>
<td>6 units</td>
</tr>
<tr>
<td><strong>15.668: People and Organizations</strong></td>
<td>Examines the historical evolution and current human and organizational contexts. Outlines major challenges facing the management profession. Activities include interactive exercises and simulations. (Spring Semester) <em>Note</em> Approved Alternate Courses: 15.301/15.310 - Managerial Psych.; 15.320 - Strategic Organizational Design</td>
<td>4 hours per week</td>
<td>9 units</td>
</tr>
<tr>
<td><strong>InternshipPlus</strong></td>
<td>Students secure an internship and work to maximize their experience, perhaps seeking additional responsibilities or taking on a special project.</td>
<td>Required during summer before GEL2 Year</td>
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<tr>
<td><strong>Engineering Practice Requirement Interview (EPR2)</strong></td>
<td>GEL2s interview an engineering leader from industry, capturing lessons learned in a written report. <strong>GEL2s in AY2015-16 have the option to complete the legacy Engineering Practice Requirement (EPR) assignment in place of the interview assignment.</strong></td>
<td>Required for completion</td>
<td></td>
</tr>
<tr>
<td><strong>Personal Leadership Development Plan (PLDP)</strong></td>
<td>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.</td>
<td>Year-long assignment</td>
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</tr>
<tr>
<td><strong>Final Presentation</strong></td>
<td>GEL2s present on their development and progress regarding the Capabilities of Effective Engineering Leaders.</td>
<td>Required for completion</td>
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</tr>
<tr>
<td><strong>Mentorship</strong></td>
<td>GEL2s have the option to be paired with mentor who is a mid/senior engineering leader in industry.</td>
<td>Recommended</td>
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Engineering Practice Requirement Essay (EPR2)

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 either be their GEL2 mentor (if the GEL2 opts to be paired with a mentor), or anyone else 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 thoughtful 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/infrastructural 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 – though, those may certainly be interesting people with great careers!

**EPR Interview Deliverables**

*NOTE: GEL2s in AY2015-16 opting to complete the Interview assignment as their EPR should submit these deliverables via email to jmfeiler@mit.edu rather than via the GEL Student Website*
1. **EPR 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 GEL Student Website) is due early in the Spring 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 report (to be submitted via the GEL Student Website) should include:
  - A description of the engineering project leader’s background (information provided in the sign-up can be reused)
  - The interviewee’s answers to the questions above
  - Your 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 (thoughtful, complete, 5-10 pages, 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
Personal Leadership Development Plan (PLDP)

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 a PLDP during the academic year.

ASSIGNMENT OVERVIEW
GELs complete a baseline PLDP soon after they enter the program via an online form within the GEL Student Website. All capabilities are listed and students can select a rating (not yet possess, introductory, intermediate, and advanced levels) and type in their rationale behind the rating. GELs will submit two milestone entries per academic year; however, the form remains live throughout the year for GELs to edit via the GEL Student Website.

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 the academic year, they'll submit a year-end PLDP entry. GEL2s repeat this process in their second year of the program.

DELIVERABLES
- GEL 1 Fall Semester PLDP submittal
- GEL 1 Spring Semester PLDP submittal
- GEL 2 Fall Semester PLDP submittal
- GEL 2 Spring Semester PLDP submittal
Ground Rules and Guidelines for Success

**Advising** – Staff members are available upon request to advise students regarding program requirements and other matters.

**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).

**The GEL Student Website and Stellar** – GELs use the GEL Student Website to submit key GEL assignments and track their progress through the program. Each GEL will set up a “profile” on the site to denote his or her academic major and contact information. (Note: Students’ coursework completion status on the GEL Student Website is self-reported and does not reflect an official transcript of GEL course status.) Students should also note that some GEL instructors may require certain assignments to be submitted via Stellar rather than the GEL Student Website: Pay attention to the specifics of each assignment. Instructors also often utilize Stellar to post readings and other course materials.

**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 advisor or the course instructor. 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 leadership labs and short courses (ESD.05/050, ESD.051, ESD.052, ESD.054, 15.668) to ascertain grading policies for each course. GELs should raise any questions about grading policies with the individual course instructor(s).

**Attendance** – GELs should refer to the specific syllabi from each of the ELLs and short courses (ESD.05/050, ESD.051, ESD.052, ESD.054, 15.668) 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 (ESD.05/050) Attendance** – as Engineering Leadership Lab is an interactive, team-based experience, absences are detrimental both to individual students and to their teams. GELs must make every effort to attend all ELLs. In the event of exceptional circumstances, GELs must email gel-absent@mit.edu and CC their team leaders in advance of any missed ELL. Please refer to the ESD.05/050 syllabus for further details about ELL attendance.

**Feedback and Reflection** – performance assessment feedback is a critical aspect of the GEL program’s leadership development approach. GELs are routinely assessed during ELLs (ESD.05/050) and must submit a self-reflection any time they receive an assessment. GELs will submit their reflections via the GEL Student Website. Given the uniqueness of this feedback-based approach compared to other classes at MIT, some new GEL students may take time to become fully accustomed to it. As such, GELs are encouraged to discuss the feedback process with their team leaders, their advisor, or the instructors.

**The GEL Student Leadership Organization** – participants who have been accepted into the GEL Year Two 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.
The GEL Student Website

A portal for submitting GEL assignments & tracking program progress  
URL: gel-students.mit.edu

How to Log On:

- You will soon receive an email with your temporary log-in credentials
- If you do not receive this email, contact John Feiler (jmfeiler@mit.edu)

As soon as you’ve logged on, please set up a profile with your full name and academic information:
The welcome screen will allow you to submit the required assignments & track progress:

Yellowcard Reflections

Create a new yellowcard reflection

Requirements

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
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</tr>
<tr>
<td>GEL 1 PLDP - Spring - Second GEL Semester</td>
<td>not started</td>
</tr>
<tr>
<td>GEL 1 Engineering Practice Requirement Essay: Sign-up Form</td>
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<tr>
<td>GEL 1 Engineering Practice Requirement Essay</td>
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<td>ESD.051J: Engineering, Innovation and Design</td>
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<tr>
<td>ESD.054: Engineering Leadership 1</td>
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<td>ESD.055: Engineering Leadership Lab 1</td>
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<td>ESD.054: Engineering Leadership 2</td>
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Assessment Cards & Debriefing

**Assessment (Yellow) Card:** Assesses each GEL student while they are in a leadership role. The primary evaluation will focus on the leadership capabilities. It will also list leadership capabilities to sustain or improve upon.

Students may be evaluated in all or some of the 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 yellow card and submit it online through the GEL Stellar site.* This is a time 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.*

The following effective capabilities 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, highlighting both positive and negative actions, review the assessment card.

**Attitudes of Leadership (Core Values):** Students should reflect on their beliefs and attitudes, and further evolve their sense of responsibility and the personal capabilities that form a foundation for effective leadership. For effective engineering leaders, these include:

- **Initiative (IN)** – Ability and willingness to assess risk and to take initiative, to create a vision and course of action, without the help or advice of others.
- **Ethical Action and Integrity (EI)** – An adherence to ethical standards and principles, and demonstration of the courage to act ethically and with integrity, and to practice according to the norms of professional responsibility and one’s responsibility to society.
- **Resourcefulness, Flexibility and Change (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 time. A willingness to accept and respond to change, embrace various views, be adaptable, and formulate and take alternative courses of action when necessary.
- **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 you and others. Commitment to the absolute responsibility to persevere and deliver on time, pursuing necessary follow-up. Focus on the tasks at hand with passion, discipline, and intensity.
- **Decision Making in the face of Uncertainty (DM)** – Ability and willingness to make decisions informed by the information at hand, factoring in risks, uncertainty and potentially conflicting objectives, even if 100% of the needed information is not available.
- **Trust and Loyalty (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, 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, these specialize in:

- **Interpersonal Skills (IS)** – Understanding and respecting the needs, capabilities, and characteristics of individuals and the group, and the resources that individuals with different backgrounds can bring to an organization. Coaching and teaching, providing and receiving evaluation and feedback, and demonstrating the essential elements of gracious professionalism necessary to be an effective engineering leader.

- **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 to those with and without technical backgrounds, and from different cultures and/or backgrounds.

- **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 solution.

- **Structured Communications (SC)** – Being able to create a strategy and structure to formal communications, and present information orally, in written and graphical form to both engineers and non-engineers in a clear and concise manner.

- **Inquiring and Dialoging (ID)** – Listening to others with the intention of genuinely understanding their thoughts and feelings. Creating constructive dialog, and recognizing the ideas of others may be better than yours. Listening to and being willing to learn from everybody.

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?
Appendix 1: InternshipPlus

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 GEL 2 class.

- **How does it work?** Rising GEL 2s seek and find their own summer internships (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 online forms at the GEL Student Website.

You’re strongly encouraged to engage with your supervisor about InternshipPlus. Supervisors can help provide you 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 GEL 2 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 forum will go live at the beginning of the summer (URL will be announced). Let’s share our observations, our progress, and ask each other challenging questions.

- **Teleconferences** – GEL will host two teleconferences (via MIT’s WebEx tool), one in early summer and one in mid-summer. Your cohort will come together briefly in these virtual meetings to discuss the major themes you’re encountering in your internships.

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; craft it and shape in a way that helps you develop as an engineering leader!
Appendix 2: GEL2 Final Assignment

GEL2 Final Assignment

Reflection 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 time to consider the following: Did I truly earn my GEL 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 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 Internship+ 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 panel. The presentation itself should be around 15-20 minutes.
- 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 time collecting artifacts to incorporate into your presentation. Instead, focus on reflection.
- Try to concentrate on development that occurred during engineering-related experiences.
Appendix 3: Selected FAQs

Q. Am I eligible to join GEL?

All MIT School of Engineering students (students from other majors may also be eligible – please inquire) are eligible to join GEL. Students may first apply to the program in their sophomore year; they may enter as juniors or seniors. Prospective students should have an interest in working in engineering-related industries and have the bandwidth and willingness to commit to program requirements.

Q. What are some key benefits of GEL?

In addition to developing your engineering leadership abilities, GEL offers opportunities to grow your personal and professional networks, to collaborate with students across multiple engineering disciplines, and to make connections with potential employers. Many GELs have continued to maintain their GEL network years after completing the program; many are still in touch with their GEL mentors; and many continue to work at companies they’ve connected with through GEL. In more ways than one, GEL sets the stage for a successful engineering career and provides a foundation for becoming a leader in industry.

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

For GEL1, prospective students will fill out an application and complete an interview. GEL’s admission season is typically early in the Spring Semester, check the website for deadlines and announcements. For GEL2, the process involves a self-evaluation and in some cases an interview.

Q. Why should I participate in GEL?

Consider joining GEL if you strive to enhance your leadership ability in engineering or technical contexts. 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 you’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 you’ll need to enhance your engineering leadership ability.

Q. What are the requirements of the GEL Year One and GEL Year Two programs?

GEL1 and GEL2 completion requirements are outlined in detail on the GEL website and in the student handbook.

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
- GEL alums help make career connections for current GELs

Q. How is GEL governed?

GEL receives guidance from an Industry Advisory Board (IAB), consisting of senior engineering leaders from top engineering companies throughout the country, and a Governing Board (GB) consisting of key MIT institute officials and financial supporters. GEL also collaborates with institute faculty members on educational and curricular aspects of the program.

Q. Where do GEL alums 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 and professional education programs.
Appendix 4: Capabilities of Effective Engineering Leaders
Version 3.6, June 2011

Engineers design and build things that meet the needs of customers, beneficiaries and ultimately society. These tasks 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 is dedicated to empowering MIT students to make the very most of their talents and to help them set and achieve personal goals, including the leading or founding of teams and organizations which tackle and solve the problems of the market and society that can be addressed (at least in part) by technical solutions.

Specifically, we seek to educate and develop the character of outstanding MIT students as the potential future leaders of engineering practice and development. In this program, engineering leadership is defined as the technical leadership of change: the innovative conception, design and implementation of new products/processes/projects/materials/molecules/software/systems, supported by the invention of enabling technologies, to meet the needs of customers and society.

We start with the assumption that many students entering university have already demonstrated leadership potential. At the same time, we observe that with a focus on engineering science, many engineering curricula 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, deepen, and broaden their engineering leadership attitudes and skills.

We want students to graduate having developed the attitudes of leadership: core values and character. They need to have developed the skills of leadership, represented below under the headings of: relating to others, making sense of context, creating visions and realizing the vision. Finally, in order to be effective engineering leaders, they of course need to have developed a deep understanding of the underlying knowledge of engineering, science and technology.

These capabilities of engineering leadership were anchored in the scholarship of leadership, and a consensus building process among engineering leaders. One of the ways to describe leadership is the “skills approach”, which places emphasis on the skills or abilities that can be learned or developed (Northouse 2010). The Gordon – MIT Engineering Leadership Program Capabilities of an Engineering Leader was based on one such capabilities model – the Four Capabilities model, developed at the MIT Sloan School of Management (Ancona 2007). During the winter and spring of 2008, a series of workshops were held at MIT, bringing together program stakeholders with diverse view of engineering leadership: alumni, students, faculty, leaders from industry, military leaders, community leaders and those from other leadership programs at MIT. The first draft of the Capabilities of an Engineering Leader emerged as a consensus of this group, specializing the general Four Capabilities model to engineering. In several subsequent stakeholder engagements with engineering leaders from industry, the document has evolved to its present form.

We believe engineering leadership can best be taught and developed by linking in a timely and systematic way:

- Coursework that provides the analytical concepts and frameworks for understanding engineering leadership;
- Opportunities on and off-campus to experience and practice leadership,
- Opportunities to reflect, discuss, and gain feedback from peers, faculty and experienced engineering mentors on lessons learned from leadership activities.

In some greater detail, these leadership capabilities can be described as presented below.
1. **The Attitudes of Leadership - Core Personal Values and Character:** students should reflect on their beliefs and attitudes, and further evolve their sense of responsibility and the personal capabilities that form a foundation for effective leadership. For effective engineering leaders, these include:

- **Initiative** – Ability and willingness to assess risk and to take initiative, to create a vision and course of action, without the help or advice of others. [2.4.1]

- **Decision Making in the Face of Uncertainty** – Ability and willingness to make decisions informed by 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 you and others. Commitment to the absolute responsibility to persevere and deliver on time, pursuing necessary follow-up. Focus on the tasks at hand with passion, discipline, intensity. [2.4.2]

- **Resourcefulness, Flexibility and Change** – 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 time. 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** – An adherence to ethical standards and principles, and demonstration of the courage to act ethically and with integrity, and to practice according to the norms of professional responsibility and one’s responsibility to society. [2.5.1](f)

- **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. [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]

- **Vision and Intention in Life** – Determining a pathway to one’s eventual contribution to and impact on society, and how engineering plays a role in ones intentions. Committing to a personal vision, and the intention to inspire others. [2.5.3]

- **Self-Awareness and Self-Improvement** – Awareness of one’s own personal, interpersonal and professional skills, and strengths and weaknesses. [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)
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, these specialize to:

- *Inquiring and Dialoging* – Listening to others with the intention of genuinely understanding their thoughts and feelings. Creating constructive dialog, and recognizing the ideas of others may be better than yours. Listening to and being willing to learn from everybody. [3.2.7]

- *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]

- Interpersonal Skills – Understanding and respecting the needs and characteristics of individuals and the group, and the resources that individuals with different backgrounds can bring to an organization. Coaching and teaching, providing and receiving evaluation and feedback, and the essential elements of gracious professionalism necessary to be an effective engineering leader. [3.1] (d)

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

3. **Making Sense of Context**: making sense of the world around us, and coming to understand the context in which the leader is operating - making a mental map of the complex environment, and explaining it simply to others. For effective engineering leaders, these specialize to:

- Awareness of the Societal and Natural Context – An awareness and understanding of the world’s problems, challenges, and opportunities, and the historical and contemporary role of engineering in addressing them. An understanding of the natural context, and the need for sustainability. Specifically identifying 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 – An understanding of 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 Awareness – Understanding the goals and culture of the enterprise in which one works, the shared beliefs, goals and strategies of the enterprise, and norms for working successfully and bringing about 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, and how they 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 inter-relationships 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, these specialize to:
   • Identifying the Issue, Problem or Paradox – Synthesizing the understanding or 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 Imagining and Communicating Possibilities – Understanding how to create new ideas and approaches. Creating and communicating visions for new technical products and systems, and new engineering-based enterprises that deliver new capabilities. [2.4.3]

   • Defining the Solution – Identifying a vision for the solution, and setting achievable goals for performance (including quality), budget and schedule. These are guided by the views of the customer, reflect the possibilities of technology, meet regulatory and political constraints, and consider competitive forces and the needs of internal stakeholders. [4.3.1]

   • Creating the Solution Concept – Creating and selecting the concept and architecture for the technical solution, which might be innovative or evolutionary, and then defining the specifications and interfaces of the solution so that realization can be effective. [4.3.2, 4.3.3]

5. Delivering on the Vision: leading transformation by designing processes and approaches to delivering on the vision, to move from abstraction to innovation, invention and implementation, i.e., to get the engineering done. For effective engineering leaders, these specialize to:

   • Building and Leading an Organization and Extended Organization – Building an organization by recruiting key players with complementary and superior skills, defining team processes, roles and responsibilities, setting expectations, creating incentives and motivating the team. Lead an organization by employing appropriate modes of leadership under various conditions, and leading group decision-making. Assess organizational and individual performance. Observe, reflect and build on the leadership qualities of others. Develop approaches to incorporating competence outside of one’s enterprise in an extended organization. Understand how to manage change. [4.2.4] If desirable, create a new engineering-based entrepreneurial enterprise. [4.2.3]
• **Planning** and Managing a Project to Completion – Choosing a development strategy (waterfall, spiral, etc.), and devising a plan of action, and alternative plans if needed, to achieve the goals and deliver on time. Identifying and removing obstacles. Controlling the project to the plan. Identifying when the project is off plan and re-planning appropriately. Managing and apportioning the resources of the team, to achieve the desired outcome within the human, time, 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 and critically evaluating and applying judgment to solutions proposed by others, and to corroborating inputs. Evaluating evidence, and identifying the validity of key assumptions - 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.

• Innovation – Designing and introducing new goods and services to the marketplace. Based on goals and concept, identify, advocate for and amass the required resources (financial, etc.), design a solution with the appropriate balance of existing and new technology, reuse and new development, and flexibility and adaptability. Consider current and future competition. Consider sustainability in the design and implementation. Validate the effectiveness of the outcomes. [4.4] (c)

• **Invention** – Imagining possibilities based on emerging technology or science, and inventing a practical device, material, process or way of working that enables or enhances a new good or service. Adhere to and exploit intellectual property regimes.

• Implementation and Operation – Applying the methods of engineering development to implementation of engineering outcomes and systems. Consider quality, variability, robustness and appropriate testing. Operate the solution effectively in such a way that the needs of the customer and society are repeatedly and reliably met. Design, implement and operate the project, product or system [4.5, 4.6], or model, manipulate and make the material or biomolecule.

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,k), 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).
Notes on Sources:
The important inputs for this description of capabilities are:

1. The MIT Sloan Leadership Model, reflected in the Harvard Business Review article “In Praise of the Incomplete Leader” by Deborah Ancona, Thomas W. Malone, Wanda J. Orlikowski, and Peter M. Senge (February 2007). The topical organization of the above capabilities into Sensemaking, Relating, Visioning and Realizing the Vision (called by them Inventing) is due to this work.

2. The “CDIO Syllabus, a Statement of Goals for Undergraduate Engineering Education” a taxonomy of desirable engineering knowledge, skills and attitudes of engineers, originally presented in a report by Edward Crawley in January 2001 (see www.cdio.org) and later included in the book Rethinking Engineering Education, the CDIO Approach by Edward Crawley, Johan Malmqvist, Soren Ostlund, and Doris Brodeur, Springer, 2007. The notations in [square brackets] above correlates topics with the CDIO Syllabus, and notations in italics show significant additions to the topics in the CDIO Syllabus. The CDIO Syllabus was updated in June 2011 to capture many of the topics in italics.
