A Study on the Work of MIT Mechanical Engineering Graduates

by

Brandon Nigel Wright

Submitted to the
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in Partial Fulfillment of the Requirements for the Degree of
Bachelor of Science in Mechanical Engineering

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Undergraduate Officer
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Abstract

This study seeks to collect rich data about Mechanical Engineering alumni’s work lives using qualitative and interpretive social research methods. Semi-structured interviews were conducted with several alumni from the MIT Mechanical Engineering department. Main topics discussed in these interviews were current work activities, career motivations, important job skills, the value of an MIT education, and potential improvements to the MIT alumni experience.

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Title: Weber-Shaughness Professor of Mechanical Engineering and Engineering Systems
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I would also like to thank Professor Warren Seering who has given me invaluable advice during the process of putting together all this work. I would also like to acknowledge the support of Brandy Baker and Leslie Regan in finding alumni for me to interview, as well as thank the alumni themselves who took time out of their busy schedules to talk to me.

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Chapter I: Introduction and Literature Review

Project Objective

The objective of this project is to obtain better information on the state of practicing engineers through semi-structured interviews of MIT alumni from the Mechanical Engineering department. We hope to provide information that will help align undergraduate engineering education with the skills necessary to succeed in an engineering career. In addition, we hope that the information we can collect in the course of this thesis will help undergraduates be better informed when choosing their major.

Literature Review

What is Engineering Anyway?

There are generally two strands of thought that characterize the ways people think about the work that engineers do. The vast majority of engineers, who subscribe to the thinking of technical rationality, consider engineers to be individuals who often draw upon a wealth of technical knowledge and considers these technical activities to be the essence of an engineer’s work and social interactions to distract from this work. This contrasts the perspective of heterogeneous engineering, put forth increasingly by scholars in the field of Science, Technology, and Society (STS), which suggests that the people involved in bringing any engineering project to completion have quite varied backgrounds, and so social skills are imperative for all stakeholders in order to coordinate the various skillsets with the ultimate goals.

Prior Fieldwork on MIT Alumni: Kristen Wolfe’s Thesis

A 2004 thesis by Kristen Wolfe provides strong evidence that the claims of pervasive heterogeneous engineering by STS researchers may be true, at least in the case of MIT alumni. Through conducting an online survey with over 300 respondents, Kristen’s work shows that MIT’s alumni use communication skills and broadly defined quantitative/science skills much more often than the specific skills they may have learned in the course of earning their Mechanical Engineering degree.

Chapter II: Research Methodology

Theoretical Framework

This study was conducted from the point of view of interpretive social science, where we sought to consider as much as possible the perspective of the respondents and represent that in the reported data. Along those lines, I consciously tried to not decide how to summarize the data based on how I might categorize their experiences but instead focused on what words they used to describe their work. This meant, for example, that if someone described the company as large scale, I recorded that they worked at a large company, without cross referencing what is generally thought of as large or looking up the number of employees.
As I will go on to discuss further, the type of sampling we used to find respondents was one known as convenience sampling which is associated with a number of biases that develop as a result of artificial limits placed on who can potentially be part of the sample.4

We conducted interviews in a semi-structured style in the hopes that we would be able to balance both the desire for meaningful, representative responses with the need to collect data which is richer than has usually been the case for research on this topic. We hoped to collect information not only on what alumni do, but also how and why they choose to do it.

Alumni Recruitment

We sought to recruit alumni by a series of electronic messages which served the dual purpose of providing information about the study as well as acting as a mechanism through which they could consent. An initial e-mail to alumni informed them of the purpose and motivation for the study as well as providing them a means of contacting me to schedule an interview. I followed up these responses with an additional message that laid out the terms in detail sufficient enough to follow best practices in obtaining informed consent. I asked that respondents read these terms and consent by continuing the process of scheduling an interview. For the full text of these e-mails, see Appendix 1: Correspondence with Alumni.

I made a spreadsheet of the names with all of my alumni contacts’ participation status in order to make sure that I did not contact the same person twice about the study and at the same time would spread out the timing of interview request e-mails so that in any given period I wouldn’t be overwhelmed by responses. I found it important as I continued the interview recruitment process to confirm with my respondents that we were either in the same time zone or they were aware that there was a time difference and that was acceptable.

We found alumni to interview by way of lists of e-mail addresses given to us by administrators at the undergraduate and graduate Mechanical Engineering offices as well as the names of close contacts in the alumni community. Judging by the sample demographics provided in table 1 and comparing them to the population of all MIT alumni, it’s clear that our sample includes many more young alumni than is representative.

Preliminary Interviews

I conducted one early unstructured interview with a graduate who was working at a large engineering firm in order to have some idea of the range of responses I might need to create questions to learn about. This first interview gave a great deal of direction to the structure of the question tree which is presented in full in Appendix 2.

After doing a number of interviews using this question tree, however, we found that respondents’ answers didn’t neatly conform to any of the categories which I had delineated in the tree and so I opted for a less structured interview protocol in later interviews. I also found that laying out potential answers for questions as I had in the first set of semi-structured interviews caused me, as an interviewer, to ask leading questions of the informants, potentially undermining the quality of the results. This effect is discussed further in Potential Sources of Bias, under Experimental Results and Analysis.
Technical Protocols
All interviews after the initial one were conducted over the phone through the VoIP application Skype. I would call the respondents from Skype on my personal computer to a phone number they had provided for the purpose of the interview. We purchased an inexpensive (approximately $3 per month) Skype calling plan that would cover calls to the United States and Canada to defray the potentially high cost of hours of phone calls. I also used some free software found on Softpedia in order to create recordings of the interviews for respondents who consented.

Privacy Protocols
I named the audio files within which the interview recordings are stored as well as the corresponding notes which describe the content of the interview with a numerical code generated randomly. There is a single file that contains both the names of study participants and their corresponding code number which remains in the sole possession of Warren Seering. The audio files of the interviews as well as the notes I took on them exist only on two thumb drives owned by the Mechanical Engineering Department and secured in an undisclosed location until further notice.

In reporting data collected in the course of this study, I was careful not to reveal any details about the informant that might make it possible for any third party to discern their identity.

Data Reduction
I took notes during all interviews, supplementing these with notes from memory and notes taken while listening to the recordings post-interview. After that, I looked over the notes to see what sort of commonalities existed between my conversations with different alumni. I then used a rubric to evaluate how many alums had mentioned something for a given question so I could better interpret the trends. I have reported the rubric in Appendix 4, with the rows swapped around so a given row from each table does not describe a single interview.
Chapter III: Experimental Results and Analysis

Sample Demographics

<table>
<thead>
<tr>
<th>Company Types (Based on Respondent Descriptions)</th>
<th>Number of Respondents</th>
</tr>
</thead>
<tbody>
<tr>
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</tr>
<tr>
<td>Small Engineering Firm</td>
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</tr>
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</thead>
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<tr>
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<th>Number of Respondents</th>
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<tbody>
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<tr>
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<tr>
<td>4-5</td>
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<table>
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</tr>
<tr>
<td>Female</td>
<td>5</td>
</tr>
</tbody>
</table>

Figure 1: Table with information about the studied alumni.

Findings on the Process of Conducting Semi-Structured Interviews

A common occurrence during interviews was for respondents to answer questions that were different from the ones I had asked. In particular, answers to an early question about the responsibilities of our alumni often would receive a sound of confusion after which the respondent might give me a quick response laying out a description of their job before answering. My hope when I wrote that question was that people might be able to answer both at once and save time in the course of interviewing because there is probably a lot of overlap between what someone does and what they are responsible for. What tended to happen though, was that people would answer both separately, which, considering the sort of momentary confusion, might have meant it would be preferable to split questions, even if they might be redundant.

About halfway through the study, it started to become clear that the information I was collecting about what skills people use was not particularly enhanced by the fact that we were collecting data in interviews. Usually, using a qualitative method such as a semi-structured interview might yield results that can be used to paint a fuller picture about a certain topic. But in this case, it seemed like from my responses, people would just list off skills in a way that would not really surpass the richness that they could report skills on a multiple choice survey. Knowing this, I decided to revise my question list, removing the questions that asked what skills alumni used and replacing it with a question that asked how they used technical skills (see Appendices 2 and 3). Questions that allowed a respondent to express why or how they did something seemed to be much more useful in eliciting meaningful responses, possibly because it did not make the informants feel that they needed to constraining their answer (as much) to a preconceived notion of a desired answer.
Additionally, I found that the responses were too varied and disparate from those that I had anticipated in the initial iteration of my question tree (Appendix 2) for the expected responses to be useful at all. I basically had to try and ignore all the branches I had written for myself to follow the flow of the interview. In fact, as I will discuss further in the next section, there was a tendency for me to suggest responses to my informants from these expected answers, totally biasing their answers. In the future, I would suggest only using a question tree for an interview like this after extensive preliminary testing to assure that the tree is useful in the process of interviews.

One last refinement I might go on to make if there were another iteration in this research would be to create a question list where the questions are phrased more informally. The way the questions are phrased in the latest revision (Appendix 3) is slightly dry and unnatural in a way that leads me to informally paraphrase the questions when I ask them so that they might flow better in midst of conversations. When I did this in interviews, however, I think my phrasing may have changed too much between interviews in a way that could alter the responses we received to certain questions. I think a more relaxed style for the written questions could work to relieve the urge to paraphrase the questions.

For one interview, I sent the questions to a respondent ahead of time so that they could review them prior to our conversation. I think this lead to better developed responses, but I think I was slightly overwhelmed by how much more information this particular interview yielded. I’m not sure it was a result of this slight change to the experimental protocol, but the responses from this interview also tended toward an expression of broad trends rather than the more anecdotes of personal experience.

**Potential Sources of Bias**

One potential source of bias I noticed early on in the interview process was the high percentage of informants who participated in recruiting efforts for their particular company. I noticed that during interviews of alumni who were also recruiters at MIT, they might respond in more general terms to different questions, trying to describe a generalized experience of someone in their company working in a similar capacity rather than of themselves. It seems like these informants might have interpreted the questions as a representative of a company might have at, for example, a student recruitment Q&A session or networking event. I also noted that there was a tendency to downplay any aspects of their work that might be viewed as negative among these respondents. Perhaps in future work, efforts might be made to reduce the effect of this bias.

I believe that there are also biases that I hold which might have pushed the interview responses in one direction or another. Often, during the interview, a respondent might seem to be confused about what I was trying to ascertain with a given question, and I might try to give a few common responses as a means of illustrating the meaning of the question. This often lead to a situation where the informant would be primed in a way that the suggestions I put forth became their responses and may not have been the most authentic descriptions of their experience. As I conducted more interviews, I learned to let the informants struggle to find their own meaning in the questions and thus obtain better responses.
As noted earlier, there is likely a set of sample biases that should be taken into account when looking over the results. The fact that all respondents were in at least occasional contact with either the MIT undergraduate or graduate office seems to have resulted in a younger than representative sample of Mechanical Engineering alumni. Another potential sample bias I suspect may exist is that the respondents who volunteered to interview may have more positive views on MIT Mechanical Engineering than the general Mechanical Engineering alumni population since they both chose to remain in contact with the department and volunteered to help me.

**Career Motivations**

Many of the factors that guide alums in choosing their career are much more extemporaneous than I would have predicted at the beginning of the study. That said, the factor that alumni mentioned most often was their personal interest in the field or content of the work when deciding between jobs. One secondary factor, mentioned by more than a third of respondents, was working conditions, taken to mean the intangible aspects of a workplace such as the personalities and aspirations of co-workers or more broadly company culture. Equally important were the tangible benefits, such as living in a given location, having a certain income, or being provided a set of benefits (like health insurance) associated with a given position.

A recent graduate working at a smaller engineering firm described her motivations in this way:

“Did an internship at [small tech company] my junior year, which convinced me that I’d never be happy in industry. Tried to start my own company and I found that the costs were very high so I decided to get a job. The team is very pro-open source. The work they are doing has lots of cultural goals, improving science. It’s a job that pays but also [plays toward] my passions, morals, ethics, personal feelings about the world. [These all played into an eventual decision to stay in the position for the long-term.]”

This response was representative of many of the stories of the informants I interviewed in that it featured someone who had tried a number of different options and then settled on work when requirements for working conditions, interest in work or the field, and tangible benefits converged. It’s worth noting that per the sample demographics table, many of our respondents had not spent that much time in the working world yet, and so probably spent a decent amount of their time thus far exploring different options.

**Interactions**

The interview analysis rubric indicated that engineers most reliably interact with managers and other businesspeople, with all but one interviewee expressing that they spent a significant amount of time working with these groups of people. Respondents also seemed to interact with technical people in relatively similar fields as themselves (e.g. Mechanical Engineer vs. Materials Scientist) or people in more disparate fields (Mechanical Engineer vs. Electrical Engineer) at equally high rates, about a third of respondents indicated each.

These broad trends do not adequately describe the interactions of graduates, simply because the nature of who people work with shifts so much over time. As many respondents noted in
struggling to answer this question as truthfully as possible, every day, week, or month of interactions might be different depending on what needs to get done. More than this though, the interviews revealed that there was a definitely shift in the roles people take on as they spend more time at a company.

It seems like for the first year or so, when a new employee is being trained and brought into a new company, much of their work might be more individualized and structured, lending itself to be more helpful in supporting learning in the individual employee. Their interaction or reporting chain might be relatively simple, with most work related interaction occurring between the employee and a given manager or lead engineer. This seemed to reflect the experiences of almost all respondents who had been at their current job less than 12 months or so.

This model for interaction did not continue to hold for employees who had been at same company for a significant amount of time (more than 1 year). We found that these employees had much more diverse interactions and tended to work on teams with diverse skillsets and technical backgrounds. The basic structure that seemed common between industries was that of a small team of engineers who worked together with a lead engineer, project manager, or product manager. This team might look to a number of expert engineers and scientists (accessible to all these smaller teams) within the company for technical recommendations and advice. I’ve created a schematic showing these connections as well as what roles our graduates seem to take up based on my interviews, with graduate roles indicated by rounded boxes. As might be expected, people seem to work usually within the context of an engineering team early on in their career and move on to became either lead engineers, managers, or specialized expert engineers.
Additionally, this sort of interaction structure does not adequately describe the interactions of those engineers whose companies do not develop but instead acquire technology. Such engineers expressed that most of their time was spent working with outside vendors who would bring proposals for new technology. They also noted that the teams they worked on were more specialized and homogeneous with respect to skillsets, featuring more people with similar technical backgrounds.

One final phenomenon was the emergence of interaction structures that featured aspects of international collaboration. As companies continue to outsource manufacturing to remote locations in order to reduce operating costs, there are implications for the next generation of engineers. These engineers seem to work in a team similar to that represented in figure 2 at their workplace but must also constantly communicate with another team whose roles and titles mirror theirs and is located wherever in the world manufacturing takes place.

**Decisions**

We asked a question during interviews which lead respondents to reflect on the kinds of decisions they make in the course of their work. The results from these interviews revealed that what was more interesting might have been the process by which they made the decisions rather than the actual content or result of those decisions. I chose to analyze the inputs that our graduates used to make their work decisions, choosing one of sociotechnical, technical, or economic inputs for each respondent based on how they described their decision making process. A sociotechnical approach would use both the perspectives of other people (even if they were technical perspectives) within and outside the company in concert with technical facts in driving
decisions. On the other hand, a technical approach would be overwhelmingly driven by the scientific or engineering facts of a given problem or situation in order to form a decision. Lastly, I recorded inputs as economic if little technical information was relevant and only financial concerns were important in making decisions. The greatest number of respondents seemed to use a purely technical decision making style while sociotechnical decision makers included just one less respondent. There was only one purely economic decision maker in the graduates I interviewed.

One sociotechnical thinker at a large engineering firm responded in this way:

“When you have an issue, often times you might come up with a couple solutions; the engineer will decide which one is the lowest risk and the best solution. There’s a lot of different factors that drive the decision you arrive at... Anything that you do, you have to consider, ‘is industrial design happy? Is the marketing team happy, with how it affects consumers? Is the quality team happy, because you’re creating a reliable part?’ I have to juggle all those teams’ preferences and try to come to a solution that satisfies everyone, and if it doesn’t, you just have to explain clearly your reasoning and provide data so that it makes sense.”

This graduate’s testimony is very representative of the mindset of a typical sociotechnical decision maker. They perceive myriad concerns that all must be addressed in the solution to a problem, that the quality or feasibility of a given solution cannot be understood using a single metric, and that the various stakeholders should all be acknowledged, even if the final decision will not be in their best interests.

A technical decision maker described their decisions in this way:

“All your [engineering] background comes to bear on a problem and you have to make a decision, an engineering decision: ‘Whether the product is ready to go into production versus... do we need to do some extensive analysis to see if it will hold up?’ You’re asked to make those decisions of, ‘do we have enough knowledge to go forward or is it going to take doing more analysis or testing of the product before it gets fielded?’”

There is a greater emphasis here on the analytical and technical aspects of engineering, such as the correlations and equations one might have used back in engineering school to try and understand a situation to the greatest degree possible. To be sure, other concerns such as excess use of resources (in this case those needed for any additional testing) might inform a decision as well, but they are consistently secondary to the justification for the decision which is rooted in technical knowledge. I do not suggest here that one person would consistently think exclusively in one of these two ways, but instead that people might have a tendency toward one of them in their work.

One additional trend I noticed was that the more specialized employees like expert engineers or expert scientists were much more likely to make technically-informed decisions. These employees were often more involved with the small-scale development of new technology than guiding broader innovation. I might conjecture that those who hope to lead a diverse group of engineers in efforts to develop technology often need to think and decide things socio-
technically. This may be because their role both does not provide them time to gain the superior technical expertise needed to make wholly technically decisions and the role is often explicitly designed to force leaders to make broad, sociotechnical decisions (e.g. making a decision on whether to invest more time and resources in developing product or technology where a number of concerns technical and non-technical must be considered).

Work, Skills and Knowledge

The general flow of the interviews themselves lead to a need for a section to have an integrated discussion of work, skills and knowledge. Respondents seemed to have trouble expressing the skills and knowledge they needed for their work without talking about the work and vice-versa. Thus, I decided to try and organize this section as one where I will illustrate what the alumni do by describing the skills they use to do it.

Communication

All but one of the alumni I interviewed explicitly mentioned communication as either a vital skill or communicating as a significant amount of their work. Different people understood communication in different ways. Activities people considered communication were as varied as creating and editing CAD and design specifications, giving power point presentations, and communicating goals to a team of engineers or consultants.

One respondent described the technique he used to convey the connection between the technology a design team might be working on and the large-scale impact potential investors are more interested in:

“I have to take something that’s very complex and difficult to understand for someone who’s not skilled in the art and I have to translate that without losing its meaning. It’s called chunking up...We’re creating technology to replace [mundane technical component]. What people want to hear about, what people really care about is all the way abstracted to the top, we are opening a new market where [a new innovative product] will be prolific...I have to connect those two dots; if you leave either of those on their own, they don’t make any sense. One side is fantasy, the other is dry Mechanical Engineering...A lot of the time when I’m sitting on design reviews or when I’m engaging with any stakeholders my job is, from the beginning, to make sure that is clearly understood what we are talking about and what the purpose of that is.”

This respondent would go on to talk about how his idea of communication at its best was knowing what to say to who at the right time. This perspective was common among all the engineers I talked to who had some amount of influence on business decisions within their respective company, a slightly more than half of the people I talked to. This was especially true of those working in the consulting industry where maintaining client firm relationships is a key responsibility given the nature of the job is one where they have to “fix” issues in struggling firms who may not perceive problems to exist.

Yet, I would be remiss not to return to the sentiment expressed by the engineer whose quote I earlier used to represent sociotechnical thinking: “Anything that you do, you have to consider, ‘is
industrial design happy? Is the marketing team happy, with how it affects consumers? Is the quality team happy, because you’re creating a reliable part?” I have to juggle all those teams’ preferences and try to come to a solution that satisfies everyone, and if it doesn’t, you just have to explain clearly your reasoning and provide data so that it makes sense.”

This reflects a common sentiment among engineers who have spent more than a couple of years working that the mechanical engineer, as compared to other specific engineers is often tasked with integration in a number of ways. It seems here that communication serves the role of the vehicle through which the inputs for decisions are collected, and the resulting decisions are disseminated with their commensurate justifications. This need not be confined to simply making a design or business decision, but instead could be a reasonable way of understanding how mechanical engineers can, as more than a third of respondents noted is part of their daily work, integrate a variety of technical components in a way that addresses whatever concerns may arise. This often practically manifests itself in the commonplace distribution, discussion and collaborative refinement of design documentation between various engineers. Thus, communication is for our graduates both an indispensable skill and a common activity.

**Leadership and Management**

Although the alumni mostly tended to be younger, nearly half of them were in management or leadership positions in their respective companies. This meant that for many, there was a need to pick up skills like practical business sense and other human resources related skills on the job. To be sure, given the nature of the employees and the work, having a technical background was supremely important in establishing trust with other engineers.

One alum working as a technical lead described his main responsibilities in the following way: “The technical lead is responsible for working with more specialized engineers, such as mechanical, optical, electrical, engineers. They are responsible for providing all of them feedback, making sure it all fits together. Making sure everyone’s working on the same thing and that the goals are understood, and they are all lined up. There’s a lot of technical discussions, a lot of reviewing documentation, presentations, double-checking mechanical CAD and electrical schematics.”

Another graduate, leading a smaller engineering firm, noted the importance of technical knowledge in having the influence needed to be effective as a leader: “If I didn’t have a Mechanical Engineering background, I wouldn’t have any trust from the product development side of the company. I wouldn’t have the ability to communicate [technically] to other people, I wouldn’t have the ability to help guide the strategy.”

These comments reinforce my earlier point about the importance of integrative skills to today’s mechanical engineers, and supports the notion that this is especially important for leaders in innovation. The first explicitly notes that his job is to assure that a number of different engineers with varied backgrounds are all working toward the same goals and that their work will all be compatible. The second notes that he needed technical skills to be able to guide the product development process, implying that engineering management might be best thought of as a
process of combining business acumen with technical knowledge and in parallel aligning financial goals (and needs) with technical ones.

Analytics and Engineering

Whatever work is technically and analytically intensive is typically understood as engineering. The analytic work is often understood as the backbone and essence of engineering work. Considering that almost all my respondents indicated various types of analytical work as part of their key responsibilities, perhaps analysis deserves that characterization. My interviews revealed that not all the analytical work engineers do is the same. I created two models of analytical work. Detailed analytical work was characterized by consistently working on a small number of projects or components, limited incidence of engineering integration, and limited collaboration. Broad analytical work was characterized by a working on a large number of projects, either simultaneously or in series, as well as by high incidence of engineering integration and group collaboration.

One engineer whose work I categorized as broadly analytical worked at a large corporation in a position where he worked with smaller vendors to develop new technology. Since it did not make sense for the large company he worked for to develop the technology themselves, his job was to seek out and evaluate proposals for technology from various vendors, making recommendations to invest in technologies that were viable. This work lead the graduate to engage with a large number of projects, but only with a limited amount of time and with a limited amount of depth. This work also had highly integrative elements, since he needed to choose technologies which were both technically viable and developed at a price and for a purpose that will serve the financial interests of the company.

A younger engineer who had just started working at a smaller engineering firm did work that was more detail-oriented analytical. She would create software and write up documentation, based on tasks that were assigned to her by one of her co-workers who operated in a product manager type position. She could do this work at any time and often from remote locations, highlighting the largely individualized nature of her responsibilities and illustrating the common traits of detail-based analytics, particularly limited integration and integration.

I found that slightly more respondents described their work in terms of descriptors more associated with broad analytics and that these informants were the ones who had been in the workplace for two or more years, while those who did work I associated with detailed analytics had almost always started work at their current job less than a year before the time of the study. The alumni who had been working for a longer time also described doing more detailed analytic work during their first year or so at their company while they were being trained and being given more broadly analytic work in later years. It seems that perhaps while engineers are being trained and brought into the culture of their workplace, management tends to give them more individual projects similar to the way that they might receive in school in order to teach them some skills and provide a good measure of the degree to which they have acquired the skills.
Individual Work

Based on the single quantitative question, it seems that for our alumni, working alone is more an anomaly than a regular occurrence. All but one respondent indicated that they spend at least as much time working with other people as they do alone and most respondents said they usually spent significantly more time working in groups or pairs than they did alone. Even more than just that, some of the respondents went on to say that of the time they spent working alone, a good amount of the time was spent reading and drafting e-mails to other employees and business contacts. In this way, it seems that even when alumni are working alone, they are still constantly connected to others.

Surprises

I sought to explore the experience of shifting between engineering in the academic context and the industry context. I wanted to expand on some of the research findings from my literature review, where researchers found that engineers worked more in groups in industry, worked on less-structured problems, and generally do less “pure” [technical] engineering work. I asked some of the alumni who I spoke with what surprised them or was unexpected about their work or their work lives. While I think the numbers were small enough that the results cannot be generalized much, the responses might be a starting point for understanding the gap between expectations of engineering and early career experiences. Since the vast majority of study participants weren’t more than 5 years out of school, my data probably characterizes a good amount of immediate reactions to the academia-industry transition. At the same time, though, people tended not to have strong reaction to the question and needed more coaching to get a response for this question, which might mean that there really is not that much that is surprising about work once you have gone through the whole recruitment process and compared a bunch of different potential job placements.

An Informal Workplace

A couple of the alumni with whom I spoke mentioned that there was a generally low-key feel to their workplace that they were surprised by when they first started working. One mentioned that co-workers and their boss did not mind if they worked strange hours or were away from the office regularly as long as their work got done. Another noted that they could wear jeans every day and that the office was less organized than expected. Even though this result was not really expected given the literature review, it does suggest that perhaps engineering students may have a skewed or fuzzy view of the engineering practice possibly due to the lack of media representation of the profession relative to that of higher status doctors, lawyers, scientists, as suggested by Johri, or for some other reason.

More Collaborative Work

There were just as many comments about the largely collaborative nature of engineering practice as there were on formality. Alumni noted that relative to their expectations, they spent a lot of time engaging with technical materials either in groups or with business associates outside their particular firm. It is possible this was due to the overwhelmingly individual nature of much academic engineering coursework and its corresponding evaluation process.
Most Valuable Part of the MIT Experience

I asked all the alumni I interviewed about what they valued most about their MIT experience or being part of MIT as an institution or social group. We sought here to understand what people perceive as being worthwhile about an MIT education, but also how it may have helped them so far in life.

Technical Skills

Just over half of the alumni in the sample group mentioned that the technical and quantitative knowledge they gained while at MIT was one of the most valuable things they graduated with. Since having technical knowledge is a virtual prerequisite for any job working with technology, it is not really a surprise that the graduates working in that field would appreciate having learned these things. That they mentioned it explicitly in relation to MIT (rather than, say, getting an engineering degree) specifically might mean that there is a prevailing perception among alumni that they have been exposed to more or better information in the course of their education than other engineers.

The Network

About a third of respondents mentioned that access to the alumni network was very helpful in helping to shape career paths.

One respondent noted that her friends from other elite institutions struggled to find work, since the alumni network is less tight knit:
“I’ve heard from folks that have graduated from one of [MIT’s peer institutions] that people are less open to the networking or relative strangers calling them out of the blue...I find it easy to find work; I’m not sure if it’s because of the name or the network. ”

Another respondent noted that the network was so important, it was well worth it to miss some lectures if that meant he would be closer to those around him:

Interviewer: “So the network was important to you?”
Alum: “Big time. The network was extremely important. Extremely important. Every single thing I’ve done in my career has been a chance occurrence...If I had had all of the knowledge, had I gone to class every day, and just class, I would have got about 10% of the value that I got out of MIT...The [club sports team] was one of the most important things I did at MIT, in hindsight, and the [Gordon Engineering Leadership] program, and my Fraternity. No surprise there; people matter.”

The alumni who mentioned that the network at MIT was important to them were more likely to work in smaller companies. I would conjecture that in these smaller companies, the desire for new employees to fit well in the company culture would lead to more hiring of people that current employees know who might share similar interests and personalities. This might be in contrast to the alumni working at larger companies who might not know anyone at the company and therefore attribute their achievement as due to their technical proficiency and understand this as more important.
Reputation

“It’s the respect you get as an MIT alum, unless you don’t prove to be worth it. But the assumption is that you know what you’re talking about and they’ll believe you.”

Although only one of the alumni explicitly mentioned this, it seemed to be taken for granted that because of MIT’s high-profile that graduates have something of an aura of infallibility about them until they make mistakes. This is a factor that can work for or against graduates: it can benefit graduates since they might be given more responsibility earlier, but they also run the risk of hurting their reputation since their early mistakes can have bigger repercussions given that people are so willing to believe whatever you have to say. Managing expectations related to this perception of excellence was key for at least one graduate.

Mental Fortitude and Problem Solving

About a third of informants mentioned a potent combination of mental fortitude and problem solving skills as being the most valuable outcome of an MIT education. For these alumni, it was not just that MIT students could function under pressure or could solve problems but instead that they had extensively honed the ability to do both at the same time.

One student described this phenomenon among MIT graduates more generally:
“The problem solving skills that MIT teaches you; that’s something that always makes the students stand out later, when they go into a working environment. They are able to work under pressure, they are able to make good educated decisions. A lot of MIT students are more ready to go directly into a high-pressure, highly technical environment.”

Another described an anecdote that neatly illustrates the situational nature of this particular skill or ability:
“It would be silly things like, ‘I need to print copies of a presentation for an important client meeting and the printer doesn’t work’...what do you do? I don’t think I got all this training and work at this job so I could worry about how to print pieces of paper, but when you’re there in that situation, this is a real problem...being able to handle whatever random life issues get thrown at you is key.”

Graduates mentioned that this quality might have been part of the students’ personalities even before they came to MIT, that this may partially be something that the MIT admissions office actively selects for. But they also claimed that there were particular experiences, chugging through problem sets or dealing with parts that do not fit together in a design project at the last minute, for example, that would challenge people and train these qualities of resilience, resourcefulness and ingenuity. One alumnus mentioned that among many graduates there is a common opinion that life after MIT is significantly easier and in this way the stresses of work-life do not really compare to those of the institute.
Improving the Alumni Experience

So that this study would have the required outcome of benefitting its participants and also so that we might be able to strengthen the institutes relationship with our alumni, we decided to ask what graduates think MIT could do better or do more of in order to improve their experiences post-graduation.

Pushing the Boundaries of the Network

More than three-fourths of the alumni I talked to mentioned that they would like to expand their personal network of alumni as well as other potential business contacts. This certainly supports the idea that many alumni have of personal connections being very important to their success.

Some, like this graduate were looking for mentorship from people in their field:

“Something I’d like, one thing that has become really valuable is when I meet people who are five years ahead of me, ten years ahead of me, twenty years ahead of me, that I would want to be like, that’s always nice. And having a great mentor like that if always valuable. And finding that is always difficult.”

Others felt that the MIT network they had developed during school was too uniformly technical, and wanted to branch out and make friends with different careers to be exposed to more perspectives:

“I struggle sometimes with having friends outside engineering. If I have trouble and my Bluetooth firmware is not working, [I need to know] “how do I fix XYZ technical problem?” I have a whole host of friends I can ask who will be awake and willing to help, people I’ve built friendships with over the years. I struggle a lot more if I have questions about anything not engineering-related: I’m interested in social anthropology, cognitive science FMRI, marketing, accounting etc. Connecting with those people is hard because I haven’t built up friendships over five years. Maybe help me make friends outside of engineering.”

Other responses along these lines mentioned the hope that there would be more opportunities for alumni involvement with the operation of MIT and staying connected. Some mentioned that they would like some means of finding potential research partners or co-founders for companies within the alumni network.

Resource Access and Continuing Education

About a third of alumni questioned mentioned better access to academic resources and continuing education as a place MIT could improve on.

Alumni seemed not to have very strong views on continuing education, generally not having sought it out at any point. One mentioned that they had entertained the idea of doing one of the programs but the inconvenience of travelling to Cambridge and other logistical hurdles were hard to overcome. Another graduate mentioned their support for online programs like edX that made it easy for her to review material from classes that would help her with work.
As far as resource access, a couple alumni mentioned having some mechanism for access to library or research journals, even if there was some associated fee, would be very helpful in terms of facilitating continued learning. Another graduate noted that the research digests that are sent out to alumni are not filtered with enough granularity to have research they would be interested in. A potential fix of offering more choices in terms of which types of articles was suggested.

Chapter IV: Future Work

Further research on the work of Mechanical Engineers could continue in 3 main thrusts. One might work to connect the largely qualitative results that I detail in this thesis with the quantitative work of Kristen Wolf and others who have amassed quantitative data on these topics. Another could work to establish greater granularity in understanding how responses differ by considering in greater detail the types of jobs in engineering that our alumni hold, as well as what kinds of companies for which they work. The last thread of research that could be conducted might work to do more in-depth interviews focusing on one of the topics I have discussed within this thesis, thereby increasing the depth of knowledge we have about one particular aspect of engineering.
Appendix 1: Correspondence with Alumni

Initial E-mail Sample Message:

Hello,

My name is Brandon Wright and I am working on a senior thesis on engineering education. I’m hoping to conduct phone interviews with alumni to gather information about the careers of Mechanical Engineering graduates. This information will help the department align its educational offerings with the constantly changing needs of the field and help provide undergraduates with more information about where a major in Mechanical Engineering might take them.

If you are interested in being interviewed for this project, please e-mail me with what time of day is best to call at bnwright@mit.edu

Thank you,
Brandon Wright

Follow up E-mail Sample Message:

Hi,

Thank you for volunteering to participate in my study of Mechanical Engineering graduates. I’d like you to read the following statement of information about the study and then decide if you’d like to participate.

You have been asked to participate in a research study conducted by Brandon Wright from the Mechanical Engineering Department at the Massachusetts Institute of Technology (M.I.T.). The purpose of the study is to collect information about the work life of Mechanical Engineering graduates: The results of this study will be included in Brandon Wright’s Bachelor thesis. You were selected as a possible participant in this study because you were identified as an MIT Mechanical Engineering alumna/alumni. You should read the information below, and ask questions about anything you do not understand, before deciding whether or not to participate.

• This interview is voluntary. You have the right not to answer any question, and to stop the interview at any time or for any reason. I expect that the interview will take about 30 minutes.

• You will not be compensated for this interview.

• Unless you give us permission to use your name or title in any publications that may result from this research, any information or quotes you provide us will be anonymously credited.

I would like to record this interview so that we can use it for reference while proceeding with this study. I will not record this interview without your permission. If you do grant permission for this conversation to be recorded, you have the right to revoke recording permission and/or end
the interview at any time. If you elect not to be recorded, I would still like to talk with you.

This project will be completed by 6/15/2015.

Responding to this e-mail that you would like to participate indicates that you understand the procedures described above, questions have been answered to your satisfaction, and you agree to participate in this study.

Having read the terms, would any of the times [specific times for informant] work for you on [specific date for informant]? If so, please respond with your phone number and have your phone available at that time.
Appendix 2: Preliminary Question Tree for Semi-structured Interviews

Part A: Interview Protocol and Question Tree

At the beginning of all interviews, we will make an introductory statement to remind interviewees of the nature of the study:

Hi [Name of Informant].

Thank you for volunteering to help me with my senior thesis by taking the time for this interview. This project is designed to help MIT undergraduates make their major decisions and later career decisions. We hope that collecting this information on the careers of our graduates will give current and future undergraduates a better sense of what awaits them post-graduation.

Next we will ask for consent in recording the interview:

It will be helpful in making the most of the interview if I can record our conversation to take notes. Let me know if you are comfortable with this.

The following is a question tree delineating questions we plan to ask informants. Out of the below questions, italicized text indicates anticipated responses of informants.

What was your year of graduation from MIT?

How many companies have you worked for since graduating?
  -> What was your key responsibility at each job?

Why did you choose to take your current job? Paying back student loans, In line with ideals, stability…

What are you responsible for at your current job?
  -> Modelling/CAD/CAM/Finite Elements Work
    -> About how many hours do you spend per week on that?
      -> Do you create/edit/verify the quality of CAD Work?
  -> Business Decisions
    -> What do these decisions entail?
    -> How do you make these decisions?
    -> About how many hours do you spend per week on that?
  -> Management
    -> How many people do you manage?
    -> Is their work technical?
    -> About how many hours do you spend per week on that?
  -> Research
    -> What topics do you research?
    -> About how many hours do you spend per week on that?
Is there anything else you are responsible for?

What decisions do you make?

- Design Approval
  - How often do you make such decisions?

- Financial Approval
  - How are you instructed to make these decisions?
  - How often do you make such decisions?

- Personnel Decisions
  - Are you involved in hiring or promotion decisions?
  - How often do you make such decisions?

- Job Responsibility (for self)
  - How much agency do you have in choosing your day-to-day activities?
  - How often do you make such decisions?

Are there any other decisions you make?

Who do you interact with and why?

- Vendors
  - Which vendors do you interact with?

- Managers
  - What is your relationship with management like?

- Other engineers
  - How is this important to your job and success for projects?

- Marketing people
  - How is this important to your job and success for projects?

- Is there anyone else you interact with?

What fraction of your time do you spend alone?

What skills do you rely on in the course of your job?

- Spoken interpersonal communication (Presentations, informal conversations etc.)
  - How do you think you developed these skills?
  - Are these skills sufficient?
  - How often is it important to use these skills?

- Management
  - How do you think you developed these skills?
  - Are these skills sufficient?
  - How often is it important to use these skills?

- Technical (Scientific, Mathematical, Engineering)
  - How do you think you developed these skills?
  - Are these skills sufficient?
  - How often is it important to use these skills?

- Written communication (Specifications, Design justifications etc.)
  - How do you think you developed these skills?
  - Are these skills sufficient?
  - How often is it important to use these skills?
Are there any other skills you use?

What about MIT was most valuable to you?

-> Network/Connections
   -> How did you benefit from being part of the MIT network?

-> Instruction/Classes
   -> Which classes were most helpful?
   -> How did classes inform your work, career path?

-> Experiences (Research, MIT-related Internship or Externship)
   -> What experience in particular was valuable?

Is there anyway MIT could have assisted you in learning as an alum?
Appendix 3: Revised Semi-Structured Interview Questions

Hi [Name of Informant].

Thank you for volunteering to help me with my senior thesis by taking the time for this interview. This project is designed to help MIT undergraduates make their major decisions and later career decisions. We hope that collecting this information on the careers of our graduates will give current and future undergraduates a better sense of what awaits them post-graduation.

It will be helpful in making the most of the interview if I can record our conversation to take notes. Let me know if you are comfortable with this.

What was your year of graduation from MIT?

How many companies have you worked for since graduating?

What are you responsible for at your current job?

What decisions do you make?

Why did you choose to take your current job?

Who do you interact with and why?

How do you use your technical skills?

What fraction of your time do you spend working alone?

Did anything surprise you about the work you do now? Are there any aspects that were unexpected?

What about your MIT experience was most valuable to you?

Is there anyway MIT could have assisted you as an alum?
## Appendix 4: Full Response Rubric

Notes: “X” marks in a row denote that in a given interview a respondent mentioned that topic. For percentage of time working and decisions tables, I chose one that best represented the informant’s point of view from each interview, since the data might not be meaningful otherwise.

### Motivation

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<th>Location, Pay, Benefits</th>
<th>Broad Interest in Field or Work</th>
<th>Working Conditions</th>
<th>Company Reputation</th>
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### Responsibilities

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### Decisions

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<th>Economic Inputs</th>
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### Interactions

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<th>Engineers (Different Discipline)</th>
<th>Business people (Marketing, Executives etc.)</th>
<th>Reporting Manager</th>
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### Unexpected Aspects

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### Valuable about MIT

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### Improving Alumni Experience

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### Percentage of Time Working Alone

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### References

2. Ibid
5. Johri, 127
6. Ibid, 119