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What Engineering Leaders Lead: The Career Outcomes of an Engineering Leadership Program's Alumni Community

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Abstract

This paper presents survey findings on the career outcomes of an undergraduate Engineering Leadership (EL) program's alumni community. Findings were collected as part of a broader longitudinal assessment initiative recently launched at the Gordon-MIT Engineering Leadership Program (GEL), which acquires data from incoming, current, and outgoing program participants and from program alumni to track developmental progress and outcomes. While we briefly introduce this broader ongoing assessment initiative and its aims, we focus here on findings and implications from a specific survey instance: that which was deployed to GEL's alumni who are currently working and have up to 11 years of work experience since completing the program (n = 293). We report the types of occupations undertaken by these Engineering Leadership alumni and examine how they compare to those of the broader School of Engineering in which the program resides. We present several characterizations of program alums' careers as a function of years of work experience, including: occupation type, extent and nature of supervisory experience, whether individuals have undertaken "technical expert" roles, extent of career advancement, and key intersections of such variables (e.g., instances of roles simultaneously characterized as both supervisor and technical expert). We then present qualitative written responses from alumni about perceived challenges and opportunities related to career advancement, highlighting alums' sentiments of how the EL program supported (or could have better supported) their careers. We find that a majority of alumni in our sample (63%) are working in managerial positions by the decade mark in their career, yet that these alumni have advanced into management along different paths, with some remaining more technical while retaining an engineer title, and others following a less technical executive pathway that nonetheless remains connected to engineering. We also find that alumni encounter career challenges in areas of organization-level leadership skills and in navigating possible career and role types. Based on findings, we discuss potential opportunity areas through which educators can enhance the effectiveness of EL programs.

Introduction

Curricular and co-curricular Engineering Leadership (EL) programs have proliferated across North American engineering schools in recent years [1, 2], with over 50 programs now established [2]. Many of these programs, however, are in their formative or early operational years, and it is estimated that fewer than 10 of the most active programs operating today had launched prior to 2010 [1]. A new opportunity is therefore emerging for larger-scale, longer-term evaluations of post-EL program alumni outcomes relative to what had been possible earlier in this era of EL programs growth. Toward this opportunity, this paper introduces findings from an examination of alumni outcomes, spanning up to 11 years after program completion, from among nearly 300 graduates from the Gordon-MIT Engineering Leadership program (GEL). Our study characterizes the career types and career trajectories that GEL alumni have followed, while examining alums' self-evaluation of GEL's impact on their engineering leadership-related skills and abilities, and their retrospective sense of value obtained from program participation. Our aim is to assess how GEL supports (and can better support) alums' effectiveness in the engineering and engineering-related careers they pursue.

Given the early state of wide-scale EL programs operation, a relatively small number of prior studies have examined the longer-term alumni outcomes of EL course or program participants (e.g., [3-6]). Lang et al. [3], for instance, employed a survey of n=136 alumni to assess job placement, career advancement, and alums' retrospective sense of skills development based on EL program participation. Building upon Lang et al.'s work at the same institution, Stevens et al. [4] conducted a survey-based comparative assessment of program alumni and non-program alumni, each with up to 25 years since undergraduate degree completion, in terms of self-evaluated achievement of program intended learning outcomes (n=146 and n=133 for program alumni and comparison groups, respectively). Paul and Falls [5] employed a smaller sample of alumni interview participants spanning four graduation years (n=12) to conduct a thematic analysis of alums' descriptions of how EL capabilities have impacted their early career success. Bennet et al. [6], meanwhile, conducted a survey study of alumni with up to 13 years of experience (n=48) designed to measure perceived value gained from EL course participation. A common finding across all of these studies has been a measurable sense of value or benefit toward career effectiveness from EL program participation. Though it follows in a similar vein, our current study complements and extends this prior work by including an expanded characterization of alums' careers to examine how graduates employ their EL educations across career types and advancement paths. Our survey sample (n=293) enables one of the larger-scale EL program alumni career characterizations conducted to date. Further, and as we proceed to discuss, this study's alumni survey is designed to be an integral component of a longer-term longitudinal program assessment initiative currently being rolled-out at GEL.

Background

As increasing numbers of EL programs have now been operating continuously for a decade or longer, they face an additional type of program evaluation challenge compared to those of their earliest years. Program launches, especially at the onset of the present era of EL program expansion, often entailed substantial effort directed at curricular definition [7] and near-term evaluation, such as pre-/post- program assessments designed to enable course or program refinement [8, 9]. However, EL program-level goals and visions often include emphases on long-term career outcomes of participants (e.g., [10-13]), such as GEL's aim to develop "the future leaders of engineering practice and technological development" [10]. As EL programs' lifespans now approach the points in time when alumni are reaching mid-career stages, new types of outcomes become measurable that are pertinent to programs' evaluation against these broader goals. These outcomes include, for instance, extents of career advancement, types of leadership positions attained, and alums' sense of preparedness for leadership roles. Assessment in these areas requires the measurement of downstream variables many years after graduation, and, ideally, includes the ability to connect in-program assessment measures and control variables to these downstream measures. We proceed to share GEL's conceptual plan for a longitudinal assessment system that will examine students' development and achievement during and after the years spent in the program. Though these plans are still in-process, we describe them at a high level to provide context for the alumni-specific outcomes discussion that is the prime focus of this paper.

Historical overview of the GEL program

Launched in 2007, the Bernard M. Gordon-MIT Engineering Leadership Program (GEL) is a co-curricular program targeted at undergraduate juniors and seniors. This certificate program can be taken as a one- or two-year experience, with the latter option providing additional peer-leadership opportunities and coursework leading to an "advanced" designation on participants' engineering

leadership certificates. Across both formats of the program, 1,032 students have been awarded certificates between the program's first full year of operation in its present form (AY2009-2010) and May 2021, which is the timeframe examined by the assessment study underlying this paper. Intended to be a catalyst for future engineering leaders in practice, GEL employs a participant selection process that includes written applications, where students highlight prior motivating experiences and their degree of engineering intent, and individual entrance interviews. The curricular foundation of the program, the *Capabilities of Effective Engineering Leaders* [10], was developed through a series of workshops spanning several months at the program's inception attended by faculty and scholars in engineering and leadership, successful practitioners from industry, and military leaders. The program's core structure is described in more detail by de Weck et al. [14], and can be summarized as consisting of three "legs": 1) an Engineering Leadership Lab (ELL) where students meet weekly in small teams to face leadership challenges keyed to the *Capabilities*, 2) an Engineering Leadership class (EL), synchronized to the lab, where students study the academic background underlying the leadership capabilities prior to the related Leadership Lab and discuss and reflect on the lessons learned following a given lab, and 3) one from a number of elective courses that fulfill a Design and Innovation Leadership Requirement (D&ILR), which focuses on the engineering design process and the roles of teamwork and leadership therein.

Incorporating alumni outcomes measurement in a longitudinal assessment plan

Early in its history, GEL began periodically conducting pre-/post- program assessments rooted in measurement of students' self-efficacy beliefs [15] pertinent to learning objectives underlying the *Capabilities of Effective Engineering Leaders* (see, e.g., [16] for a detailed description of another EL program's similar assessment approach). Changes in same-student self-efficacy beliefs between the beginning and end of the program were assessed. The magnitudes of same-student change for each learning objective, as well as the outgoing measures for each objective, were then examined at an aggregate cohort level to establish comparably stronger and weaker areas in intended learning in a given cohort. This approach enabled prioritization of program refinement efforts: objectives whose measures were marked by either (or both) a relatively low positive average change, or a relatively low outgoing measure, were targeted for improvement. This "local" assessment approach aided program continuous enhancement, but is effectively uncalibrated from real-world engineering leadership outcomes. Findings from this approach were only interpreted in a relative sense (i.e., which objectives' achievement appeared to be in greater need of addressing relative to other objectives).

Prior literature has pointed to the benefits of a longitudinal approach to EL program assessment [4, 8]. In a longitudinal approach, assessments conducted at an early stage in a timeline (such as prior to the start of a course or program) can be linked to intermediate and outgoing assessments as well as to post-graduation assessments [17]. Here, same-student changes and achievements can be examined while controlling for initial conditions (e.g., a lower incoming assessment or a lack of prior experience), and while assessing more "objective," later-stage outcomes such as specific career achievements deemed pertinent to program objectives. Similar to a future program assessment plan described by Stevens et al. [4] for Penn State University's Engineering Leadership Development Minor, GEL plans to couple pre- and post-program assessments with longitudinal alumni assessments. Our conceptual plan for a sequential set of longitudinal survey instances administered to all program participants will include survey-specific measures in the following areas:

- Incoming survey: academic program information, self-efficacy beliefs in *Capabilities of Effective Engineering Leaders*, occupational intentions and preferences, demographics

- Intermediate survey: self-efficacy beliefs in *Capabilities of Effective Engineering Leaders*, occupational intentions and preferences, evaluation of experiences in the GEL program
- End of senior year survey: self-efficacy beliefs in *Capabilities of Effective Engineering Leaders*, post-graduation career or graduate school plans, GEL program outgoing evaluation
- Alumni survey (described in the remainder of this paper)

As successive surveys are collected and processed for the same student cohorts over time, more advanced analyses will be possible, such as examining correlations between assessed in-program development and external (i.e., alumni) outcomes. We also plan to examine differences in outcomes between the participants in the 1-year and 2-year program variants, across participants of different academic backgrounds, and, eventually, between participants and non-participant comparison groups. We expect to report on comparative longitudinal findings in future publications. The present study, meanwhile, focuses on an initial alumni survey that was deployed to existing program graduates across all graduation years for purposes of establishing a baseline alumni characterization.

Methods

The alumni survey conducted for this paper was hosted in Qualtrics XM online survey software. Since this survey is one component of the larger GEL longitudinal assessment, it is incorporated into the same Qualtrics project as all other survey components. We established one common survey landing webpage to greet invited respondents who could be at any point within the timeline of the planned longitudinal assessment (i.e., incoming students, intermediate students, graduating seniors, or alumni). Here we followed methods described by Audette et al. [17] for conducting longitudinal surveys by which participants are asked a few simple personal questions designed to yield consistent and enduring answers, and whose answers each constitute a single character of a multi-character Self-Generated Identification Code (SGIC). Recording participant SGICs enables us to connect future survey responses from the same participants to past responses; however, the findings reported in this paper are based only on a single survey event: that which was deployed to GEL program alumni.

Following the online survey's welcome/consent and SGIC screens, respondents next answered a series of questions that ascertained the appropriate survey instance to route them to (i.e., from among the longitudinal sequence of student and alumni surveys). Here, respondents were asked to provide information about their current academic semester or alumni status, as well as to confirm their GEL program completion status. Based on the status information provided, conditional logic within the Qualtrics survey then routed the respondent appropriately. While our discussion in the remainder of this paper is limited to GEL alumni survey instance, deployment, data collection, and analysis for other survey instances remains ongoing and we plan to report on them in the future. Though this longitudinal survey system is designed to follow individuals over time, we opted to launch the alumni component of the survey (to those of all years of graduation) for survey testing and past alumni characterization purposes, even though the individuals surveyed had not previously responded to the precursory student survey instances. The survey discussed in this paper was deployed via email solicitation in November 2021.

The survey was organized into separate sections focusing on occupational outcomes (including occupational fields, titles, and experience), work characterization and advancement (including engineering-relatedness of work, and supervisory and technical responsibilities over time), and retrospective GEL program evaluation (including quantitative and qualitative measures of

perceived program value, skills and abilities gained, and opportunities to strengthen the program). Survey question verbiage in each of these areas is presented alongside findings in the *Results* section.

Following the presentation of summary statistics in the initial subsections of *Results*, we introduce several sets of findings that focus on the conditional sub-sample of respondents who work in engineering-related roles and who simultaneously hold supervisory responsibilities. We conducted these conditional analyses to gain insights into the nature of work, associated challenges encountered, and extent of career preparedness among those who have advanced comparatively deeply into the realm of engineering leadership work. We do not purport that this conditional sub-sample represents all individuals in our sample engaging in engineering leadership-related work (especially given non-positional and distributed modes of leadership [18]), yet we required a consistent method of bounding the scope of occupational experiences on which to focus, given the quantity and variety of occupational outcomes we observed. There are undoubtedly many others among our sample pursuing or engaging in engineering leadership across different types of careers or earlier in their engineering leadership journeys; for these reasons, we frame the findings that follow as *pertinent* to the engineering leadership education community without claiming they are comprehensive. Meanwhile, we discuss the generalizability limitations of findings and follow-on research directions in *Limitations of results.*

Results

Survey response characterization

Our survey campaign yielded 345 survey responses from GEL alumni. This sample represents 33% of the 1,032 individuals who had earned a GEL certificate by the time of the survey and 44% of the 794 individuals who were invited to be surveyed (all alumni for whom the GEL program had a valid email address on file were invited). Over 80% of respondents indicated that they were presently working, while the remainder indicated that they were in school (15%) or indicated "other" as their employment status (4%). Table 1 summarizes the breakdown of responses by employment status.

Table 1. Employment status of GEL alumni survey respondents

Working		In school[2]	Other
81%		15%	4%
Working without a graduate degree	Working with a graduate degree		
50%	31%		

Notes:
1. All percentages are based on n = 330 survey responses in which an employment status was provided
2. "In school" refers to those who denoted "student" as their current employment status

Respondents were asked: "In total, how many years of full-time work experience do you have?" Results indicated a median experience of four years (mean = 4.1, std. dev. = 2.7). The range, up to a maximum of 11 years of work experience, encompasses the expected range among the GEL alumni population. The first completion certificates from GEL, as the program is presently formulated, were awarded in May 2010 and this survey was deployed in November 2021. The findings discussed in the remainder of this paper are from among the 293 alumni survey respondents who indicated they have worked at a full-time job at some point since completing their undergraduate degree.

Occupational outcomes

Respondents were asked to "please select the option that best represents the primary occupational field of your work" from among the list of fields shown in Appendix A. Occupational fields were selected to be broadly categorizable within the system of Standard Occupational Classifications (SOCs) used by the U.S. Bureau of Labor Statistics [19], though we employed a limited set of aggregate occupation titles for sake of brevity of the list. Care was taken not to create aggregate titles that spanned separate major occupation groups in the SOC system; for instance, software-related occupations are categorized under "computer and mathematical occupations" in this system, rather than among engineering occupations, so we established "software engineer or software developer" as distinct from "engineer." In addition to the original GEL alumni occupational data collected for this study, the authors requested and acquired existing MIT School of Engineering (SoE) alumni occupational data, also collected within 2021, for comparative purposes from MIT's Office of Institutional Research. The SoE data employed a broader occupational categorization scheme than that of the GEL alumni survey, so further category aggregation of the GEL data was necessary to enable GEL-SoE comparisons. Table 2 presents the top-four reported occupation categories among GEL alumni survey respondents alongside those of the broader School of Engineering alumni community.

Table 2. Initial and later occupation categories: GEL alumni and MIT School of Engineering alumni

Initial occupations[1]			
Among all School of Engineering alumni[2]		*Among GEL program alumni*[3]	
Computing & SW occupations	41%	Engineering occupations	37%
Engineering occupations	23%	Computing & SW occupations	17%
Consulting occupations	12%	Consulting occupations	15%
Scientist occupations	10%	Management occupations	10%
Later occupations (~10 years)[1]			
Among all School of Engineering alumni[4]		*Among GEL program alumni*[5]	
Engineering occupations	31%	Management occupations	47%
Computing & SW occupations	24%	Computing & SW occupations	18%
Management occupations	16%	Engineering occupations	12%
Scientist occupations	9%	*3-way tie*: Consulting occupations Finance occupations Scientist occupations	6%

Notes:
1. Broad occupational categories are used here to encompass categories used across three different surveys: MIT's *Graduating Student Survey* that is issued to all graduating undergraduates in close proximity to degree completion, MIT's *Undergraduate Alumni Survey* that is issued approximately 10 years post-graduation, and the survey from this current study issued to GEL program alumni across all years of experience simultaneously
2. Counted here are School of Engineering graduating student respondents (n = 163)
3. Counted here are GEL alumni with 0 to 1 year of experience reporting on initial occupations (n = 81)
4. Counted here are School of Engineering alumni respondents (n = 270)
5. Counted here are GEL alumni with > 9 years of experience (n = 17)
6. "Management occupations" encompasses any type of management occupation, including general and business managers, executives, and project and product managers

Though MIT conducts surveys of undergraduate alumni at various time points after graduation, the survey instances that inquire about categories of occupations take place soon after graduation and at approximately the 10-year point. Comparing GEL alumni occupational participation with that of the broader School of Engineering alumni was therefore possible at such an interval, but not at shorter intervals. The upper half of Table 2 shows initial occupation category comparisons, while the lower half shows category comparisons near the 10-year point. In terms of initial occupations, findings suggest that GEL alumni participate in conventionally-categorized engineering work and in management work to a greater extent than the broader SoE alumni community, while SoE alumni engage in computing/software work and scientist work to a greater extent than GEL alumni. By the 10-year point, a further noticeable jump in managerial work appears to be undertaken by GEL alumni relative to the broader SoE alumni, who, in turn, appear to remain more engaged in engineering and computing/software work. Due to imperfect sample matching (in points of time, measures used, and subsample sizes), we cannot make formal statistical comparisons between the SoE and GEL alumni communities' occupations, so these comparisons must be interpreted with caution. These initial findings, nonetheless, suggest a likelihood that GEL alumni pursue managerial roles to a greater extent than their institutional peers. We plan to revisit these comparisons in the near future as larger numbers of GEL alumni reach the 10-year point. Meanwhile, we proceed to examine GEL alumni occupations in greater detail at earlier time points within our own survey sample.

Table 3 presents the more granular occupational participation findings for GEL alumni based on the occupation designations listed in Appendix A. The results in Table 3 illustrate occupational participation across all experience levels in the sample. At this full-sample level, we find that engineering occupations (non-software) are the most prevalent (at 31% of the sample), followed software engineering or development (20%), project and product management (15%), and general management occupations (8%). All other occupations represent 4% or less of the sample.

Table 3. Present occupational fields of GEL alumni (full sample, across all experience levels)

Occupation[1]	Percentage of responses[2]
Engineer (all except software engineer)	31%
Software engineer or developer	20%
Project or product manager	15%
Manager (general, business management, or executive)	8%
Management consultant	4%
Technical consultant	4%
Military	3%
Scientist (life, physical, or social)	3%

Notes:
1. Any occupations beyond those listed in this table were indicated by < 3% of respondents
2. Percentages are based on n = 270 total surveys in which an occupation was indicated

Table 4, meanwhile, compares the top-four occupations for subsets of GEL alumni based on their years of work experience. Here we compare subsets with zero to two years of work experience,

three to five years of experience, and six or more years of experience. These experience categories allow us to include at least 80 respondents in each subset. Engineer and software engineer/developer roles sustain their places as the top-two most prevalent roles across all experience categories; however, the least experienced among alumni appear to participate to a greater extent in engineering-categorized roles compared to the most experienced. The aggregate proportion of alumni working in engineer and software engineer/developer roles is 53% for the most recent graduates, compared to 43% for those alumni with six or greater years of experience. Meanwhile, we find that the proportion of alumni working in management-related roles steadily increases between the least and most experienced alumni in our sample.

Table 4. Occupational fields of GEL alumni at different work experience levels

Among those with 0 to 2 years of experience		Among those with 3 to 5 years of experience		Among those with ≥ 6 years of experience	
Engineer (all except SW eng.)	37%	Engineer (all except SW eng.)	33%	Engineer (all except SW eng.)	22%
Software engineer or developer	16%	Software engineer or developer	23%	Software engineer or developer	21%
Project or product manager	10%	Project or product manager	17%	Project or product manager	19%
Management consultant	9%	Manager (general/bus./exec.)	6%	Manager (general/bus./exec.)	19%
n = 81 for this experience range		*n = 108 for this experience range*		*n = 81 for this experience range*	

Engineering-relatedness of alums' work

Recent literature suggests an increasing prevalence of occupational roles undertaken by engineering graduates that are in close proximity to conventional engineering roles, but are not titled as such [20, 21]. These roles can be categorized in areas such as project management, product management, system or software architecting, among many others, although categorization can vary significantly. A recent National Academy of Engineering (US) report estimates that over 40% of engineering graduates likely work at these types of roles [20]. Magarian and Seering [21], meanwhile, proposed an intermediate occupational category with regard to the engineering-relatedness of roles (i.e., an engineering-relatedness status between such roles prevalently understood to be "engineering" and those commonly understood as non-engineering). Those authors suggest this intermediate categorization of work, which they label as "engineering-conpar," consists of work coupled in unique ways to that of traditionally-categorized engineers (see: Table 9 within [21]) as marked by interdependences between the work activities of these occupational groups. In the GEL alumni survey, we inquired about "engineering coupling" of occupations to all of those alumni respondents who did not indicate "engineer" or "software engineer/developer" as their primary role (n = 131) using the following question:

> Do you consider your current job to be closely coupled with "engineering"?
> *meaning, do you do any/all of: specifying product/system parameters to engineers, moderating or influencing engineers' work, assessing/validating engineers' work, or directing/leading/managing engineers?*

Table 5 shows the response breakdown to this prompt, indicating that 70% of GEL alumni who do not directly identify as engineers nonetheless believe that their work is closely

coupled to engineering. Table 5 also provides the top-four occupational categories among those respondents who indicated working in roles closely coupled to engineering, as well as those from among the 30% who felt their work was not closely coupled to engineering. These findings suggest that many of those alumni who ostensibly "exit" engineering undertake work, primarily of a managerial nature, that is in close proximity to engineering and likely involves frequent collaboration and engagement with engineers.

Table 5. Engineering relatedness of alums' work (among respondents not identifying as engineers)

Among those respondents who do not identify as an engineer, software engineer, or software developer (n = 131)			
Indicate that their work **is closely coupled** with engineering	70%	**Top-4 occupations within subset (n = 92)**	
		Project or product manager	40%
		Manager (general/bus./exec.)	18%
		Technical consultant	11%
		Military	7%
Indicate that their work **is not closely coupled** with engineering	30%	**Top-4 occupations within subset (n = 39)**	
		Management consultant	23%
		Manager (general/bus./exec.)	10%
		Project or product manager	10%
		Scientist (life, physical, or social)	10%

Supervisory experience

Figure 1 illustrates the proportions of GEL alumni engaged in supervisory positions at different stages of work experience. Survey respondents were asked: "At a paid full-time job, have you ever served as a manager with people formally reporting to you?" If participants answered "yes," they were then asked to indicate their total experience (in years) as a manager with direct-reports. Further, only those who answered "yes" were asked a follow-on question about additional supervisory responsibilities (i.e., "At a paid full-time job, have you ever served as a manager of managers (i.e., managers reported to you)?") and those affirming were asked about total experience in such roles. Lastly, those who indicated they had experience managing managers were asked about executive-level supervisory experience (i.e., "Have you ever served in a top executive role in a company or organization larger than 10 persons?") and those affirming were asked to indicate their total years of experience as an executive. Using the same three experience-level subsets as Table 4, Figure 1 shows the proportions of respondents in terms of their supervisory responsibilities, ranging from individual contributor (i.e., no supervisory responsibilities) to executive-level, at different work experience levels. Here we observe that 92% of GEL graduates begin their careers as individual contributors, yet those with six or greater years of experience are, by that point, more likely than not to have gained supervisory experience. We also note that no GEL graduates indicated starting their careers as executives;

yet, intermediate and executive levels of supervisory experience appear to grow over time such that by the ≥ 6-year point, nearly a quarter of the sample indicates having held intermediate or advanced supervisory experience. We report respondents' durations of supervisory experience, in conjunction with other findings, in Appendices D and E.

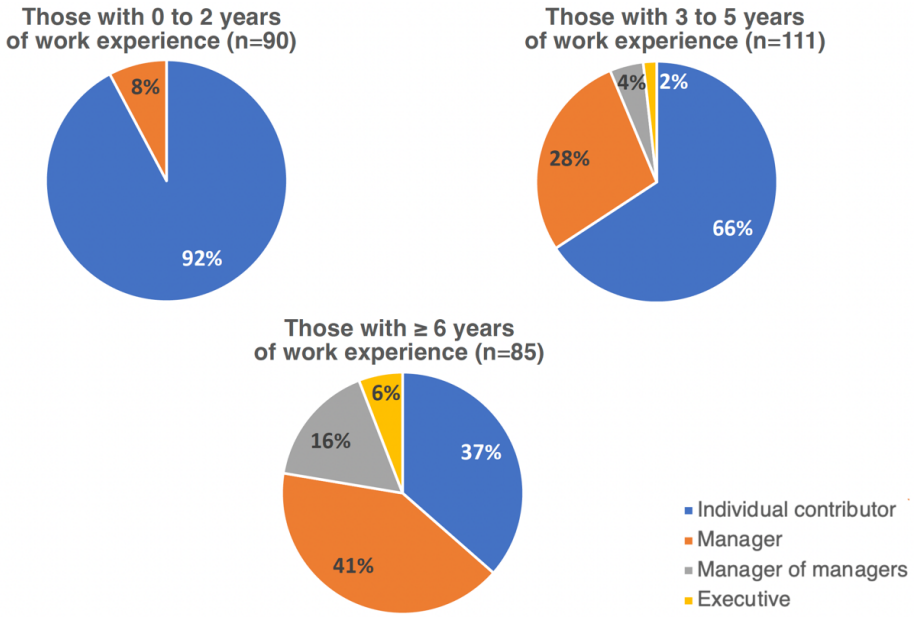

Figure 1. Extent of supervisory responsibilities of GEL alumni at different experience levels

Technical expert roles

Aware of literature describing the coexistence of technical specialist and generalist roles among engineers in industry [22, 23], we sought to understand the proportion of GEL alumni who have attained roles considered by employers to be "technical expert" roles. Each GEL alumni survey respondent was asked:

> Have you ever served in a technical expert role at an employer?
> *For instance, as a "principal [engineer, scientist]," "subject matter expert," "technical fellow," etc.? Please answer to the best of your ability, as titles and designations of these roles vary across employers.*

Each respondent who answered "yes" to the above question was then asked "are you currently serving in a technical expert role?," allowing us to ascertain if the present occupation they provided falls into this designation. Figure 2 shows the proportions of GEL alumni who report having been engaged in technical expert roles by various timeframes in their work experience. Findings indicate that alumni experience in technical expert roles grows considerably over time, with only 8% of respondents indicating that early career roles fall into this category, while 42% of respondents who have been working six or more years have indicated serving in technical expert roles.

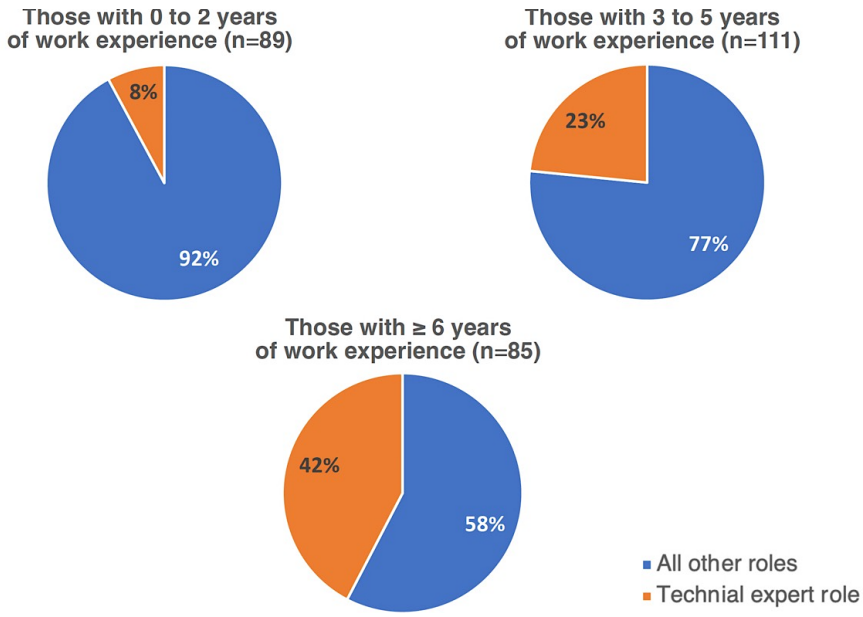

Figure 2. Participation in technical expert roles among GEL alumni at different experience levels

Multidimensional roles: Those who are engineers and supervisors

GEL alumni survey respondents were asked "What is your current primary job title?" and were provided an open-ended text field in which to type a response. Appendix B presents job titles reported by respondents who indicated that they are an engineer (or software engineer/developer) and who also indicated being a supervisor (at any level of supervisory responsibility). Appendix C, meanwhile, presents titles from those who did not indicate being an engineer or software engineer/developer, yet who indicated that their work is engineering-coupled, and who indicated being a supervisor. Alongside the job titles, Appendix B and Appendix C also show each respondent's level of supervisory responsibility and whether they are presently serving as a technical expert. Tables 6 and 7 summarize this appendix data to present the count of engineer-managers and engineering-coupled managers, respectively, who hold supervisory roles at different levels and hold technical expert roles. Findings in these tables demonstrate that engineering and supervisory responsibilities can intersect, sometimes also coinciding with requirements for deep technical expertise.

Table 6. Respondents working as engineers (including SW engineer/developers) and who are supervisors

	Supervisory level			
Total in Sample[1]	Managers	Managers of Managers	Executives	**Technical experts**
36	32	4	0	15

Notes:
1. Appendix B includes a list of the job titles associated with each respondent counted here

Table 7. Respondents working in engineering-coupled roles and who are supervisors

	Supervisory level			
Total in Sample[1]	Managers	Managers of Managers	Executives	**Technical experts**
50	33	11	6	11

Notes:
1. Appendix C includes a list of the job titles associated with each respondent counted here

However, an examination of Table 6 compared to Table 7 suggests that the roles more distant from conventional engineering categorization (i.e., Table 7's engineering-coupled roles) may be associated with higher levels of managerial rank; for instance, there are no "engineers" who also indicate being "executives," yet six individuals indicate being executives while in engineering-coupled roles. These

findings paint a nuanced picture of an engineering career progression in ascendence of managerial rank; while it appears commonplace for engineers to be managers (dispelling notions of a harsh engineering-vs-management bifurcation), it appears that engineering identity nonetheless wanes as higher-level managerial and executive roles are attained.

Retrospective evaluation: EL program support toward career effectiveness and advancement

Survey respondents were asked to retrospectively assess the value they felt they obtained from GEL program participation. Two high-level evaluative prompts asked respondents to provide ratings on a five-point scale, ranging from "strongly disagree" to "strongly agree," of the statements: "I recommend that current MIT engineering students should participate in the GEL program" and "I can attribute advancement in my career, at least in part, to skills I gained during the GEL program." Figure 3 shows the spread of responses to these prompts.

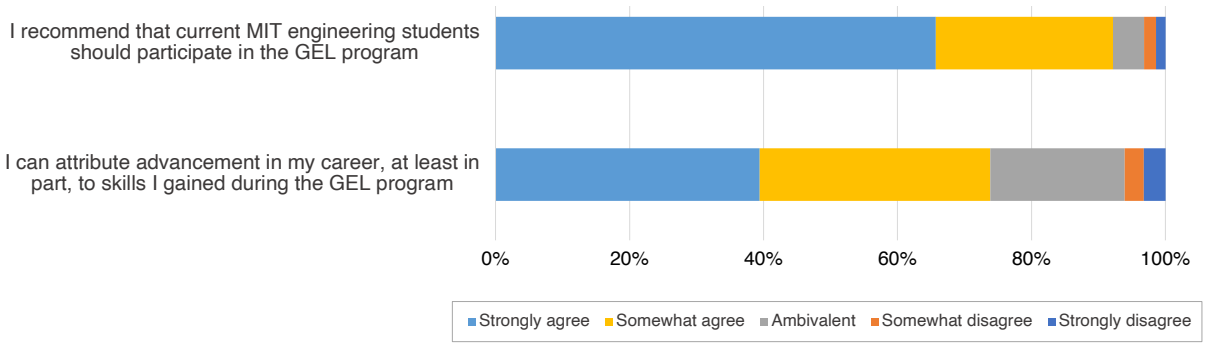

Figure 3. Retrospective program evaluation ratings from GEL alumni (n= 280)

Respondents were also asked to assess high-level intended outcomes of GEL in areas of teamwork, team leadership, stakeholder management, and communication to decision makers. Five-point scales, ranging from "strongly disagree" to "strongly agree," were also used for these ratings. The prompt statements are shown on the left side of Figure 4, while the horizontal bar graphs in Figure 4 illustrate the spread of rating responses to the prompts. While ratings were generally strong in all cases, with majorities indicating "somewhat" or "strong" agreement to all, findings suggest variation across these outcomes in terms of how well alumni feel the GEL program helped them achieve outcomes. For instance, the lowest-rated statement, on communicating to senior decision makers, received a mean agreement rating of 4.0/5 compared to a mean rating of 4.4/5 for the top-rated statement on teamwork.

To complement the program evaluation ratings data, the survey also posed open-ended qualitative prompts. The first of these prompts inquired about respondents' experiences navigating career advancement with an aim of uncovering opportunities for better supporting the career growth of those pursuing engineering leadership career paths. This prompt stated: "Based on your experiences, you are invited to share any insights you may have about challenges and/or opportunities related to career advancement." A paragraph text entry box collected written responses. We received 88 total responses. Our examination in this paper focuses on the subset of responses received from GEL alumni working in engineering (including software engineering/development) and engineering-coupled occupations who also indicate being supervisors (38 responses), the unabridged list of which is provided in Appendix D. Meanwhile, Table 8 presents an abridged sample of these responses that are expressed in the form of a lesson-learned about career advancement. In Appendix D, each respondent's occupation sub-type, total years of work experience, and total years of supervisory experience are denoted.

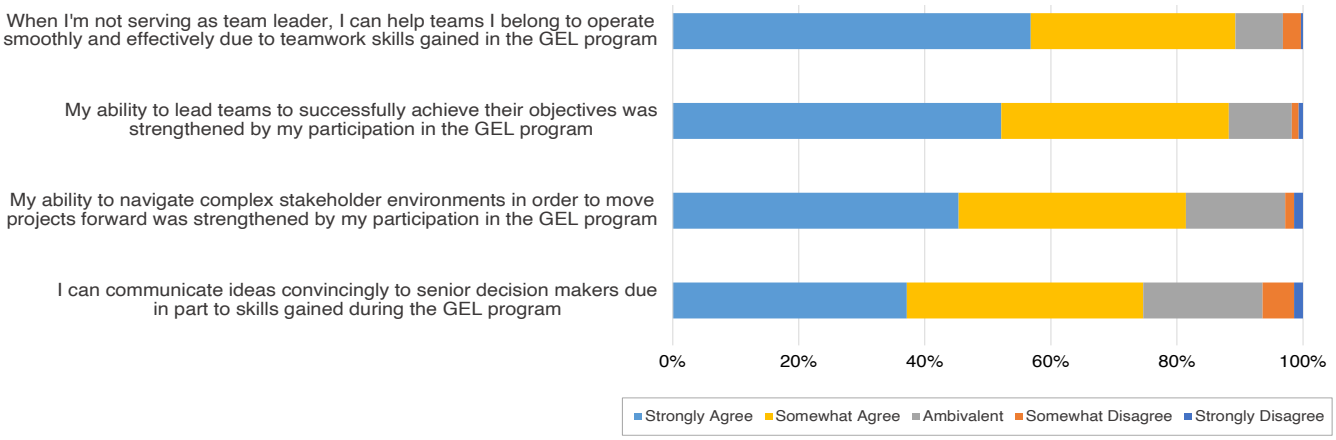

Figure 4. Alumni retrospective feedback on GEL program's role in strengthening key abilities (n=280)

As shown in Table 8, responses cover a range of topics from mentorship to work-life balance to advancement tactics and beyond. We note themes in the areas of challenges due to organizational impediments (Responses A016, A018, A019), approaches for boosting one's promotability (Responses A008, A012, A030), and how relationships can aid career navigation (Responses A009, A020, A033), among others. We further examine and interpret these responses in *Discussion*.

Table 8. GEL alums' insights about challenges or opportunities related to career advancement (abridged)

Resp. no.[1]	Insights about challenges or opportunities related to career advancement[2, 3]
A006	"A lot of advancement depends on the company as well as yourself. Look for opportunities outside of your role to show your capabilities."
A008	"I've found that promotions are closely tied to finding and executing projects outside of your assigned statement of work."
A009	"In the early years, it is critical to have an advocate, for example, a manager who understands what you are doing and values your contributions. I've seen many people become frustrated and even scale back their effort because they don't feel that their manager adequately advocates for/appreciates them. I've personally experienced both ends of the spectrum."
A012	"Bring it up yourself if you feel you are ready. Ask questions about how promotions are determined / what to expect. Let your managers know...what roles and responsibilities you would like to have - don't assume they know or that your current role pre-determines your next."
A016	"Very difficult to navigate organizational politics, especially early in my career. Wish MIT / GEL had discussed this more."
A018	"Changing employers is the fastest way to advance. In many companies you will be limited by your superiors - you can't go through them, so go around."
A019	"The common saying seems accurate you need to move around to move up. Not necessarily to a new employer (particularly at large companies) you can apply to requisitions at the current company to get promotions and new opportunities. Bad managers will block this because they don't want to have to replace people. My career advancement definitely accelerated once I left my old employer and found management at a new company that would advocate for me and act as my sponsor...I see too many people get stuck in bad situations at an employer and don't remember leaving is always an option."
A020	"At my company there isn't a formal career planning/coaching service within HR so it's really on the individual to take initiative and ownership of this career trajectory and discussions about career advancement with their supervisor"
A030	"To get promoted fast it helps to fill a unique void in skill sets at the organization."
A033	"Networking and mentorship are key. I often skipped some events because they felt very draining and/or not as productive, but I now realize the importance of that in finding the right career and even later finding the right team through seeking your network. Great people know other great people...Changing industries and working in a different field is also incredibly challenging especially as a new graduate...The key here is to learn how to market your skills learned outside of the classroom/lab...Final challenge is getting promoted to a manager role in <5 years...Gaining trust and showing ambition and initiative goes a long way in this case."
A034	"Do your role as if you're already working in your next/promotion role. This gives you insight into your manager's mindset, as well as buying you free experience."

Notes:
1. Responses are part of the unabridged set shown in Appendix D
2. Question: "Based on your experiences, you are invited to share any insights you may have about challenges or opportunities related to advancement:"
3. Some quotations are curtailed here due to space constraints (as indicated by elipses […]). Full text for all responses is shown in Appendix D

A second open-ended question asked: "Please share any insights you have about how the GEL program has helped you succeed or how the program should evolve to better prepare students for career success." We received 107 total responses to this prompt. Again, we focus on the subset of responses from alumni working in engineering or engineering-coupled roles and who are supervisors (44 responses), the unabridged list of which is provided in Appendix E. Table 9 presents a sample of these responses that identify program sources of career support or improvement opportunities.

Table 9. GEL alums' insights about program strengths and opportunities areas (abridged)

Resp. no.[1]	Insights about how the GEL program has helped you succeed or how the program should evolve to better prepare students[2, 3]
B003	"When I participated in GEL there was a strong emphasis in working in a corporate [sic], where I think there could have been equal emphasis on starting your own venture as well. Both need different types of leadership experience."
B004	"GEL was the most practical and hands-on experience I had at MIT that gave exposure to what 'work' looks like - namely how to communicate with people in diverse environments. I...hope...that GEL continues to cultivate excellent communication skills..."
B008	"When working, there really are no soft skills...there are only skills which help you achieve your goals and those that don't. Those are both technical and non-technical. I have had to speak to...investors, board members, customers, etc. and having been in even mock/simulated leadership roles through GEL helped me keep getting better every time."
B009	"GEL was hands-down the best course/program I took part in while at MIT. Every experiential lab granted new skills that I still use to this day...From how to manage teams, to reporting up, to talking with industry experts, everything was useful, even if I didn't realize it at the time. I would suggest that GEL a) continues this experiential approach to learning practical skills and b) adopt a mentorship program much like [that of the MIT Undergraduate Practice Opportunity Program]..."
B010	"GEL was instrumental in my career. I was able to discover a career (product management) which I was not aware before the program. Then, I was able to engage with staff and students to really advance and challenge my capabilities. This helped me enter the workplace as a professional, ahead of my peers, since I was able to work well with others..."
B015	"Several scenarios I encounter everyday remind me of GEL labs....We are always figuring out how to design a product based on cost, needs, user, people indirectly affected... and it can get quite challenging. My biggest suggestion is to think of GEL as a series of mini lessons about your career...If you remember the objective of your labs and how you achieved them, you will...be able to apply them..."
B016	"The [Engineering Leadership Labs] were excellent! They put me in situations that definitely happened to me again in my career, and I was well prepared to handle them as a result...I'd love to have met and gotten to know more of the [participants in the optional second year of the program] when I was a [first year participant]. I wish we had more social events together..."
B017	"My MIT degree and my technical skills are what got me the job I have...The leadership and communication skills I got to refine through GEL are what got me my promotions and have made me an integral member of my department."
B024	"The most practical...skills...that have contributed to my career advancement were from [my GEL Design & Innovation course]. [I learned] to reason about stakeholders, navigate uncertainty, and tell a narrative…[skills] indispensable to my professional life."
B029	"One of the most important things I did at MIT, though I wish there were more of an emphasis on entrepreneurship (maybe working with [MIT's Martin Trust Center for Entrepreneurship]). I co-founded my healthcare tech startup 5 years ago...I used a lot of the skills I learned at GEL to create good product market fit and launch a successful product!"
B030	"More time spend [sic] on fundamentals of business and organizations, e.g. explanation of common metrics in different industries (revenue, margin, ARR, engagement, retention, activation, bill through rate, etc.) and explanation of the roles and incentives of different organizations within a business (sales, marketing, FP&A, operations, etc.). A lot of new grads spend a lot of time just learning how the business world functions...Some context in school would speed up that learning process..."
B032	"GEL does a fantastic job at teaching practical skills that help so much in the engineering workplace...I often wish my colleagues had...similar experiences like GEL...GEL did a nice job at prepping for the first few years out of school, but I realized being a manager how many topics GEL didn't cover. There might have been an opportunity to have more manager [Leadership Labs]..."
B036	"I use the 10 step design process [from GEL] all the time when writing technical proposals and project documents."
B037	"...The one recommendation I have for future career prep is perhaps having more facetime/conversations with industry guests with unique roles (non-traditional software engineering roles) to learn more about what they do. For example, I did not know what a Solutions Engineer or Product Manager really does until 3+ years in my job. It would've been amazing to have had a GEL alum in that role explain the day-to-day of the job in a career session or such. I would've certainly sought that path sooner."
B041	"GEL was an excellent practice arena, and encouraged a lot of helpful mindsets. I think it would be even more valuable if combined with technical projects (e.g. [an engineering castone course])..."

Notes:
1. Responses are part of the unabridged set shown in Appendix E
2. Survey question: "Please share any insights you have about how GEL has helped you succeed or about how the program should evolve to better prepare students for career success."
3. Some quotations are curtailed here due to space constraints (as indicated by elipses […]). Full text for all responses is shown in Appendix E

Table 9 highlights various developmental experiences that alumni attribute to their time in the program as well as program critiques and recommendations. For instance, feedback points to an appreciation of the program's experiential format of learning (Responses B004, B008, B009, B016, B041), communication skills development (Responses B004, B017), and coverage of engineering design processes (Responses B015, B024, B036), while suggesting that GEL grow to include greater focus on entrepreneurship (Responses B003, B029), and to increase opportunities for mentorship from industry practitioners (Responses B009, B037), among other suggestions. We further examine potential program enhancement opportunities substantiated by findings in Table 9 in *Discussion*.

Limitations of results

Several factors restrict the generalizability of our findings and the comprehensiveness of analyses that can be performed on them. For instance, it is unclear the extent to which career preparedness, opportunities, and challenges encountered by GEL graduates are similar to those of other programs' graduates. Our findings must be interpreted as those of a single program and single institution. While job opportunities available to graduates may differ by institution, so too may curricula and developmental experiences across EL programs [2, 24] and across their host universities, limiting our ability to interpret how challenges reported by GEL alumni would be perceived as challenges by other programs' alumni. Therefore, this paper's primary contribution lies in calling attention to areas where other programs may wish to "shine the flashlight" as they conduct their own alumni outcomes assessments. By sharing the skills our alumni are grateful for, the types of career challenges they felt inadequately prepared for, and the nature of the engineering-related work they take on (especially in areas where leadership and technical skills intersect), it is our hope that other programs are assisted in establishing the scope that they include in their own assessments.

Further, our sample itself reflects only $^{1}/_{3}$ of the overall GEL alumni community. While this sample size may be adequate to characterize our program's outcomes, given that this is our first and (thus far) only alumni survey, it is not possible to know the extent to which our sample may be biased toward alumni who felt comparably better or worse about their experiences in GEL, or who may be more or less likely to be thriving in their careers. We therefore frame our findings as representing *types* of outcomes, experiences, challenges, and opportunities that, to some extent, can be expected among a similar sample. Within our sample, meanwhile, we are not yet able to conduct several of the subset comparative analyses we aspire toward. For instance, some respondent characteristics, including demographics and degree majors, are collected earlier in the longitudinal sequence of surveys and can be linked to future alumni responses, but are not available in this present dataset. We therefore cannot yet conduct important analyses to assess the equitability of program outcomes across diverse demographic groups and plan to do so in the near future as data collection progresses. We are also not yet able to make connections between assessment data collected during individuals' student years and findings from their alumni years. Our student surveys include incoming and outgoing self-efficacy measures and measures of the extent to which participants engaged with the program, so we will soon be able to examine same-individual associations between student measures and alumni measures. We plan to report on such longitudinal analyses in the future as data are collected and processed.

Lastly, the scope conditions of our analyses of engineering leaders among alumni limit the comprehensiveness of those analyses. We elected to analyze engineer-supervisors as a sample of practicing engineering leaders among our overall sample. This choice has the benefit of being clear and consistent, yet carries with it the tradeoff of leaving the un-titled, aspiring, and early-career engineering leaders' outcomes relatively unexamined here. These other conceptualizations of who is an engineering leader are undoubtedly relevant to the EL educator community, yet require

future researchers to establish a means of consistent identification of subsamples of interest. In the meantime, we frame our current findings of engineer-supervisor outcomes as offering pertinent yet incomplete insights into the developmental needs, challenges faced, and occupational work scope of engineering leadership practitioners among engineering leadership program graduates.

Discussion

An examination of GEL alumni survey data suggests that no single type of career dominates the sample. Though many alumni (51%) indicated working in engineering or software engineering/ developer occupations (Table 3), it is clear that these graduates are far from a homogenous group – especially as individuals' roles evolve and diverge with years of work experience. This variation among participant career paths, at first glance, implies a challenge for those designing EL program curricula with an aim of professional preparation. For instance, many GEL alumni will never work in engineering-titled roles or will ostensibly exit engineering as they gain experience. Yet, as we consider a slightly broader umbrella of engineering occupational participation, we identify a substantive community among alumni who can connect their work directly or indirectly to the engineering professional realm, who are likely to exercise leadership in their work, and who can point to ways in which their time in an EL program has supported their career. Our discussion of GEL alumni outcomes, therefore, avoids painting with a broad brush, while proposing tractable ways of conceptualizing the career pathways along which alumni are leveraging (or could be leveraging) EL program learning.

The complex careers landscape among EL program graduates

Characterization of the GEL alumni community reveals a mix of different and coexisting career narratives. For instance, we expected some alumni would engage in management- and consulting-related work as their careers progressed [25], but did not expect to observe nearly 20% of our graduates taking on these roles at or soon after undergraduate graduation (Table 4). This finding builds upon recent literature indicating that some contemporary employers have established entry-level positions in these areas that have historically required prior work experience [23]. Yet, despite this rise in opportunities for engineering graduates outside the traditional bounds of engineering, any concerns that a sizable percentage of EL program graduates are failing to apply their EL skills toward engineering work appear largely unfounded in our findings. Though 49% of GEL alumni do not indicate engineering (or software engineering/development) as their primary occupation (Table 3), a strong majority (70%) of these "non-engineers" report working in roles closely coupled to engineering (Table 5). As recent prior work suggests, job titles or rigid occupational categories can be poor identifiers of whether graduates are working in engineering-related roles [21]. A more pertinent statistic may be the total percentage of alumni that report working in either an engineering or an engineering-coupled role (85% in the case of our sample). With this larger subset as a starting point, we can then break down how alumni therein carry leadership and technical responsibilities and are benefitting from (or could benefit further from) their engineering leadership education.

Literature has long highlighted the possibility of individuals serving as both engineers and as managers [26-29]. We expected, however, to observe a trend of these engineer-managers letting go of deep technical responsibilities in concert with acquiring supervisory duties [30, 31]. Many of those in our sample do seem to conform to that pattern; yet, as shown in Table 6, 42% of the 36 individuals who independently identified as both an engineer and as a supervisor also indicated simultaneously serving in a "technical expert" role. While our simple measure of technical expert status cannot reveal the detailed nature of these individuals' work, this finding nonetheless raises the possibility that some individuals sustain relatively high levels of technical responsibility while managing direct-reports in

the first decade of their career. It may therefore be important for EL educators to avoid describing a sharp fork in the road between the more technical and the more managerial career paths to students.

Yet, our findings also suggest another layer to the story about technical and managerial trajectories. While we discussed the prevalence of engineer-managers in *Results*, we also noted a comparable dearth of engineer-directors ("managers of managers") or engineer-executives, despite having 26 directors or executives in the sample to examine. In fact, of these 26 individuals, only four identified as engineers and only three identified as technical experts (Appendices B and C). These findings are not surprising: we expected that engineering identity would wane as executive rank was achieved [30, 31]. Yet, two observations stand out from our findings that build upon the prior literature in this area. First, if we had not explicitly asked about "engineering coupling" of respondents' work (Table 5) in this survey, we would not have ascertained that 17 of the 22 "non-engineer" directors/executives actually assess their work as closely coupled to engineering (Table 7); rather, we would have risked simply conceiving of these individuals as leaving engineering. These "non-engineering" directors' and executives' self-reported occupation categories spanned general/business management, product and project management, military, and consulting. Secondly, while our findings suggest that there may not be a sharp fork in the road between technical and managerial career paths, the findings nonetheless do imply a soft and eventual fork in the road, as the comparison of managerial rank of the individuals counted in Table 6 and those counted in Table 7 suggests. These findings complement those in other recent research, which similarly highlight multiple possible advancement trajectories (as opposed to a clear-cut distinction between a "technical track" and a "management track") for engineering graduates [29]. Though this study's subsample sizes are small and these trends require future examination in larger samples with statistical inference, these observations invite continued study of the career tradeoffs that aspiring engineering leaders should contemplate as they weigh pursuing more technically-focused versus executive-pathway contexts of leadership.

As prior works have pointed out, most EL student cohorts are self-selected [32], so causal attribution of student outcomes to program participation is often difficult. Yet, even non-causal characterizations of EL participants' career outcomes can assist EL educators by providing an awareness of what to expect about students' career needs. In the case of this study's findings, we note that GEL participants seem to have a higher proclivity toward management and management-related jobs, both immediately following graduation and within the first decade of their career, relative to their peers in broader engineering school cohorts (Table 2). Further, we found that GEL alumni advance into these roles at a substantial pace; for instance: 8% reported being in supervisory roles within their first two years of graduating, while 63% reported being supervisors by the time they have six to 11 years of work experience (Figure 1). This finding suggests that formal managerial responsibility is not proximally distant for many program participants. EL programs therefore face the possibility that many of their graduates will encounter challenges beyond teamwork and team leadership relatively early in their careers, including in such areas as working with senior stakeholders, navigating advancement into and through managerial ranks, and working amidst organizational politics (e.g., Table 8). We conclude our discussion with a review of potential opportunities for EL programs to strengthen student development in areas pertinent to the types of career experiences and trajectories evident in our sample.

Opportunities for program enhancement

Growing participants' capabilities for handling organization-level issues and challenges stands out as an opportunity for curricular refinement in GEL based on both quantitative and qualitative feedback collected in this study. It is unsurprising, given GEL's comparatively more intensive focus on teamwork and team-level leadership skills, that alumni report being better prepared in those areas

(see: top two items in Figure 4). While the GEL curriculum includes individual modules (each featuring learning activities) on working with organizational stakeholders and navigating organizational cultures, these elements are neither as pervasive nor recurrent in our curriculum as teamwork and team leadership objectives, which essentially form the backbone of the program. Further, our findings appear to support the present prioritization of objectives, given that very few alumni in our sample achieve significant managerial rank within their first two years. Yet, alumni have been shown to ascend quickly (Figure 1) and are likely pursuing advancement before promotions are formally received. In other words, findings suggest that comparably advanced organization-level capabilities are more pertinent within the first two to five years of alums' careers than we had anticipated.

Qualitative findings reinforce these insights about strengthening organization-level foci in the program. As one respondent indicated, "[it has been] very difficult to navigate organizational politics, especially early in my career" (Table 8, Response A016). Another offered a more pointed conclusion: "In many companies you will be limited by your superiors – you can't go through them, so go around" (Table 8, Response A018). Other related commentary in Table 8 was more friendly to respondents' present employers, suggesting the importance of getting to know one's company (A006), understanding connections between an organization's skills "voids" and where one can contribute (A030), and working to gain insight into one's "manager's mindset" (A034), among others. When retrospectively critiquing the GEL program, some respondents similarly pointed to boosting organization-level learning opportunities, for instance: "[GEL should spend] more time on fundamentals of business and organizations..." (Table 9, Response B030). Another respondent mentioned a distinction between skills needed soon after college compared to those that one needs upon advancing: "GEL did a nice job at prepping me for the first few years out of school, but I realized being a manager how many topics GEL didn't cover" (Table 9, Response B032).

Several alumni, meanwhile, commented on the importance of building professional connections and relationships, especially those that support career growth and navigation. As one respondent explains: "In the early years, it is critical to have an advocate..." (Table 8, Response A009). Another, reflecting upon a specific corporate experience, advises: "...it's really on the individual to take initiative...[to have] discussions about career advancement with their supervisor" (Table 8, Response A020). Meanwhile, another respondent points to career networking as critical to finding the right roles and teams to join (Table 8, Response A033). While the GEL curriculum includes interpersonal communication-related learning experiences that cover employee-supervisor interactions and interactions with influential members of organizations (such as during modules on "Inquiring and Dialoguing"), the above feedback suggests an opportunity to expand learning and practice opportunities into the area of building relationships that are career navigation-related.

Further, alumni feedback also indicates a desire to gain more careers-related knowledge from the GEL program itself. Given the complex and wide-spanning occupations landscape faced by program graduates, it is perhaps unsurprising that retrospective feedback highlights both an appreciation for careers information obtained through GEL, as well as a perceived need for more guidance on jobs, roles, and pathways. "GEL was instrumental in my career. I was able to discover a career (product management) which I was not aware of before the program...," explains one respondent (Table 9, Response B010). Yet, another respondent suggests dedicating more time in the program to an "explanation of the roles and incentives of different organizations within a business " (Table 9, Response B030). Another, meanwhile, shares how they learned about unique occupational roles in the years following graduation, wishing they could have acquired this knowledge during the program from guests or speakers with industry experience (Table 9, Response B037). Industry guests dubbed

"engineers in the room," have been a longstanding fixture of GEL, but they primarily comment on learning experiences they witness in the classroom and those experiences' pertinence in their field or industry. Historically, less time has been spent discussing career journeys and occupational roles of these guests. GEL also hosts an optional mentor-pairing initiative that roughly $^1/_3$ of students join, and while careers and roles are discussed here, each student hears from only one working professional in this regard. By comparison, GEL hosts roughly 60 "engineers in the room" annually that all participants meet briefly. Our findings suggest an opportunity to engage with program guests differently, with greater focus placed on experiences and lessons-learned about career navigation and roles.

While the EL program opportunities discussed above reflect the prominent themes among the acquired alumni feedback, we must note that the set of opportunities highlighted above is far from comprehensive. Comments in Appendix E, for instance, include additional program suggestions such as increasing emphasis on entrepreneurship-related skills, marketing the program more deliberately to those pursuing graduate school, and increasing focus on certain communication skills, among others. For GEL in particular, some of these suggestions require more delicate consideration than themes outlined above, since the program exists alongside partner and peer programs (e.g., MIT's Trust Center for Entrepreneurship and MIT's School of Engineering Communications Lab) that cover the suggested scope and are accessible to the same students. However, these suggestions serve as a reminder to remain vigilant for collaboration and integration opportunities among MIT's peer programs. Moreover, beyond GEL, each EL program's host university context differs, and, in turn, the pertinence of primary and secondary feedback themes may differ across EL programs as well.

Conclusions

An often-heard adage among educators is that teachers can learn from their students as much as students learn from their teachers. While the alumni surveyed for this study are a few years removed from being students, it is clear, through their rich early career experiences, that they still have much to teach their EL educators. Foremost, we learned that there is no one predominant way in which GEL graduates engage in engineering leadership in their careers. Alumni follow varied career paths, many of which evade traditional categorization. Roughly half of GEL alumni have not held "engineering" titles – yet, almost all alumni (85%) work within close proximity to engineering. Further, prominent subsets of alumni have each followed distinctly different routes into management. Some have remained deeply technical as they maintained engineering job titles while leading direct-reports, while others have forgone deep technical responsibilities and engineering titles as they have advanced toward executive-level roles. Yet, as anticipated, nearly all alumni begin their careers as individual contributors and find the teamwork and peer leadership skills central to the GEL curriculum to be quite valuable. For many, however, time spent as an individual contributor is brief, with over $^1/_3$ becoming supervisors by the 5-year point in their careers and a majority doing so by the decade mark. We learned that these fast-rising alumni face organization-level challenges earlier in their career than we expected, and for which they feel GEL could have better prepared them. We also learned that alumni quickly encounter a wide array of possible work roles and advancement paths – especially those opportunities in the "engineering-coupled" realm of Product Management, Solutions Engineering, or Systems Architecting (among many others) – that they find both enticing and mysterious. Toward this intrigue, a summative question raised by our findings asks: to what extent should undergraduate EL programs bring the organizational realities of engineering work, the complexities of its career paths and role types, and the notion of engineering leadership as a lifelong journey into the EL curriculum? Findings from one EL program cannot answer this question on their own, but we hope these findings, in conjunction with those from other programs, can contribute to a deeper understanding of how to best prepare future engineering leaders to thrive in their careers.

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Appendix A - List of occupation names presented in survey

Occupations [1]
Engineer (all except software engineer)
Software engineer or software developer
Computer scientist or mathematician (not identifying as 'engineer')
Scientist (life, physical, or social)
Data scientist or quantitative analyst
Project or product manager
Technical consultant
Management consultant
Manager (general, business management, or executive)
Finance, banking/investing, or venture capital occupation
Healthcare practitioner (including medical doctor)
Legal occupation (including lawyer or attorney)
Arts, design, or media occupation
Architect (building or landscape)
City or urban planner
Entertainment or sports occupation
Military
Education: preK-12 (including teachers)
Academia: university faculty
Academia: non-facuty (including university researchers & instructors)
Other (please specify): _____

Notes:

1. Occupation titles are presented in the order in which they appeared in a drop-down list within this study's online survey instrument

Appendix B - Job titles among those who identify as both engineers (including software engineers/developers) and supervisors. Titles are presented exactly as provided by the respondent

	Supervisory level			
Job title	Manager	Manager of Managers	Executive	**Technical expert**
Architect	x			x
Chief Enterprise Engineer	x			x
Coastal Engineer	x			
Design Engineer II	x			
Director of Engineering		x		
Director of Engineering		x		
Drilling Engineer	x			
Electrical Design Engineer	x			
Engineering Manager	x			
Engineering Manager	x			
Engineering Manager	x			
Founding Software Engineer	x			
Instrument Operations Systems Engineer	x			
Lead Developer	x			x
Lead Electrical Engineer	x			x
Lead Launch Engineer	x			
Lead Mechanical Engineer	x			
Mammalian Engineer 3	x			
Mechanical engineer	x			
Mechatronics Engineer	x			
Principal Engineer	x			x
Process Engineer	x			
Product Development Engineer	x			
Project Engineer		x		x
Research [sic]	x			x
Senior Machine Learning Engineer	x			
Senior Member of Technical Staff	x			x
Senior Reservoir Engineer	x			x
Senior Software Engineer	x			
Software Engineer	x			
Software Engineer	x			x
Staff Engineer	x			x
Staff Software Architect	x			x
Team Lead + Tech Lead	x			x
Technical Architect	x			x
Technical Director		x		x

Appendix C - Job titles among respondents who work in engineering-coupled roles and who are supervisors. Titles are presented exactly as provided by the respondent

Job title	Supervisory level			Technical expert
	Manager	Manager of Managers	Executive	
Application Manager	x			
Architectural Engineer	x			
CEO			x	
CEO, Co-founder			x	
CEO, Founder	x			
Chief Operating Officer	x			x
Chief Operating Officer		x		
Cofounder	x			
Deputy Branch Chief, Architecture Integration		x		
Director of Business Development	x			
Director of Business Development			x	
Director of Implementations	x			x
Director of Product Management	x			
Director, Baseball Projects	x			
Division Officer	x			
Division Officer		x		
Environmental Consultant	x			
Field Operations Coordinator	x			
Head of Product	x			
Internal Project Chief Engineer	x			x
Lead Data Analytics Manager	x			
Manager, Data & insights	x			x
Manager, Supply Chain		x		
Operations Consultant	x			
Operations Developer	x			x
Plant Manager		x		
PM Manager	x			
Product Manager	x			
Product Manager	x			
Product Manager		x		x
Product Manager	x			
Program Manager	x			
Project Manager (R&D Program Integration Manager)		x		
Research Director / Co-Founder	x			x
Senior Advisor	x			x
Senior Director of Product Management		x		
Senior Manager		x		
Software Engineering Manager	x			x
Solutions Architect	x			
Submarine Officer		x		
Technical Instructor	x			
Technical Product Manager	x			x
Technical Product Manager	x			x
Technical Program Manager	x			
Technical Second Line Supervisor	x			
Technical Translator	x			
Test Pilot		x		
Vice President of Engineering			x	
VP Product			x	
VP, Product			x	

Appendix D - GEL alumni insights about challenges or opportunities related to career advancement

Resp. no.	Insights about challenges or opportunities related to career advancement[1]	Respondent characteristics		
		Relation to engineering[2]	Total work experience (yrs.)	Total supervisory experience (yrs.)
A001	"Worked at early-stage organizations / companies, so the career ladders weren't as defined as in larger corporations."	EC	6	1
A002	"-Managing work/life balance -Setting clear expectations with managers/direct reports -Having clear separation between a friendship and a working relationship"	EC	5	3
A003	"I think the biggest struggle is balancing work with lifestyle/friends/family. Fast career advancement takes time/energy and it detracts from other aspects of life."	EC	4	1
A004	"Career advancement at large companies is rather slow the traditional way (i.e., staying in the same position for multiple years). Rapid career growth happens through diagonal promotions to different companies or entrepreneurship."	EC	4	2
A005	"At my current employer there are a very limited amount of promotions that one can achieve in their career. Reaching level 5 is seen as the goal for many supervisors to get their reports to achieve. As a result, talented engineers who do really well starting off feel they are undervalued and unappreciated as they wait for years to be promoted to the next level. At other companies they would be considered senior engineers but at this one they are seen as junior with decades to go to reach meaningful promotion."	E	5	1
A006	"A lot of advancement depends on the company as well as yourself. Look for opportunities outside of your role to show your capabilities."	EC	10	2
A007	"Some companies focus more on career development / advancement than others. If your company doesn't prioritize this, you have to be more vocal and advocate for yourself to move."	EC	5	4
A008	"I've found that promotions are closely tied to finding and executing projects outside of your assigned statement of work."	EC	6	1
A009	"In the early years, it is critical to have an advocate, for example, a manager who understands what you are doing and values your contributions. I've seen many people become frustrated and even scale back their effort because they don't feel that their manager adequately advocates for/appreciates them. I've personally experienced both ends of the spectrum."	E	3	2
A010	"My current company has two career paths for engineers - technical track and management track. My previous company did not have this divide, but also had no serious technical roles, even within R&D. It has been very clear to me, in my short career, that the engineers pushed through the management track without training, skill/people development, and interest in the track are easy to spot and detrimental to the building and functioning of internal teams. GEL is a great program for students before they enter the industry and would be a great program to adapt for companies, too!"	E	3	2
A011	"Choosing between technical and management tracks, especially when the organization shares inside information with managers but not with non-managing technical leaders is stifling. Just because I want to continue to develop technical skills doesn't mean I don't have insight into non-technical issues"	EC	9	3
A012	"Bring it up yourself if you feel you are ready. Ask questions about how promotions are determined / what to expect. Let your managers know what you want/what roles and responsibilities you would like to have - don't assume they know or that your current role pre-determines your next."	E	5	1

Appendix D continued...

Resp. no.	Insights about challenges or opportunities related to career advancement[1]	Respondent characteristics		
		Relation to engineering[2]	Total work experience (yrs.)	Total supervisory experience (yrs.)
A013	"Having a broad skillset to draw on for new roles has helped me in my career advancement. "	EC	8	3
A014	"Premature advancement especially without proper training prior to the promotion can actually work against one's career."	EC	8	5
A015	"Tech-first roles strongly benefit from management / leadership skills, and vice versa. While the career trajectories split between individual contributor and manager roles, that's more a matter of choosing a primary focus than an excuse to ignore the other field completely."	ESW	6	2
A016	"Very difficult to navigate organizational politics, especially early in my career. Wish MIT / GEL had discussed this more."	EC	5	2
A017	"My organization does not generally give raises for increases in responsibility (except at the highest levels of management). Increases in impactful work is reflected in the annual pay increases."	E	3	1
A018	"Changing employers is the fastest way to advance. In many companies you will be limited by your superiors - you can't go through them, so go around."	E	2	< 1
A019	"The common saying seems accurate you need to move around to move up. Not necessarily to a new employer (particularly at large companies) you can apply to requisitions at the current company to get promotions and new opportunities. Bad managers will block this because they don't want to have to replace people. My career advancement definitely accelerated once I left my old employer and found management at a new company that would advocate for me and act as my sponsor. I had heard about that relationship in trainings and talks but never found that at my old employer. So sometimes the answer is to cut your losses and try something new. I see too many people get stuck in bad situations at an employer and don't remember leaving is always an option."	EC	7	1
A020	"At my company there isn't a formal career planning/coaching service within HR so it's really on the individual to take initiative and ownership of this career trajectory and discussions about career advancement with their supervisor"	E	7	1
A021	"The soft skills master [sic] even more than GEL prepared me for."	EC	9	2
A022	"Air Force is (currently) distinct from industry and other government positions in that officers must be managers first, technical experts second, at least in the engineering fields."	EC	7	2
A023	"All my promotions came when changing employer. Every job I've held had annual increases & good praise, but it was rarely reflected in a significant title + compensation increase."	EC	9	1
A024	"Career advancement in the startup world is largely tied to how quickly the company grows. In a larger company (e.g. Google), career advancement is more likely to require a longer minimum time between roles."	EC	10	2
A025	"Large companies , especially those that contract with the government, often have rigid systems in place to advance people through a career path that is often based on years of service rather then ability and accomplishments. Some exceptions can be made but only with very high level support (eg, CEO)."	E	11	6

Appendix D continued...

Resp. no.	Insights about challenges or opportunities related to career advancement[1]	Respondent characteristics: Relation to engineering[2]	Total work experience (yrs.)	Total supervisory experience (yrs.)
A026	"Sometimes it's hard to know what exactly you need to do to get to the next step. No one will give you candid feedback until it's performance review time."	ESW	3	1
A027	"I work in a niche field that starts entry level employees with very low pay/title and has greater than average opportunities for rapid advancement."	EC	4	2
A028	"Military promotions are very railroaded."	EC	8	8
A029	"The skills necessary to excel as an individual contributor are different from those required of a manager (the "what got you here won't get you there" concept). Engineer-types are often motivated and fulfilled by building or being close to the building, and moving up the management track tends to move you increasingly further from the action. In product management, a lot of roles expect a senior product leader to spend most of their time on a GM-esque role which is almost an entirely different function from product management. Product management is still in the early days of defining a clear individual contributor or even small-group leader track (aka "principal product manager")."	EC	10	5
A030	"To get promoted fast it helps to fill a unique void in skill sets at the organization."	E	6	1
A031	"I have struggled to fit within traditional engineering organizational roles. I have always felt that I contribute significantly more to a company across technical and business areas and identify gaps in the team and company then strive to fill them. There are many things I add which cannot be represented in a resume or a few interviews. For this reason, I have found during interviews that I get placed in an artificial box and assumptions which underplay my ability to improve the company, especially at larger companies."	E	3	3
A032	"Changing titles/level as an engineer without a laddering system. My title has not changed for a long time even though I am more experienced."	ESW	6	6
A033	"Networking and mentorship are key. I often skipped some events because they felt very draining and/or not as productive, but I now realize the importance of that in finding the right career and even later finding the right team through seeking your network. Great people know other great people. Changing industries and working in a different field is also incredibly challenging especially as a new graduate. For example, a non-engineer with only research experience wanting to become a product manager may be dismissed from a lot of recruitment processes because they don't have relevant experience. The key here is to learn how to market your skills learned outside of the classroom/lab (GEL, events, student clubs, side projects, etc) and making sure that shines i [sic] you [sic] resume of [sic] first screening interview. Final challenge is getting promoted to a manager role in <5 years. That's often very challenging because you are asking for a role that usually requires 10+ years experience. Gaining trust and showing ambition and initiative goes a long way in this	EC	5	1
A034	"Do your role as if you're already working in your next/promotion role. This gives you insight into your manager's mindset, as well as buying you free experience."	EC	8	4
A035	"Challenges with moving to being a first time manager."	ESW	6	1

Appendix D continued...

Resp. no.	Insights about challenges or opportunities related to career advancement[1]	Respondent characteristics: Relation to engineering[2]	Total work experience (yrs.)	Total supervisory experience (yrs.)
A036	"Having been a start-up exec.. [sic] and now working in the R&D project management realm at a 4000+ people org, it is challenging to device on next steps. I feel that as a project manager - your job is really from project to project. The transition to program and portfolio management isn't clear from there either. And when many people around you have been PM for 20-30 years and are your n+1s it's tough to feel that there is a path for functional growth."	EC	5	2
A037	"Startups take time. Got fired from a startup a few times while figuring out how to collaborate well with a lot on the line. Now doing my best to scale in a role that has a little breathing room while building the organization."	EC	5	2
A038	"I think "technical leadership" or "technical management" are real career tracks, but necessarily involve less direct technical execution than a pure technical role"	ESW	7	2

Notes:
1. Question: "Based on your experiences, you are invited to share any insights you may have about challenges or opportunities related to advancement:"
2. E = "Engineer," ESW = "Software Engineer or Software Developer," EC = "Engineering-Coupled"

Appendix E - GEL alumni insights about program strengths and opportunities areas

Resp. no.	Insights about how the GEL program has helped you succeed or how the program should evolve to better prepare students[1]	Respondent characteristics		
		Relation to engineering[2]	Total work experience (yrs.)	Total supervisory experience (yrs.)
B001	"Increase focus on explicit leadership skills for students who don't have hands-on building expertise."	EC	4	2
B002	"100% recommend GEL to all students I talk to. The lessons I learned at GEL I use every day, despite it being years since I graduated. Much more impactful than my major."	EC	6	1
B003	"When I participated in GEL there was a strong emphasis in working in a corporate [sic], where I think there could have been equal emphasis on starting your own venture as well. Both need different types of leadership experience."	EC	9	1
B004	"GEL was the most practical and hands-on experience I had at MIT that gave exposure to what 'work' looks like - namely how to communicate with people in diverse environments. I value that communication education from the program and hope to see that GEL continues to cultivate excellent communication skills from its participants."	E	5	1
B005	"My GEL education was as important to my personal/professional growth & development as my course major was. I benefitted deeply, and continue to do so."	EC	4	1
B006	"Public speaking skills and learning how to properly do technical presentations was crucial practice for me. Understanding that practice is required, knowing your audience, and having confidence are what I believe set ordinary engineers apart from their peers."	E	5	1
B007	"GEL puts a tremendous amount of weight on the actual application behind some of the management theory you learn. That's super valuable to actually *apply* some of the things you learn and it's rare you'd get an opportunity to have focused practice on these skills so early in your career."	EC	3	1
B008	"When working, there really are no soft skills...there are only skills which help you achieve your goals and those that don't. Those are both technical and non-technical. I have had to speak to (prospective and current) investors, board members, customers, etc. and having been in even mock/simulated leadership roles through GEL helped me keep getting better every time."	E	2	< 1
B009	"GEL was hands-down the best course/program I took part in while at MIT. Every experiential lab granted new skills that I still use to this day in my day-to-day. From how to manage teams, to reporting up, to talking with industry experts, everything was useful, even if I didn't realize it at the time. I would suggest that GEL a) continues this experiential approach to learning practical skills and b) adopt a mentorship program much like [that of the MIT Undergraduate Practice Opportunity Program]. has done with their Milestone Mentor Program. I have been a Milestone Mentor two years in a row, but would prefer to do the same work with GEL students covering GEL topics since I believe more strongly in the GEL mission."	EC	5	4
B010	"GEL was instrumental in my career. I was able to discover a career (product management) which I was not aware before the program. Then, I was able to engage with staff and students to really advance and challenge my capabilities. This helped me enter the workplace as a professional, ahead of my peers, since I was able to work well with others in a fast-paced and technical team."	EC	8	5
B011	"I had pretty strong leadership training and experience prior but I think the average MIT student could benefit from GEL."	E	3	1

Appendix E continued...

Resp. no.	Insights about how the GEL program has helped you succeed or how the program should evolve to better prepare students[1]	Respondent characteristics		
		Relation to engineering[2]	Total work experience (yrs.)	Total supervisory experience (yrs.)
B012	"The EL classes are a great summary of key leadership concepts to the point that I very quickly advanced to coaching many of my company's soft skills internal trainings. [Engineering Leadership Lab] is also a great simulation of my job working with a variety of teams consisting of engineers and other stakeholders (maintenance, quality) "	EC	2	1
B013	"The training of soft skills and immersion into simulated labs are powerful teaching tools. As students, we spend 90% of the time studying the technical fields, but in the field, I believe soft skills are equally if not more important than technical know-how."	EC	6	1
B014	"I think I have advanced unusually quickly in my organization due to the skills I've gained in these programs. I work in an R&D-focused organization and sometimes it seems like individuals have received excellent prior training on the research side (e.g. completing a PhD), but less so on the management/leading technical teams. When I was an undergrad in GEL, it seemed like the program was primarily marketed to undergrads who wanted to go into industry straight after graduation. It should be advertised that these skills are of value even if your immediate next step is graduate school."	E	3	2
B015	"Several scenarios I encounter everyday remind me of GEL labs. One in particular is the generator design lab. We are always figuring out how to design a product based on cost, needs, user, people indirectly affected... and it can get quite challenging. My biggest suggestion is to think of GEL as a series of mini lessons about your career. You don't need to remember every detail, but if you remember the objective of your labs and how you achieved them, you will always be able to apply them in real time at work."	E	5	1
B016	"The [Engineering Leadership Labs] were excellent! They put me in situations that definitely happened to me again in my career, and I was well prepared to handle them as a result. I'd love to have met and gotten to know more of the [participants in the optional second year of the program] when I was a [first year program participant]. I wish we had more social events together where we could meet and share experiences."	ESW	6	2
B018	"I enjoyed GEL a lot and made friends, but I'm not sure what skills I learned through the ELLs that have helped me in management, even though I always liked them. The things that have been most relevant to me in my role as a manager were learned at the offsite in New Hampshire [for GEL's Project Engineering course] and through the classes we took on product innovation and ethics/company case studies. I primarily joined GEL for the networking opportunity, and took those things away as a bonus."	ESW	6	4
B019	"I think what the GEL program really helps with is getting the muscle memory for a lot of these situations. One thing that is difficult is that MIT being a top institution you run into a lot of seasoned leaders in the program so it can be tough for people who are still developing those skills to feel comfortable. I know for myself i was definitely in the bottom half of the leadership skills at that time, but out in the world I'm top tier. So it's funny how that goes sometimes. Not sure what the GEL program can do to develop more of the leaders that need the nudge instead of mainly the ones that don't really need it at all. Particularly in [GEL's optional second year]."	EC	7	1
B020	"Probably 80% of the skills I use on a daily basis are the leadership capabilities I practiced in GEL. I cannot emphasize enough how much of a positive impact the program had on my career."	E	7	1

Appendix E continued...

Resp. no.	Insights about how the GEL program has helped you succeed or how the program should evolve to better prepare students[1]	Respondent characteristics		
		Relation to engineering[2]	Total work experience (yrs.)	Total supervisory experience (yrs.)
B021	"Similar to [MIT's Undergraduate Practice Opportunity Program], I had lots of takeaways from role-playing exercises that helped me relate personally & more viscerally feel why the skills mattered, and what they could change. it also helped me get a better "spidey sense" for when things were going wrong in the real-world & predict the common pitfalls of team & project management. I also had strong memories from [GEL's course in Design & Innovation Leadership]."	EC	9	1
B022	"I cannot recommend GEL enough. I hope one day it is a required part of the MIT curriculum, as it provided a "rounding out" to my technical education that made me able to rapidly enter strategically important roles wherever I worked. This has been a major accelerant in my career."	EC	10	2
B023	"GEL to [sic] the initial [MIT Undergraduate Practice Opporutnity Program] concepts and refined them heavily, giving me a strong foundation to start my career and a heightened awareness of the skill I needed to continuously focus my own development on."	E	8	3
B024	"The most practical day to day skills that I use and that have contributed to my career advancement were from [my GEL Design & Innovation Leadership course]. [This] class taught me to reason about stakeholders, navigate uncertainty, and tell a narrative about my work that has been indispensable to my professional life."	EC	7	4
B025	"I've only recently moved into a military position that is very engineering focused. The lessons learned in GEL have been coming back to me in bits and pieces after a 10 year gap. I do have some of my old GEL materials available, but it would be fantastic if GEL alumni could reach back to a consolidated lesson sharepoint or handbook that distills the main lessons of the ELLs as a memory jogger."	EC	10	5
B026	"Perhaps aided in part by my transition from the hard engineering world into the sports/entertainment industry, I've derived a lot of value from the soft leadership skills that I learned in GEL, such as organizing an inclusive team, defining specifications, understanding stakeholder needs, communicating through conflict, and providing meaningful feedback. After some time in industry, I've become more and more convinced that engineering ideas can only be as valuable as the communication that accompanies them. GEL provided many valuable insights into how to optimize the people side of engineering, which made the engineering rigor of the rest of my degree relevant and actionable. One small area that I felt a little bit underequipped for was general public speaking / presentation skills / slide design. I'm not sure if or how that fits in the GEL arc, but perhaps a potential area for the program to evolve in over time."	EC	4	2
B027	"Very good supplement to military service."	EC	8	8
B028	"It's amazing to me how difficult these skills come to so many people in the workplace. Having a handle on them, even to a small degree, can jumpstart your career significantly. Even if you are not a subject matter expert, these skills allow you to influence at a higher level than you might expect, simply by organizing people and efforts effectively."	ESW	7	3
B029	"One of the most important things I did at MIT, though I wish there were more of an emphasis on entrepreneurship (maybe working with [MIT's Martin Trust Center for Entrepreneurship]). I co-founded my healthcare tech startup 5 years ago and have been running it ever since. Early on, I used a lot of the skills I learned at GEL to create good product market fit and launch a successful product!"	EC	8	4

Appendix E continued...

Resp. no.	Insights about how the GEL program has helped you succeed or how the program should evolve to better prepare students[1]	Respondent characteristics: Relation to engineering[2]	Total work experience (yrs.)	Total supervisory experience (yrs.)
B030	"More time spend on fundamentals of business and organizations, e.g. explanation of common metrics in different industries (revenue, margin, ARR, engagement, retention, activation, bill through rate, etc.) and explanation of the roles and incentives of different organizations within a business (sales, marketing, FP&A, operations, etc.). A lot of new grads spend a lot of time just learning how the business world functions and gaining an understanding of and empathy for non-engineering roles. Some context in school would speed up that learning process dramatically and also help students be more successful in interviews."	EC	10	5
B031	"I feel that my GEL experiences have given me a unique ability within my teams to recognize and help others see the concerns our stakeholders have. Thus, I am frequently the go-to person when people can't see eye-to-eye about a path forward and need help including others' perspectives. Technically, stakeholders appreciate that I anticipate their needs and communicate my design decisions in the products I deliver."	E	5	1
B032	"GEL does a fantastic job at teaching practical skills that help so much in the engineering workplace. When I see challenges at work, I often wish my colleagues had had the similar experiences like GEL in their past. GEL did a nice job at prepping for the first few years out of school, but I realized being a manager how many topics GEL didn't cover. There might have been an opportunity to have more manager [Engineering Leadership Labs]. I distinctly remember and can point to times where I've used skills on team formation, product management from the [January term] class, testing assumptions when confronting colleagues, and ethics frameworks."	E	6	1
B033	"GEL built a foundation and framework for me to think about the challenges I face at work everyday. It gave me a head start in advancing my career. GEL could very easily not be aimed at just people wishing to be engineering leaders, and be useful for anyone planning to enter industry."	ESW	5	1
B034	"I think GEL is a great compliment to an MIT engineering education. I don't think it is in any way a substitute for internships to show how work actually happens and give practice in team environments - and I think opportunities like student vehicle teams are a great way to get that experience - but GEL is a way to learn WHY good leadership and teamwork skills work and so is an important "piece of the pie" in engineering leadership learning."	E	7	2
B035	"GEL labs and evaluations helped me consider key communication and team work characteristics that I still use to this day. I've seen projects fail due to lack of communication and poor ownership assignment countless times that were identified and repeated throughout the GEL program. The program reinforced my personality traits that work well in engineering team environments and identified others I needed to focus on more consciously."	E	3	3
B036	"I use the 10 step design process [from my GEL Design & Innovation Leadership course] all the time when writing technical proposals and project documents."	ESW	6	6

Appendix E continued...

Resp. no.	Insights about how the GEL program has helped you succeed or how the program should evolve to better prepare students[1]	Respondent characteristics		
		Relation to engineering[2]	Total work experience (yrs.)	Total supervisory experience (yrs.)
B037	"GEL has given me so many soft skills and project management experience I didn't have in my curriculum. The motto of having to complete tasks/projects 'to-spec, on-time and within budget' has been core to how I've managed my personal and team projects and gained a lot of respect from my peers, managers and team members. The one recommendation I have for future career prep is perhaps having more facetime/conversations with industry guests with unique roles (non-traditional software engineering roles) to learn more about what they do. For example, I did not know what a Solutions Engineer or Product Manager really does until 3+ years in my job. It would've been amazing to have had a GEL alum in that role explain the day-to-day of the job in a career session or such. I woud've certainly sought that path sooner."	EC	5	1
B038	"Excellent primer for engineering leadership. Key to its success is it's close coupling with industry leaders and it's InternshipPlus program that opens up doors to industry mentors that are ready and willing to go above and beyond."	EC	8	4
B039	"Taught me about what success for an engineering team can look like and how to be good at leading engineering teams."	ESW	6	1
B040	"See my comments earlier."	EC	6	1
B041	"GEL was an excellent practice arena, and encouraged a lot of helpful mindsets. I think it would be even more valuable if combined with technical projects (e.g. [an engineering castone course]). I also think that [MIT's Oral Communication course] was invaluable when combined with GEL."	EC	5	1
B042	"[the GEL Engineering Leadership course instructor's] lectures on decision making and prioritization and just him talking about the challenges he face[d] ended up being far more valuable in the long run. In the short run, the [leadership] labs were helpful after I graduated to see how to be a good-teammate and learn to build a team. But as I got to have more responsibilities the case studies we read are things I often think about."	EC	5	2
B043	"Conflict is an essential part of what happens during collaboration. MIT's egalitarian nature is NOT representative of the workplace. Instead, these cultures must be built in the smallest interactions. I wish that were more focused on - how to remain collaborative, prefrontal cortex grounded before/during/after conflict."	EC	5	2
B044	"The most important thing I got from GEL was the framing of considering problems from an organizational perspective and not just a technical one. The best coolest most novel technology won't go anywhere if nobody ever hears about it or knows how to use it."	ESW	7	2

Notes:

1. Survey question: "Please share any insights you have about how the GEL program has helped you succeed or about how the program should evolve to better prepare students for career success:"
2. E = "Engineer," ESW = "Software Engineer or Software Developer," EC = "Engineering-Coupled"