

## **Staying In or Getting Out: The Relationship Between Undergraduate Work Exposure and Job Satisfaction After Graduation**

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## **Introduction**

Past research has focused on the ways engineering students talk about the work they hope to do as professional engineers after graduation, which the authors refer to as their 'images of work.'<sup>1</sup> These authors found that students' initial images of work were marked by hopefulness and aspiration; students wanted to design new technologies and engage in innovation. As the students moved through their undergraduate education, however, their images of work became more mundane. Often this mundaneness emerged as a result of having direct work experience in professional engineering settings. In other words, having work experience made students' images of work more specific, while at the same time shifting them from the hopeful to the mundane. In addition to direct work experience, the authors note that students can gain familiarity with professional engineering work through their coursework or from family members who are engineers. With a few exceptions, this hopeful-to-mundane pattern characterized the development of students' images of work during the course of their education.

In this prior work authors described the images of work of students while they were still in college, leaving open the question of how those images evolve when students pass the threshold from school to experiences in professional engineering workplaces. In this paper, we report on work in progress about the college occupational pathways of young engineers, that is, the progression of internships and cooperative work placements engineering students took on during their college years and after graduation. Our participants are 16 young engineers from three different universities in the Midwest. 15 of these engineers have graduated from college and were interviewed within 18 months of their college graduation. The remaining young engineer is a current student. Based on these interviews, Vinson reconstructed the series of internships and co-op placements each engineer had on the way to his/her first full-time job after college. In the analysis we focus on how these engineers reflect on their fit in each job and how they account for their decision to pursue a second term of internship or co-op at an organization or, alternately, how they decided not to return. We highlight the cases of three engineers who represent two different experiences of young engineers: trying lots of internships as a student and finding a good fit before graduation versus trying one internship as a student and perceiving oneself as a poor fit for one's job after graduation. We therefore use this analysis to examine the relationship between undergraduate work experience, perceived fit in a work environment, and attrition/persistence in engineering.

Analyses in this area are important to conduct because there is a stable pattern of women and certain minority groups being underrepresented in engineering. In order to resolve this systemic inequality, it is important to investigate how the processes that contribute to differential and unequal outcomes for otherwise qualified students operate. This paper contributes to other work in this area by examining the role of undergraduate work experience in perceived fit and persistence in/attrition from engineering.

## Background

Prior research in engineering education<sup>2</sup> as well as more general socio-cultural perspectives on learning argue that identity formation is an important dimension of learning.<sup>3</sup> People develop ‘cultural models’—or *images* as Jocuns et al. called them—of kinds of people they are or aspire to become, and in turn these cultural models decisively shape people’s pathways toward or away from those possible selves they might become.<sup>1,4</sup> This is as true of engineers as every other possible self for which the world has assembled a gallery of images.

One concept that links the literature on images of work to the literature on STEM education in other fields is the concept of “reconciling work” developed by Jocuns et al. This refers to how students perceive their fit with the dominant image of engineering supported by their engineering school. When students perceive themselves as different from this dominant image, they do reconciling work to make themselves better fit that image. In some cases, engineering students forgo reconciling work and simply switch to a major that they feel fits them better.

These individual and social psychological self-assessments of fit are only part of the story in explaining larger processes like occupational sex segregation, major selection and career persistence. Nevertheless, these windows into the reflections and assessments of young engineers are important because we need to understand how existing and stable inequalities in the field of engineering are reproduced during engineering education and training.

### *Conceptualizing Fit—Past Research on Engineering Education*

A large body of literature focuses on how engineering students and recent graduates persist to degree, take up professional engineering work after graduation, or leave engineering during college or after graduation (for a discussion see Fouad et al. 2016). Much research in this area focuses on the experiences of women and underrepresented minorities in both education and professional work, since these groups are still underrepresented in engineering as a whole. These analyses generally focus on identifying factors that promote persistence or predict attrition. Some analyses include a third path for students—leaving engineering for another STEM field (see Cech et al. 2011 for an example).

However, studies of attrition and persistence typically do not examine the role of work experiences in shaping engineering students’ nascent careers. It is customary for engineering students to take summer internships in industry, and some engineering schools provide pathways for students to enroll in multi-term co-operative education programs with firms. In our paper, we focus on turnover or retention from individual jobs as a way of adding nuance to the literature on persistence and attrition. This is a more local analysis than asking if students leave their major altogether by transferring to another STEM field or out of STEM entirely. Our analysis opens up a new space of play for looking at why engineers change jobs as students and the implications this may have for theories of attrition/persistence.

In a recent paper, Seron and colleagues<sup>7</sup> discuss the differential experiences of men and women engineering students in internships. The authors discuss undergraduate internships as anticipatory socialization experiences that can lead women to think that they are not a fit for

careers in engineering. The authors describe several ways in which women have different experiences from men, particularly in confronting sexist environments or supervisors. In addition, particularly for women, the authors write, a boring or mundane internship can lead students to question whether they belong in engineering at all.

The accounts presented in this paper add to this story by highlighting the experiences of students at and after graduation. One caveat, however—our sample is somewhat different from Seron et al.'s in that they followed engineers through their undergraduate experience whereas we selected engineers at career launch (the end of or shortly after their undergraduate experience). In this sense, we are selecting from a sample of engineers who already made it through their education—we do not, in general, have the opportunity to track students as they leave engineering (with the exception of Karen). Nevertheless, our data show how young engineers productively and reflexively handle job discontents, such that negative employment experiences leading to job turnover did not also lead to attrition from the major, but rather to persistence.

Our data provide us with engineers' undergraduate employment histories, which they explain to us during interviews. We found that engineers tended to have several different internship experiences during college. In our analysis, we show that by trying out multiple jobs, engineers in our sample often did not extrapolate poor career fit from negative work experiences. Rather, they sought out different types of jobs when making future employment decisions, declining to return to jobs that were boring, offered undesirable social environments, or where they felt they were underworked or their skills underutilized. We also show the opposite scenario—engineers who have few or no industry internships during college—and how this can lead to a rough transition into the workforce that results in early career job turnover.

By looking at the level of each individual work experience, we are able to show that what looks like mere job turnover or retention is actually a form of *calibration* based on the engineers' self-assessments of fit. In other words, engineering students make use of internship opportunities to try on several different occupational settings, and by reflecting on and juxtaposing their experiences in these settings they discern what kind of job they want after graduation. Our inductive analysis generated three types of fit: personal fit, career values fit and intellectual fit, which we operationalize below.

Cech et al.<sup>8</sup> have operationalized a set of concepts that are similar to our concept of self-assessment of fit. Their analysis builds the concept of professional role confidence, which is composed of career fit confidence and expertise confidence. These measures are developed from longitudinal survey data measuring students' confidence, based on their engineering coursework, in a number of areas: confidence in developing useful skills, advancing to the next level of engineering, being successful in their career, feeling like engineering is the right profession for them, selecting the right subfield of engineering, finding a satisfying job, and being committed to engineering.

On the surface, these concepts are very similar to our concept of self-assessment of fit. However, we are looking at work experiences, as opposed to coursework experiences. Moreover, our concept was developed inductively from interviews where students spoke not of confidence or

doubt in their abilities or preparation, but rather more pragmatically about whether certain elements of the job were a good fit for them or not.

Thus, in this paper we show that students “try on” different jobs during each internship or co-op placement and compare these various work experiences to help them determine whether that work environment or job might be a good fit for full-time work after graduation. This links their present and aspirational identities, issues of workplace culture, and notions of fit into a reflexive process of self-assessment that we were able to document in interviews. Importantly, with few exceptions, leaving a certain job did not lead to leaving engineering as a whole; rather, students moved from one engineering job to another. This adds complexity to the attrition/persistence narrative, a point we will return to in the discussion.

## **Methods**

In our study we use a case study approach wherein we seek to understand the individual experience and trajectory of each focal engineer and then look for patterns across our sample. This paper highlights the experiences of three focal engineers, who are introduced below.

The data for this work in progress come from 30 interviews with 15 engineers and 1 engineering student (sample data are displayed in table 1). The engineering student is included in the sample for this paper because he was observed in the workplace and participated in multiple interviews describing both his career aspirations and current work experiences. His case serves as important evidence of patterns noted retrospectively by the other engineers, namely that access to everyday engineering work shifts the engineer’s images of work from hopeful to mundane, prompts the engineer to undertake self-assessments of fit, and on the basis of these self-assessments of fit, to “get out” or “stay in.”

The interviewees were recruited through various means, primarily through email solicitation of soon-to-graduate or recently graduated engineering majors at Large Private University (n=6 were recruited under a previous study team member, n=6 were recruited by Vinson). Other interviewees (n=4) entered the sample as we recruited participants for the workplace observation arm of the study. Thirteen of the 16 interviewees attended (or currently attend) Large Private University (LP), two of the interviewees attended Private Religious University (PRU), and one of the interviewees attended Large Midwestern State School (LMSS).

The initial interview with each engineer was semi-structured and focused on employment history, career plans and aspirations, family background, experience of engineering coursework, and other similar themes. For those engineers with more than one interview, the interviews consisted of learning about the engineer’s current work projects, work environment and close colleagues; and assessing the engineer’s attitude about his/her work activity and workplace social environment.

The analysis was conducted in several steps. First, the interviews were professionally transcribed and then thematically coded by Vinson. From these interviews Vinson was able to reconstruct the work history of each engineer, accounting for why engineers left or returned to certain jobs. Vinson identified the engineers’ accounts of their rationales, work experiences, and self-

assessments of fit, and the narratives were summarized in case reports. The accounts of three engineers are presented in this current analysis; these engineers represent a smooth school-to-work transition, a rough school-to-work transition, and an example of how a current student weighs job options in real-time.

This data set has some limitations. Six of the 16 engineers were interviewed by a previous study team member who did not systematically ask engineers about their college employment history (these interviewees are indicated by an asterisk next to the pseudonym in Table 1). For this reason, we have no record of college employment for Samantha or Simon. Vinson has reconstructed the formerly interviewed engineers' occupational pathways to the extent possible, in one case re-interviewing an engineer. The remaining interviews were conducted by Vinson. As our study continues, our sample size will increase; we expect that this will help us compensate for the current limitations.

## Findings

Making assessments of one's fit in a job is a normal aspect of self-reflection. The engineers in the study engaged in reflections about three primary types of fit. *Personal fit* is defined as being in a work environment and having work activity that is a fit with a person's location in social categories (e.g. race, gender, class, sexuality, age) or dispositional characteristics. An example of good personal fit would be finding one's coworkers pleasant to be around. An example of poor personal fit would be experiencing gender-based discrimination. *Intellectual fit* is defined as enjoying the content of one's work, and is generally associated with work that is interesting, challenging and satisfying to accomplish (i.e. 'I enjoy design work and this job offers opportunities to do design work'). A *career values fit* includes factors like work/life balance, salary and benefits, and daily schedule. This is related to past work on the lifestyle that engineering students envision having while in college.<sup>5</sup>

### *Focal Engineers*

This paper focuses on three engineers: Julia, Chris and Karen. Data from other engineers in our sample, such as Peter, are brought in to demonstrate that these examples describe trends in the sample.

Julia, a Chemical Engineering graduate of Large Private University, tried a variety of different jobs as an undergraduate before settling on a four-term commitment to large petroleum company. She took her first post-graduation job at large petroleum company and likes her job. The job is a match for her career values and a good intellectual fit, and is a pretty good personal fit for her (one drawback is the necessity of being within an on-call radius in case her equipment malfunctions). Julia represents an engineer who has tried several different forms of work, and found an organization that is a good fit for her before graduation. Her transition to full-time work after graduation was seamless.

Chris is a current student at Large Private University. He is a student in Industrial Engineering and has worked at two companies during his college career. The first is a marketing analytics company, and the second is a supply chain management company. Because he is only halfway

through college, both of Chris' positions with these companies were entry-level, and the work he was assigned was correspondingly basic. During several interviews he compared his two jobs as he came to the decision to take a second term at one of the jobs, but not the other. He left one job because it was not an intellectual or career values fit, although it offered good personal fit. Chris represents a real-time weighing of two jobs against one another, allowing us to witness how engineering students reflect on several dimensions of fit when choosing between employment options.

Karen holds a degree in Civil Engineering from Private Religious University. During interviews she recounted her decision to leave her job as a civil-structural engineer at an engineering consulting firm where she mainly worked on drafting plans for municipal transportation structures. During interviews with Vinson Karen described that her job was not a good personal, intellectual or career values fit. She consistently articulated a desire to work with people instead of sitting at a computer terminal all day, and in January 2016 left the engineering consulting firm for a new job at large non-engineering consulting firm. Karen's case represents a rough transition from college to full-time work. Although she had an internship in civil engineering as a college student, she only had one term of engineering work experience and could not use disparate work experiences in internships to reflect on her fit in the workplace as Julia and Chris were able to do.

These cases represent a range of experiences engineers can have and adds nuance to research on persistence versus attrition of young engineers by showing how college work experiences allow students to experiment with different forms of work and various work environments. Our data suggest that satisfaction with one's job after graduation is related to having tried out several different jobs as an undergraduate. This seems intuitive, but could work at cross-purposes with cooperative education programs in both universities and industry that encourage engineers to make long-term commitments to one company. As we show below, engineers juxtapose their college work experiences and use the contrasts to illuminate areas of good and poor intellectual, personal and career values fit.

### **Case 1: Julia**

Julia is in her first year as an Operations Engineer at a large petroleum company. In comparison to the other engineers in the sample, Julia had more undergraduate work experiences and she explored a number of different types of jobs. While in college, she researched rubber compounds for tires at an automotive company, worked in environmental health and safety for a large appliance manufacturer, worked in a Bay Area finance start-up, and completed four terms of employment at the large petroleum company she got a job with after graduation. In an interview with Vinson, Julia explained why she worked in so many different settings during college:

I just had no clue what I wanted to do so I didn't want to really commit to a co-op where you go to the same company for your whole college career, and so I did my best to see as many companies as possible. Towards the end that got tricky. And it definitely helped, it ruled out a lot. I found that [large petroleum company] was the closest thing to what I wanted to do, which is why you see I repeated that one and not the others. I think [large petroleum company] is a good fit for me, but

even within that, that's such a large company, I still don't know within that what would be my best fit. [...] It was just a really good idea [to try out lots of different jobs] because when you're in engineering school, you have no idea what the jobs are.

When asked in a pre-graduation interview what made large petroleum company a good fit for her, Julia explained:

The biggest thing was the environment—the people are happy. A lot of the companies that I'd worked for, they're either tight for money or people are being overworked. [Large petroleum company] works their people really hard, but they seem very happy and excited to come to work. They're compensated well, so they weren't feeling like they are being used without being repaid. It's very structured, so maybe I like that. They have a system for everything, which—it drives some people crazy, but I really liked that it wasn't chaotic, like, it's run really well. The management, just the way they structure their business. They're so well organized, it almost operates like a machine. Yes, I really enjoyed learning from these people because when I went there, I felt like they were multiple levels above me in talent and I was really impressed and wanted to learn more how they do it.

Here Julia articulates a good personal fit. She identifies the most important aspect of large petroleum company that made it a good fit for her as the happy workplace environment. Moreover, she identifies the structured nature of the organization as appealing. Julia also articulates a good intellectual fit when she describes how impressed she was by her knowledgeable co-workers and states a desire to “learn more how they do it.” Finally, she articulates good career values fit. She recognizes that working at the company is very demanding, but notes that employees are compensated for their hard work. As noted above, one drawback to her job is her on-call restriction. Below, Julia identifies this as a “trade-off,” something undesirable about her job that is well balanced by other positive aspects of the job. In an interview that took place after she had been in her job for a couple of months:

Vinson: Do you like your job?

Julia: Yeah, I do. You know there's definitely trade-offs like being on call and stuff, but overall it's something new everyday and even people that have been there thirty years are like, you never know what's going to happen when you come in. There's a lot of teamwork, so I like interacting with a lot of people, so I enjoy that and I enjoy how the structure's set up.

A large part of Julia's familiarity with large petroleum company is explained by her several terms of employment there as a college student. However, during a pre-graduation interview she also noted that she had gained a detailed picture of the occupational expectations for professional engineers from her parents, who are both engineers. In conceptual terms, her parents serve as resources she can draw on as she navigates the job search and the workplace.<sup>2</sup> As she explained:



Vinson: What are some specific lessons that you learned from your parents about engineering?

Julia: I learned that you need to be ... You get paid well, but it's a lot of work and you're not always going to work the hours you want to. Especially if a product ... In my case, where I'm going to be like if a unit went down but in their case, it was like if a product was all [inaudible] something was wrong with a product. There are times when you work way more hours. Your life is dependent on whether things are going well at work. I learned that there's times in your life where you're going to really have to put the hours in. You need to get whatever is going wrong with this product fixed immediately. Other times you're going to have your normal leave at work when you expect to. [...] I learned that it won't always be like that. There are times where my parents would come home at 9 at night every day until something [was] fixed.

Unlike many of the other engineers in our sample, Julia's parents are both engineers and were quite open with her about their own work as she was growing up. In addition, her mother was very involved in Julia's search for jobs and internships, helping her refine her application materials, self-presentation and interviewing skills. When Vinson asked Julia to describe what she thought a typical day would be like for her on the job (in a pre-graduation interview), Julia was able to give a very detailed account of the sequence of morning tasks and meetings that take place each day, as well as speak in an informed way about the variety of projects she might be handling as an operations engineer. When asked if she felt prepared to take on this job, Julia replied definitively, "Yeah, I do. Especially with all the help that's available."

In our sample, Julia represents a best-case scenario: someone who is highly satisfied with her job because she had enough pre-graduation work experience to make an informed decision about what sort of work environment would satisfy her personally, intellectually and in terms of her career values. In this regard, her experience was similar to Kyle and Andy's experiences. She has specific and mundane images of work that she gained from college employment experience and from her parents, who are both engineers. Julia also represents a best-case scenario for engineering educators, a point we will return to in the discussion.

It is important to note that interviewing someone retrospectively about their career experiences can color the way they present those experiences. Had we followed Julia in real time through her college employment experiences, we might have a different picture of her employment satisfaction. At the least, we would have a more detailed account of her decisions to pursue or not pursue certain occupational paths. In the interest of showcasing how these decisions can be made in real time, we have included Chris' account in this paper. Chris' case anchors Julia's case by showing that he took similar factors into account when deciding between two jobs. We also include a brief discussion of Peter, who worked at the same supply chain organization as Chris (although their terms there did not overlap).

## Case 2: Chris

Chris is an Industrial Engineering major at Large Private University (LP) who worked as an intern at a supply chain management company. During interviews, Chris reflected on his employment at the supply chain company and compared it to another job he had at a marketing analytics firm. As his participation in the study came to a close, Chris came to a decision to return to the marketing analytics company instead of the supply chain company for a second term of employment.

Chris' experience at the supply chain company is characterized by good personal fit (with the exception of his commute), but poor intellectual and career values fit. When Vinson first interviewed him, he summed up his satisfaction with his job at supply chain company in this way:

Vinson: How do you like it so far?

Chris: It's pretty good. The work is okay. The people are really good, and the commute is not good. That's my overall rating. The work is pretty good, the people are really good, and then the commute is really not good.

Already at the halfway point in his first term at the supply chain company, Chris was feeling lukewarm about the actual content of the work he was assigned. The highlights of his time at the supply chain company were when he could solve problems for warehouse managers by gathering and analyzing novel data. After his term ended, Vinson asked him if he would be returning to the company for another term:

Chris: As of right now I don't think so anymore. I think right now I want to just finish my degree [and not take extra time away from coursework to work].

Vinson: Why did you change your mind?

Chris: Originally I thought that logistics was something I'd be very interested in. I think it's still interesting, but not the stuff that I was doing at [supply chain company] which was being like a warehouse engineer as opposed to a supply chain management kind of career. That's what I thought it would be more like, but it was more focused on just the managing of the warehouses pretty much.

In a follow up to that discussion, Vinson asked Chris what he thought he would be doing in his job at the supply chain management company before he began his job there. He explained:

I thought it would be a lot more optimization. Looking at areas of improvement in the network as a whole. Like looking at the whole supply chain for a client. Let's say it's like [major food manufacturer] and seeing where they have the highest demands and like the warehouse production there and then kind of analyzing the system and then doing that kind of stuff. I didn't have to do any of that [at supply chain company], so... (trailed off)

This excerpt showcases the hopeful images of work Chris held before he started at the supply chain company. As his images of work became more mundane (through exposure to the work environment), Chris was able to see that this work was not for him. This experience stands in direct contrast to Julia, who assessed her experience with the mundane aspects of work at the large petroleum company as being a good fit. This reinforced her desire to take a job with them after graduation. For Chris, merely having pleasant colleagues (personal fit) was not enough to outweigh the fact that he was dissatisfied with the actual work he was assigned to do (intellectual fit).

Chris did, however, take a second term at the marketing analytics firm where he had worked the previous summer. In the following excerpt he compared his current activities with his work activities from the previous summer:

Vinson: How's it going so far?

Chris: It's good. They are happy to have me back and I'm...in the summer I did a very short internship there, maybe like two months or less. At that time they had a specific project they needed me to do which didn't require a lot of technical training and it was just kind of...it was really important for the company—it was a normalized database basically. [...] The one they were using was very outdated. I was updating that database and [...] they were basically redesigning software to take this new data that I was compiling for them and then be able to do the same things and more things with this data than before. Instead of just comparing, they could like actually incorporate some of the data into future models. That was my job over the summer, but now they are having me actually like get trained in the program they use so I'm taking online tutorials during work time to learn how to program in that language. Then they are giving me actual models to run simulations to run for the client.

Chris later clarified that his initial position during the previous summer had essentially been data entry. This made the job even more basic than the data manipulation that had been his primary responsibility at the supply chain company. But whereas Chris knew that if he returned to the supply chain company he would be returning to the same data manipulation work, continuing his job at the marketing analytics company offered him a step up in complexity—learning a new programming language and using “actual models” to run simulations for a client. He describes his job at the marketing analytics firm as a better intellectual fit. It is also a better fit for his career values (the job offers a better commute) and offers good personal fit. As he explained (emphasis added):

Vinson: When you are looking for [future summer] internships, what kinds of things are you really interested in doing?

Chris: I think that now more I'll lean in towards like analytics side, I like that a lot. What I'm doing at [marketing analytics firm] is pretty cool. I like it a lot. If they give me full time employment after I graduate I would highly consider it

because I like the work and I like the people there. Not that I didn't like the people at [supply chain company]. They are really...

Vinson: They are some good people.

Chris: They are nice and they are really fun and it's not the people, *it's just the work. A difference between my expectations and what actually was.* It's just how it is, if I had a career choice I think that I would rather be more focused on analytics and basically using that analytics to make change for a client. Similar to what [marketing analytics firm] is doing. If there were or not even just a client maybe for a company too, I'd be okay with being in the analytics position [at] like Walmart or something. Or something where [inaudible] somewhere, like, where they have a lot of sales data, you have to go through and then analyze the data and come up with a business model. Something like that. That's what I'd be interested in applying for.

Vinson: You are really interested in taking a lot of raw data and about certain processes and figuring out how to optimize them?

Chris: Yeah. Especially according into like dollars and savings and like, yeah, that kind of stuff.

Chris went on to explain that he would like to eventually return to school for an MBA degree. The idea to get an MBA emerged through his undergraduate employment experiences, and serves as an example of how work activities and career aspirations can co-produce each other:

Vinson: Do you have any involvement with [university business school]?

Chris: No, but I do plan to go back to get an MBA at somewhere maybe 5 or 6 years after I finish or like finish my undergraduate degree first get a good amount of experience and then go back for an MBA probably.

Vinson: Cool. Has that always been part of your plans?

Chris: No, going into college I did not think so at all. It was only after taking some industrial engineering courses and then actually being in the workplace too, seeing that I think the MBA is a very important degree for industrial engineering especially, but also for other engineers too. If you want to basically take a lot of... (trailed off) In my opinion [there's] too much technical knowledge [in] school, but in the real world I think things are not as in-depth mathematically as some of the engineering classes, but taking those concepts and making them correlate to real world problem-solving or business management projects that's, I think, very important. I think it's highly valued—even at [supply chain company] I feel like a lot of the projects [department chairman] and [department manager] were having me do I was doing some of the work, but overall I could see that it's for a large

scale, kind of, trying to improve their business. I think the MBA is really helpful for that.

Vinson: What are some of the workplace experiences you have that made you think that getting an MBA would be a good move for you?

Chris: One is just talking to some of the senior management people at [marketing analytics firm] they—a lot of the VPs—all had MBAs. In order to get to their position [having an MBA] is not like necessary [or] a prerequisite, but having that at their position enables them to kind of drive the team or if it's a senior vice president at [marketing analytics firm] is like the whole organization there drive level in a certain direction. If it's for clients or something it just allows them to have that better background to make the right decision. The right business decision for their organization. I think that's really important.

Although Chris eventually decided to pursue employment only at the marketing analytics firm, his experiences at both jobs helped him identify which work environments were a fit for him personally, intellectually and in terms of his career values. Notably, in talking about his career aspirations, he moves from the mundane back to the hopeful.

It is important to note, however, that not all employment decisions are purely individual. Rather, different engineers can have similar experiences in the same company due to the particular dynamics of the company. For example, it was a pattern at supply chain company to give engineering student interns a set of basic weekly and monthly tasks, primarily reporting to individual product suppliers and warehouses on the movement of goods in and out of the warehouse. This was not only given in terms of raw product moved, but also in terms of the financial cost of moving product inefficiently. While the management of this company did not overtly acknowledge that these basic tasks were undesirable, there was an instance of joking among entry- and mid-level engineers about which engineer would have to take over these tasks when the undergraduate engineering interns were away.

Peter, another industrial engineer, also spent several terms working at the supply chain management company. Although he kept returning, he was no more satisfied with the work than Chris, but articulated a desire to uphold his multi-term commitment to the company, as well as the convenience of having steady work. As he explained:

Vinson: Where did you intern?

Peter: Supply chain company. [...] I worked there for a total of a year. Off and on. Didn't really enjoy it that much. It's interesting to know about how things work. The amount of recognizable companies that would use their warehouses and stuff was...wow. [...] That's a cool feeling to see all that. [But] there were zero meetings whatsoever. At [supply chain company] I was pretty much at my desk 40 hours a week.

Like Chris, Peter also did not enjoy the commute, although he did find the activities of the supply chain company as a whole to be interesting. However, his daily work was largely unsatisfying, with the exception of generating the monthly productivity metrics. He references these metrics in the following excerpt wherein he compares his job at supply chain company to his current job in a consulting firm:

Peter: Then another cool thing that we did was put together a monthly report that aggregates all of their information for all of the warehouses. You could see which warehouses are doing better and which ones are doing worse. What they need to concentrate on for the next month. That stuff I found interesting, but the really tedious reports? Not interesting at all. That's something that, especially looking at consulting, there's none of that.

Vinson: There's none of that?

Peter: Yeah. You may design the reports but you're not going to be constantly running a report every day, clean it up and send it off to management, here's how this site's doing. Which I think is not fun. It's something entry-level people often get stuck with because it's lowest common... (trailed off) You're the person that's paid the least so your time is less valuable than a manager's. If they're running a report, that's not the best use of their time.

Note that Peter had another internship in the Industrial Engineering department of a national insurance company between the end of his commitment to supply chain company and the beginning of his term as a consultant. His experiences at supply chain company did not clearly cause him to leave engineering for consulting (the job at the insurance company confounds our ability to argue this), but may have played a role by helping Peter discover that running reports in an office environment with few meetings and a long commute was not a good fit for him.

### **Case 3: Karen**

The third focal engineer is Karen, who is a civil engineer with a focus in structural engineering. She attended Private Religious University (PRU) before moving to a large city in the region after graduation. Karen's first job after college was at an engineering consulting firm. There she mainly worked on a project to draft the plans for railways, bridges and other related municipal transportation structures.

Unlike many of the engineers in the sample, Karen only had one term of internship as an undergraduate. The internship was in civil engineering (her major), but as she clarifies below, it was in a different branch of civil engineering (civil works) than her current job (structural engineering).

Vinson: Did you have any internships or work experiences while you were in college?

Karen: Yes. I had one between junior year and senior year at another engineering design and consulting firm. It wasn't a structure [position], it was in civil works, so that's more like drainage, grading and a lot of the plans and permits and stuff like that.

Vinson: What did you do on a daily basis while you were there?

Karen: At my internship I did a lot of editing cap plans, previous plans, they had markups so I'd do those. With civil works, because it's a lot of permits, calling officials and people to check up and make sure what we're doing is correct, or if they had write-ups or markups asking what those meant. Because it's civil works, there's a lot of copying notes down from things like meetings and things like that.

Vinson: Did you enjoy that?

Karen: I did to an extent. I feel like the civil work I did probably interacted with the public a little more than the structural side. Just because you are talking to people at the beginning, trying to do the permits. With structural it's like doing the plans, if that makes sense. But I didn't enjoy doing grading and drainage and things like that.

Vinson: Yeah. The topic of it wasn't interesting?

Karen: The topic, yeah.

After graduation, Karen found a job in civil engineering that focused on structural engineering, an exact match with her major areas. However, as she explained to me, she came to realize within four months of being on the job that it was not for her:

Vinson: What goes into planning and designing a bridge?

Karen: I think my project I work on is a little different than other bridges. I don't know because this is my first one. Ours has been following the standards given by [municipal train company]. It's very much that we choose a span. We looked up a span on the [municipal train company] standards, and then based on that span we knew certain heights things needed to be, or which beams we needed to use. It's very pre-calculated for us.

Vinson: Okay, do you enjoy doing that?

Karen: Honestly, no. My strengths are different, I feel like, than some people. [...] No, because I'm staring at a computer for eight hours a day. I knew that coming into the profession, you're going to get the grunt work, that's what's expected. But having looked at the upper management in my office, they're still doing that—staring at a computer. I don't think I can do that for the rest of my life, so I'm not happy with it.

Vinson: Would it be different for you if you weren't just using templates [from] other places to design, if you were designing new stuff like you were talking about with Freedom Tower?

Karen: I don't think it would necessarily be different. I think the problem with me is I don't mind staring at a computer for long amounts of time. I prefer that not be my entire work day, but I think the big thing for me was there's no group meetings, there's no interaction with people unless we're not doing work and just talking. I think a large part of why I don't like what I'm doing now is my supervisor. Part of me sometimes thinks if I had worked in another firm it would be different, but long story short, I think I would have enjoyed work more. But I think in the long run, because of the management roles, it's still very computer-heavy, and I want to interact with people more, and have that direct impact. [...]

Vinson: Okay, so you would see yourself leaving engineering no matter what?

Karen: Yeah, I think in the long run. Like I said, I like seeing that direct impact with whatever I do. I feel like I could be doing a more direct impact.

In January 2016, just 8 months after beginning her job at the engineering consulting firm, Karen left for a new job at a large non-engineering consulting firm where she now works in a role that she describes as a “go-between the client and the coders, doing a lot of the communication work.” In the above excerpts Karen consistently articulates personal fit as lacking in her job. This is especially evident in the way she describes dissatisfaction with her supervisor, and also with the poor social environment in the office. Not only does she mainly work at her computer, but she also has few close colleagues of a similar age, and one of her primary same-age colleagues was also dissatisfied and trying to leave the company, as well.

In terms of intellectual fit, Karen found her job unsatisfying because it was so formulaic. However, she was doubtful that she could find another engineering job that satisfied her desire to work with people and have “direct social impact.” As she later explained:

I like solving problems, which is why I joined engineering, but I feel like I want a job and a career that helps people more directly, if that makes sense. I'm looking into sectors like that [referring to innovation design and consulting]. I feel like I want to be in a management type position, maybe management consulting. Whatever topic that might be, maybe I could do management consulting for engineering. Who knows, but I feel like I want that goal more from the beginning, if that makes sense. Yeah, I feel like I would have eventually left engineering, because even the upper management isn't necessarily management, because you're still doing computer work and things like that. But you're also not having that direct social impact.

Karen represents a potential pitfall of having little or no professional engineering work experience before taking a post-graduation job. In her internship before senior year she



determined that she did not enjoy civil engineering that had to do with drainage and grading, but got clued into the fact that she enjoyed working with city officials as part of the permitting process. When her senior year came, it took her until early May to land a job at all, and that was her position with the engineering consulting firm. Karen explained that Private Religious University (PRU) was not as well connected to the design side of civil engineering as it was to construction firms that hired civil engineers, so she was unable to take advantage of university resources (like hosted recruiting events) to network for jobs. She mobilized her social network of PRU alumni, one of whom flagged her application at the engineering consulting firm. Although Karen successfully landed this new job at the consulting firm, her solitary internship experience as an undergraduate did not give her the opportunity to juxtapose two (or more) work environments, and she consequently spent the first 4 months of her new job realizing that it was not a fit, reflecting on her experience, and searching for other environments that would be a good fit. This was a higher-stakes learning experience than experienced by Julia or Chris, who encountered (and subsequently avoided returning to) undesirable work experiences as interns.

## **Discussion**

In this paper we have presented the cases of three young engineers with different career paths and self-perceptions of fit. The goals of this analysis were to 1) increase awareness of the importance of undergraduate work experiences in the overall development of the engineer's identity, and 2) present patterns across types of fit engineers consider and how their reflexive self-assessments shape the types of work they pursue after graduation. We find that students often take on a number of different types of engineering jobs and juxtapose their experiences in these environments in order to determine what might be the best work for them to do.

One important outcome of our analysis is that there can be shortcomings to talking strictly about attrition from or persistence in engineering and STEM fields, especially on a global level (i.e. persistence to degree). While these analyses are good at helping to point out how students are continually assessing their fit within their institutions and courses, these analyses tend to leave the professional work experiences of undergraduates unexamined. Because engineers have frequent and varied employment experiences, this analyses brings these experiences into consideration, showing instead how engineering students mitigate negative work experiences and persist to degree.

Based on our analysis, therefore, one practical outcome for engineering educators is further empirical confirmation of the value of undergraduate work experiences. However, while it is generally thought that a multi-term engagement with a company is desirable (it can lead to an offer of a job after graduation, for example), our data show that there is great value in having several shorter engagements with different companies. Engineering programs that build in blended school-work curricula, such as co-op programs, may allow students to have both several short-term internships and one longer-term engagement with one company.

This work-in-progress and the larger study it belongs to have the opportunity to extend our understanding of the meaning of engineers' experiences in work for their professional identity and engineering education experience.

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**Table 1: Sample description**

Pseudonym	Type of Engineer	# Jobs in College	Current Job (Jan 2016)	Pre-graduation Interviews	Post-graduation Interviews	Undergraduate Institution <sup>^</sup>
Peter	Industrial	2 (6 terms)	Consulting	1	4	LP
Julia	Chemical	4 (7 terms)	Operations Engineer, Petroleum Company	1	2	LP
Kyle	Chemical	2 (4 terms)	Improvement Engineer, Chemical Company	1	2	LP
Karen	Civil-Structural	1 (1 term)	Consultant,	0	2	PRU
Margaret	Industrial	3 (3 terms)	Associate Engineer, Logistics Company	0	1	LMSS
Chris <sup>+</sup>	Industrial	2 (2 terms)	Current Student	4	N/A	LP
Lydia	Civil-Environmental	3 (4 terms)	Consultant	0	2	PRU
Jason	Computer Science	3 (3 terms)	Consultant	0	2	LP
Kate	Industrial	1 (1 term)	Operations Engineer	1	0	LP
Connie	Biomedical	1 (1 term)	Engineer (mid-level) at Healthcare company	0	1	LP
Jon*	Civil	1 (1 term)	Assistant Project Manager, Construction Company	0	1	LP
Mallory*	Industrial	2 (2 terms)	Operations Consultant, Large Consulting Firm	0	1	LP
Samantha*	Industrial	No record	Consulting	0	1	LP
Simon*	Biomedical	No record	Consultant to Healthcare Company	0	1	LP
Andy*	Applied Math	2 (6 terms) + 1 pre-college term	Data Scientist, Tech Consulting Firm	0	1	LP
Jesse	Computer Science	3 (3 terms) + 1 pre-college term	Software Engineer in 1-year Company-based Training Program	1	0	LP

\*Interviews were collected by a previous study team member

<sup>+</sup>Denotes current student

<sup>^</sup>Key: Large Midwestern State School (LMSS)  
Private Religious University (PRU)  
Large Private University (LP)