

Entrepreneurial Intentions and Actions of Engineering Graduates: What Contributes to Increased Intentions and Continued Entrepreneurial Skill Development?

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Abstract

Some engineering graduates have the intention to become entrepreneurs. To bring this kind of intention to reality, graduates need additional skills beyond their engineering knowledge by the time they start their entrepreneurial career. In this paper we analyze Entrepreneurial Intentions of engineering graduates and explore the impact of activities to convert intentions into actions. Furthermore, we investigate what entrepreneurs were already doing as students in order to gather relevant skills for starting a venture. While previous research has focused more on Entrepreneurial Intentions within either engineering or business majors [1], or on the psychological side of intentions [2], this current work bridges the gap between intentions and Entrepreneurial Actions.

Our work is based on qualitative semi-structured interviews of participants in the Engineering Majors Survey (EMS) ¹. All 16 interviewees participated at least at two of the three nationally-representative, longitudinal Engineering Majors Surveys. The EMS is a survey designed to explore engineering students' technical, innovation, and entrepreneurial interests and experiences over time. The interviewees in this study had relatively high Entrepreneurial Intentions compared to the average of all EMS participants. Furthermore, they are categorized into three groups, that are characterized by people with increasing Entrepreneurial Intentions, decreasing Entrepreneurial Intention, or those whose intentions remained constant during the surveys.

Our open-ended interview questions were based on Flanagans' critical incident method [3] and enabled additional follow-up questions in order to deepen understanding of certain answers and situations. All interviews were recorded, transcribed and coded according to Corbin and Strauss' [4] inductive coding strategy. The analysis of the codes shows that students and early career pro-

¹The Engineering Majors Survey (EMS) was initially deployed at 27 engineering schools to over 30,000 engineering students in the spring of 2015 (EMS1.0). It was re-administered to respondents in the spring of 2016 (EMS2.0) and again in 2017 (EMS3.0)

professionals value the possibility of having an impact as well as taking responsibility for founding their own company. Furthermore, financial independence as a self-employee is another motivating factor for a significant number of interviewees.

1 Introduction

Entrepreneurship's impact on society has long been identified, discussed, and researched [5], with increased attention over the last two to three decades [6]. As the so called "engines of economic growth" [7, 8], entrepreneurs contribute significantly to different aspects of job creation, invention, as well as product and process innovation [7].

Previous research has focused on how Entrepreneurial Intentions vary among disciplinary groups (e.g., engineering vs. business majors) [1], by disciplinary group and gender [9], and on how Entrepreneurial Intentions of engineering and science students are influenced by engagement with entrepreneurship programs [2]. Our study goes further by beginning to bridge the gap between intentions and actual Entrepreneurial Actions, with a particular focus on U.S. engineering graduates (a group critical to technology-based entrepreneurship). Furthermore, our study focusing on engineering graduates, also considers how motivational factors to found a new venture relate to Entrepreneurial Intentions, thereby advancing prior work that has been exclusively focused on the motivational characteristics of women [10, 11] or that has looked at motivation of college graduates more generally [12].

For our research we consider graduates' entrepreneurial motivation and link resulting Entrepreneurial Intentions with their actions to reach the goal to start a company at some point in the future. We call the approach of gaining a specific skill-set in order to enable oneself to start a company Entrepreneurial Actions, and therefore expand upon Liao and Garnter's [13] definition slightly. They define Entrepreneurial Actions as any innovative action of an organized system of human relationships and the combination of various resources in order to reach a specific goal. Whereas the idea of Entrepreneurial Actions is barely explored in the engineering research, Entrepreneurial Intentions in contrast, are well explored in the literature [14].

This paper focuses on the initial motivation engineering graduates have to start their own company. Furthermore, we investigate what engineering graduates are currently doing and / or have done throughout their studies in order to equip themselves with the "right" skill-set. Additionally, we link existing intentions with actions, regardless of whether graduates have already founded a company, are in the process of preparing it, or are convinced to found it at some point in the future.

The paper is structured in five different sections. After the introduction, we provide background from the literature and explain how we add value to existing research. In the third section we describe our methodology including sampling, data collection and analysis. Following, that are results from the thematic analysis, followed by a concluding discussion in Section 5.

2 Literature Review

The Theory of Planned Behavior (TPB) is the theoretical framework for this paper. TPB was initially introduced by Ajzen [15] in 1991 and has been supported with empirical evidence since then. The theory says planned behaviors, such as starting a new venture, are intentional and therefore best predicted by intentions towards the behavior, not by demographics, personality, beliefs, or attitudes [15]. TPB is also an important cognitive process model for the evaluation of Entrepreneurial Intention as the model describes the complexity of the relationship between human behavior and relevant determinants of that behavior [16]. Ajzen [15] defines three relevant factors which affect a person's intention to perform a certain behavior: attitude towards the act; subjective norm; and perceived behavioral control. Krueger and Carsrud [17] stress the importance of TPB in cases with very low base rate occurrence, such as starting a new venture, where intentions enable valuable insights in the underlying process. As studying intentions gives important insights into new venture creation, using an intention-based model is suitable for the connection to entrepreneurship research, as evidenced in [17]. In our research we want to link motivational factors leading to Entrepreneurial Intentions with Entrepreneurial Actions.

As TPB does not consider the motivational link, we also consider the Shane et al. [18] framework about the entrepreneurial motivation and the entrepreneurship process. Since motivation influences various aspects of human behavior, Shane and colleagues describe entrepreneurship as a process that starts with entrepreneurial opportunity, followed by the development of an idea and the actual execution of the Entrepreneurial Action. According to their work, all three process steps are influenced by entrepreneurial motivation, such as need for achievement, locus of control, vision, desire for independence, passion, and drive of an individual. Furthermore, cognitive factors namely vision, knowledge, skills, and attitude also have an impact on the described entrepreneurial process.

For our study, we use the definition of Entrepreneurial Intentions (EI) of Thompson [14]. He defines them as the "self-acknowledged conviction by a person that intend to set up a new business venture and consciously plan to do so at some point in the future". Liao and Gartner [13] described Entrepreneurial Actions as an innovative action that, through the combination of resources and an organized system of human relationships, is directed towards a certain goal (e.g., the foundation

of a company). The longitudinal study of Kautonen et al. [19] shows that Entrepreneurial Actions are predicted by Entrepreneurial Intentions. Therefore, it is especially important to be aware of the activities that influence intentions.

While there is a growing body of research on early career engineers (e.g., [20]), there are few studies that look specifically at the early career activities of engineering graduates with respect to entrepreneurial interests, intentions and actions. That said, the study by Koch [21] is particularly noteworthy regarding pathways of engineering graduates and their success founding a company; she analyzed the impact of prior work experience (particularly first-jobs right out of school) on the startup processes executed by successful founders, including how they went about entrepreneurial opportunity recognition, evaluation and exploitation. Her results show that founders who used to work for a consultancy focused more on a linear startup process, whereas former startup employees focusing more on an iterative process.

While the afore mentioned studies have contributed to the understanding of young engineering professionals and their pathways, there are still many areas which have not yet been fully explored. Especially, motivational factors and Entrepreneurial Intentions for engineering graduates are relatively unknown. Therefore this study contributes to existing research in this field. Whereas Koch [21] described impacts of former work experience in consulting or a startup on the future career plans, there has not been a lot of research on how early career experiences in small-sized or medium-sized companies influence future plans. According to Sullivan et al. [22], it is crucial to understand the differences between business students' and engineering students' interest and motivations in order to be able to design an engineering-based learning environment. Therefore it is necessary to discover motivational factors for engineers leading to intentions and Entrepreneurial Actions at some point in the future.

3 Methodology

Sampling and Participants

The broader background for this study is based on the "Engineering Major Survey" (EMS), a large research project executed by the NSF-funded Epicenter in collaboration with the Designing Education Lab of Stanford University [23]. The EMS was initially deployed at 27 U.S. engineering schools to over 30,000 engineering students in the spring of 2015 (EMS1.0). It was re-administered to a total amount of 3,500 respondents in the spring of 2016 (EMS2.0) and again to almost 600 students in 2017 (EMS3.0). The EMS is a survey designed to explore engineering students' technical, innovation, and entrepreneurial interests and experiences over time. As the research project focuses

on Entrepreneurial Intentions the longitudinal dataset has three different time points representing the development of their intentions. For our research we identified a subset of respondents, who participated in at least two out of the three conducted surveys and additionally had at least once relatively high Entrepreneurial Intentions score compared to the average of all respondents. This enabled us to identify whether an individuals Entrepreneurial Intention had increased, decreased, or remained constant between the first and the last EMS survey and we were able to create three groups of interviewees representing different time-related developments regarding intentions, as shown in Table 1.

Table 1: Participants Intentions and their study backgrounds

Name	Development of Intentions ²	Intentions according to EMS ³	Major
Emil	C	4	Computer Science
Gustav	I	4	Other
Ingo	I	4	Mechanical Engineering
Norbert	I	4	Electrical/Communications Engineering
Dominik	I	3	Electrical/ Communications Engineering
Frederike	D	2	Engineering, general
Heinrich	C	2	Computer Science
Julia	C	2	Other
Kathrin	C	2	Mechanical Engineering
Lisa	C	2	Bioengineering/Biomedical Engineering
Martin	I	2	Computer Science
Anton	D	1	Bioengineering/Biomedical Engineering
Claudia	D	1	Engineering, general
Paula	D	1	Computer Science
Bernd	D	0	Aeronautical/Astronautical Engineering
Otto	D	0	Computer Science

This selection process of potential interview partners led to a dataset consisting of 31% female and 69% male participants, from six different universities. Four universities are public and two private; three of them are based in the west, two in the mid-west, and one on the east coast. As the paper aims to help close the existing lack in linking Entrepreneurial Intentions with actual actions, Table 1 gives an overview of the 16 participants and the development of their Entrepreneurial Intentions, where D,I,C represent decreased, increased or constant remained intentions in this order. Furthermore, the table shows the overall level of Intentions according to the EMS surveys, whereas 0 represents the lowest and 4 the highest intentions. In addition, the table shows the majors of the participants. In total 19% have founded or co-founded a for-profit or non-profit company, 6% are

² C=Constant, I=Increasing, D=Decreasing

³ Measuring on a scale of 0-4, where 0 indicates the lowest and 4 the highest level of intentions

in academia, 25% are working for a small-sized and 50% for a medium- or large-sized business. To make sure privacy is ensured, all the names of the interviewees were changed in order to hide their identity.

Data Collection and Analysis

Our dataset consists of 16 semi-structured interviews which were conducted either in person or via an online video conferencing tool with an average length of 40 minutes per person. All the interviews were audio recorded, transcribed and analyzed. To increase the reliability according to Silverman [24], the interview protocol, consisting of a total of 14 questions, was tested and modified several times by experienced qualitative researchers from the Designing Education Lab at Stanford University. The structure of the interviews itself was built around the critical incident technique [3], an approach similar to the one used by Klenk et al. [25] in interviewing 36 early career engineers about their innovation experience. The interview questions were open-ended which enabled the interviewer to ask for specific incidents rather than general events. This approach supports asking follow up questions that enabled probing of certain mentioned incidents. The questions were categorized as: introduction and recent professional experience, involvement and innovative activities, Entrepreneurial Intentions, Entrepreneurial Actions, and reflection. Furthermore, the interviewees in our study (as detailed in Section 4) were also asked about factors that attract them to found their own company at some point in the future; this future-looking stance provides additional insights as compared to a retrospective approach [10, 11].

The analysis of the interview data is based on the inductive coding strategy according to Corbin and Strauss [4]. This is known as an open coding approach that enables an expansive approach while analyzing the data. In particular this approach is crucial while formulating a grounded theory [26]. As a framework for the actual analysis we used the six-phase guide, provided by Braun and Clarke [27] which involves becoming familiar with the data, generating initial codes, searching for themes, reviewing themes, defining and naming themes, as well as producing the report. As a result of the open coding approach defined by Corbin and Strauss [4] the research question evolved over the coding process whereby the initial three research questions were reduced to just two. In this case the first research question “What attracts engineers to found their own company?” remains the same while the second “What are they currently doing to promote their Entrepreneurial Intention?” and the third research questions “What were Founders doing as students?” were combined. While the second question focuses on intentions, the third focuses more on actual actions and could be seen as a retrospective point of view. Combining the two questions enables us to create the link between intentions and actions; therefore the combined research question is defined as the

following: “What activities do engineering graduates do to become founders?”

When applying the inductive coding strategy, it is important to code without trying to fit different quotes in an preexisting coding frame, as well as the researcher’s analytic preconceptions [27]. After an initial coding of the entire dataset, we started with 105 initial 1st-order themes. As part of the analysis some of the initial 1st-order themes were dropped and others were added as the progress evolved. As a subsequent step in the analysis, similarities and variations were detected similar to Straus and Corbin’s [4] notion of axial coding in order to create overarching themes. The overarching themes consist of 1st-order themes, have more informative content and are usually formulated in phrasal descriptions or labels [27]. Miles and Huberman [28] define the process of data reduction as a form of analysis which focuses, sharpens, sorts, discards, and organizes the data in order to enable a final conclusion. After revising the codes and themes several times, 14 overarching themes emerged, whereby eight themes are related to RQ1 and six to RQ2.

Besides deciding whether a code is relevant, the ‘level’ of the identified themes has to be determined. According to Boyatzis [29], the levels can be identified at a semantic (explicit) or latent (interpretative) level. The thematic data analysis focuses on one level and a semantic approach concentrates on the surface meaning of the data. In our analysis we did not search for anything further than what was said [30], and data were organized to show patterns, enable interpretation and to set the broader meanings of the data in relation to previous literature [30].

The coding process was done with the commercial software NVivo. Due to the combination of two research questions, various 1st-order themes were combined; for example the themes “Creating ideation notes” and “Making notes” were ultimately represented by the later one. As both of the themes are describing similar things it makes sense to combine them. Similar adjustments were made to other themes, which are not specifically mentioned here. In addition to the coding process in NVivo, a code-book was created. It gives an overview of all relevant codes with a description and a representative quote. As Eisenhardt [31] suggests, independent raters, including researchers from Stanford’s Designing Education Lab have reviewed the category description. All the inconsistent descriptions have been jointly discussed and adjusted until unanimity was reached.

4 Results

In this section, we consider the themes in relation to our two research questions. First, factors triggering and motivating engineers to found their own company are considered, and second activities engineering graduates pursue related to starting a company are described. We interviewed 16 young professionals regarding their Entrepreneurial Intentions. In order to understand if graduates

have intentions in founding their own company, we asked *"Could you imagine to found your own company at some point in the future?"*. As a result, 15 out of the 16 interviewees shared their positive disposition towards entrepreneurship. The only interviewee without the intention to start a company, Paula, a software engineer in a medium-sized company is not further considered in our analysis. Nonetheless, the reason for Paula's aversion regarding entrepreneurship is powered by a negative example, as her father was having a hard time founding his own company: *"One of the major reasons why I'm not interested in going into business for myself or starting my own company is more seeing my Dad's experience. My dad is also in software, he's been ... he graduated in 1970 with a software engineering degree.... and he's done just about everything. And most recently, ... he started his own consulting business and I ... how difficult that has been for him, how he has to do his own marketing, his own billing, you know it's lots of travel, long hours, and then no work for months at a time. And that just holds no appeal for me."*

4.1 Things which attracts engineering graduates to become a founder

We have collected over 52 1st-order themes among the 15 interviews who were positive about founding in the future, which relate to engineering graduates thinking about founding their own company at some point in the future. Using the approach of Braun et al. [27], we categorized the 1st-order themes into eight overarching themes. These themes are: Advantages of being self-employed (n=11), Power to Act (n=10), Changing the World (n=8), Enjoying new Opportunities (n=8), Self-fulfillment (n=9), People Interaction (n=2), Cultural Dissatisfaction (n=2), and Others (n=2), where the numbers in brackets represent the number of interviewees who mentioned a theme. For this result's section we focus on "Advantages of being self-employed", as it is most frequently mentioned and therefore relevant for a large fraction of the interviewees. Furthermore, the aspect of power has been studied a lot and researchers came to the conclusion that it is crucial for a successful venture creation. Kotter [32] focused on the impact of power on leadership, but did not take into consideration whether someone has an engineering background. We also chose to focus on "Self-fulfillment" as the third overarching theme as it represents both, a significant number of 1st-order themes, and to be a motivational factor which has not been studied a lot in the context of entrepreneurship and engineering. The results, including initial interview quotes for the three overarching themes are presented below.

Advantage of being self-employed

Flexibility has been mentioned by 27% of the interview participants and hence is highly relevant for young graduates as a motivational factor for starting their own venture in the future. Anton, a

Bio engineering graduate, refers to his mother's freedom as she is self-employed: *"Hers [referring to her workday] was a lot more and still is a lot more. But, at the same time, she has a lot more freedom and she does what she wants. Because, she takes the clients she likes. She doesn't take the clients she doesn't like."* Even though Anton realizes the long hours his mother works, the freedom of choosing clients she likes, is compensation. It further gives him the self-confidence that he is able to do it, too, as he further explained: *"And, in that way, it just makes it seem more attainable, I guess. I'm like, my mom did it. I can do it too."*

In two of the 15 interviews, Independence was recorded as a motivating factor. For Julia, currently working in a startup, independence is extraordinary important, as she continued to mention it throughout the interview. She also mentioned that independence enables her to follow her passion starting a business: *"I don't want to depend on other people to mainstream that and come up with a company that I can join, because at the moment I think very little interest is directed towards a lot of the issues I care about, and I think it's a very good challenge to try to make that a profitable business pursuit instead of just a pet hobby, or chasing orgs around the world that happen to have just a little bit of spark of interest in it. Yeah, and I'm also just an independent person. I like the thought of setting my own terms."* In addition, she believes that an employer would limit her, as she has to chase someone else's dream: *"It's you work to build someone else's dream, which maybe at best is 95% aligned with your own dream as a really great circumstance if it is."*

Financial Independence was mentioned in a third (5) of the 15 interviews and is therefore the most frequently used 1st-order theme. This implies that participants consider money or financial independence as the biggest advantage of being a founder. Julia considers her own venture as a chance to reach wealth in order to be able to work without the pressure of earning enough money after she has successfully founded a company: *"But second is purely financial based, I want to be able to set up enough passive income streams for myself that by the time I'm over 28, or let's say in early 30s, I won't feel like I have to work a job just for the money."* Ingo is also excited about founding a successful company and the possibility of becoming financially independent as he mentioned: *"There's a lot of potential money in it. It's really cool 'cause if you win when you found a startup, if you exit well, you're set for life."* He further explains he could imagine working hard in order to get the reward later on: *"That's really compelling. It's this idea of working really hard and then after five or ten years, you can do whatever you want."* Emil, who has already started a tech company underlines material wealth: *"I think the material wealth that results from starting a company is also something that's very appealing to me."*

Power to Act

In 27% of the interviews Being Responsible was mentioned as one of the key drivers graduates value when running their own company. Ingo is a good example since he wants to be responsible to make his own decisions: *"Make decisions that ultimately I am the person responsible, right?"* Gustav talks about the lack of responsibility and hence why he values his new position more: *"This experience at [Startup Company] with being given this task and this challenge, and having to go figure it out, I never felt that sense of responsibility at a large company."*

In addition, interviewees think Decision Making is a significant way of using power. Three graduates - around a fifth of the study participants - consider it as a motivational factor. Frederike, one of the graduates who has the goal to do something on her own, highly values the power of making decisions: *"[J]ust the fact that you can make decisions. The fact that you can take it [in] what direction that you would like to take it. I think one is just the tangible management, like you own it, so therefore you can make decisions."*

Self-fulfillment

For the overarching theme "Self-fulfillment", nine relevant mentions were collected within six different 1st-order themes: Reputation (n=2), Fun Thing (n=3), Role Models (n=1), Fruition (n=1), Confidence(n=1), and Creating an ambition driven venture (n=1). For the result section we focus on 1st-order themes, which have been mentioned by more than one person and therefore, we describe "Reputation" and "Fun Thing". Reputation is important for some graduates in order to reach self-fulfillment. Interviewees, especially Ingo, highly value the fame a successful startup brings to themselves. He compares the reputation with the respect researchers get for their work: *"I'm talking about the kind of fame that very high-end researchers have. Where people in their field know and very much respect them for the work that they've done because it's significantly added to the field."* As he explains further, he likes the idea of being known for a philanthropic reason: *"I really enjoy the idea of bringing something of value into the world and being remembered for it."*

Two graduates also mentioned founding a startup would be a Fun Thing to do. Otto talks about a business he started with friends some years ago: *"I think we just had some extra money and time and we were probably just sitting around in our apartment, talking, and decided that we could invest a couple of thousand dollars and make a little bit of money on the side and it would be a fun thing to do."* In contrast to Julia, Ingo, Anton and Emil who care about money, Otto personally thinks that there is more than just money. As he mentioned that it is important to him having fun

with the creation of a company: *"If I were to start a company, it wouldn't necessarily be to make a lot of money it would be as a result of just trying to have fun with something."*

4.2 Activities engineering graduates do to become founders

To answer the second research question, we identified six overarching themes, representing 22 1st-order themes. The overarching themes are: Community interaction (n=10), Personal Development (n=10), Extracurricular Activities (n=5), Following Various Approaches (n=8), Gathering Experience (n=4), and Create Knowledge (n=4). We decided to focus on three overarching and their corresponding 1st-order themes. As current literature has already gathered insights regarding "Personal Development" and "Create Knowledge" we revisit these themes in order to find engineering specific differences. Additionally, the theme "Community Interaction" is interesting to many graduates, as it was mentioned most often. Furthermore, the literature has not collected significant data regarding the importance of community interaction.

Personal Development

Three research participants mentioned Exploring Opportunities in different environments as well as in different jobs as being important in their personal development. Ingo explains that he is actively spending time thinking about business ideas while working on side projects in order to explore ideas: *"The intention with most of them is to explore spaces in which there might be good ideas."* Emil, who is one of the research participants who already started a company, reflects on his time at medium-sized company, where he was able to do several pilot projects. It seems to be important for him to explore different opportunities as he mentions: *"Which means we were constantly doing startups, right? Every time we would go to a new place it would be like, "All right, we're gonna do mortgage fraud prediction, or we're gonna do loan refinancing prediction, or some sort of forecasting thing," and we would start from scratch, and we have to come up with a business case for it, et cetera."*

Three graduates considered Reading as important for personal development. Emil for instance, read a book about scientists and artists which inspired him to go after research as he mentioned: *"One thing I did in high school that really pushed me towards believing in the purity of going after research, and technology is I read the book Godel, Escher, Bach. And it's a book about these three different sort of artists."* Claudia, an employee in a mid-sized company, reads to expand her knowledge beyond her engineering major. She uses reading and books to build up knowledge in new areas like economics: *"Two months ago, [...] I took a basic step. For me, economics is*

difficult, I feel like I haven't gotten a real good background in it, so I bought a book more about the history of economics, the intention is to start buying more about personal and business. Which I feel like, if you have a good foundation in those, you can be fairly stable when creating a business. So I actually did that a couple of months ago. I just started that journey actually. Yeah, I didn't even think about that, but yeah, that was the whole intention."

Two out of the seven graduates, from a private school on the west coast, mentioned Entering a west coast private school as an important step for their personal development. Emil and Gustav have highly benefited from their time at the respective school, as it impacted their Entrepreneurial Intention and led to starting their own ventures. Gustav mentioned that he was not aware of entrepreneurship at all before entering university. While the interview continued he reflected on his application essay: *"I was actually applying to [west coast university]. I had never heard about the word entrepreneurship at all, prior to attending [...], but I knew that that was one of the hallmarks of people that were selected into [...] and went to [...] and did their own startups et cetera. And so I think probably had zero intention of starting my own company until then, and then I was like, "Okay, what did that entail?"*

Create Knowledge

Participating in Certain University Classes and Projects is one thing graduates have done as students in order to create a good knowledge-base. Emil, in particular, talks about the social network course at his university. He values the course because it is based on a real world dataset and thus taken out of academic context. As a result, Emil and others started a data science consulting firm: *"We started that when I took a class, 224W, it's the social networks class at [West Coast University], and the final project is they give you a real world dataset, and they say, build something for this company."* He further described the importance to cover and deal with real problems and non-fictional solutions: *"But I mean, he pulled out some really cool examples, the lecture of like, solving a real world problem that until a year ago everybody thought was completely impossible, now it's like, "Hey we got it, it works."* In addition to that, Gustav explained his learning progress when he took courses at the design department of a west coast university. He emphasized the framework he learned and the importance to apply them to real life: *"But when I think of what kinds of things have helped me the most, it's the frameworks that I learned. One, in engineering as an engineer, so this is outside of the [design program], of this is a problem. This is the background. These are the assumptions. This is our first whack at it. Okay, this is test it out. It doesn't work. Okay, go try something else. That framework is ... and kind of bringing that in with at the [design program], same thing, making a product, but also applying it to your*

life.” Going to school in general was mentioned by just one interviewee. This implies that it is either obvious or the importance is not recognized by young graduates. However, Norbert considers school as one factor, besides professional experience, that prepared him for the future. He especially mentioned design knowledge: *”I guess in terms of being prepared, the only thing I’ve been able to do is overcome design challenges. And I guess school did play a factor in that, and then this industry experience, in general, has helped prepare me to overcome these challenges, because they’re frequent and they don’t go away easily.”*

Community Interaction

Discussing Ideas with Socio-Environment is the most frequently mentioned overarching theme (n=6) within the community interaction overarching theme. It is particularly important to talk to various people for 40% of the interviewees. The people include roommates, family, colleagues and friends. Julia is a good example since she tries to talk to as many people as possible for the validation of ideas. She also mentioned that greater social pressure will result, if she spreads her idea of starting a company to her network: *”I try to talk about my ideas with as many people as possible, especially with my friends because the more people I can get to ask me how’s that going, or offer new connections or ideas or anything is always helpful. And the more people who have an expectation of me that I’m going to complete it, the more pressure I feel to complete it.”*

Networking with potential Co-founders is another theme that interview participants (n=2) mentioned. Interviewees consider friends and colleagues as valuable source for potential co-founders. While Emil was talking about his work experience, he mentioned that he met people who were experienced with entrepreneurship. He elaborated: *”And so all of the relationships I made in my year, and a couple months while I was there were basically with people who either knew startups were viable, they could succeed at them, and they were waiting for timing and ideas in order to go off and do it.”* In contrast to Emil, Julia primarily talked about her friends as potential co-founders, as she explained: *”And I also want as many of my friends as possible to go into business with me, because a lot of my friends, as I mentioned, are artists or a lot of my friends don’t really want to be working full time in the companies that they’re working for. A lot of my friends I would love to work with, so over time we talk a lot about our ideas, we eventually do hook onto things, we’re like, ”We could work on that together in a few years time, or maybe in a few months. Whenever both of us are ready this would be really exciting.” And I love that a lot.”*

The theme Life Design Day was mentioned by just one person. However, it is a different approach and a way of interacting with communities. Ingo invited his closest friends with the goal to help them with their career decisions but also to talk about different business opportunities. He further

explained the brainstorming day: *”It was on Saturday; a day-long session with six of my friends, including him, to sit down and do what I call a ”life design day”, where you basically look at the potential paths you could have for the future and you try to fit them into a coherent work view and world view. You discuss and have people throw out ideas on different ways you could approach some of the problems or career development or business ideas.”*

4.3 Quantitative Findings

Although the nature of this paper is qualitative, we attempted to connect our qualitative findings with rudimentary quantitative analysis. Since this research is rooted in the Engineering Major Survey, participants were selected in three batches with increasing, decreasing and constant Entrepreneurial Intentions over time. As a first step towards a statistical analysis, we categorized (low, medium, high) the study participants by the magnitude of their intentions indicated during the most recent survey as indicated in Table 3. To get a better understanding which activities and which motivational factors are mentioned more often among these three categories, Figure 1 and 2 are developed.

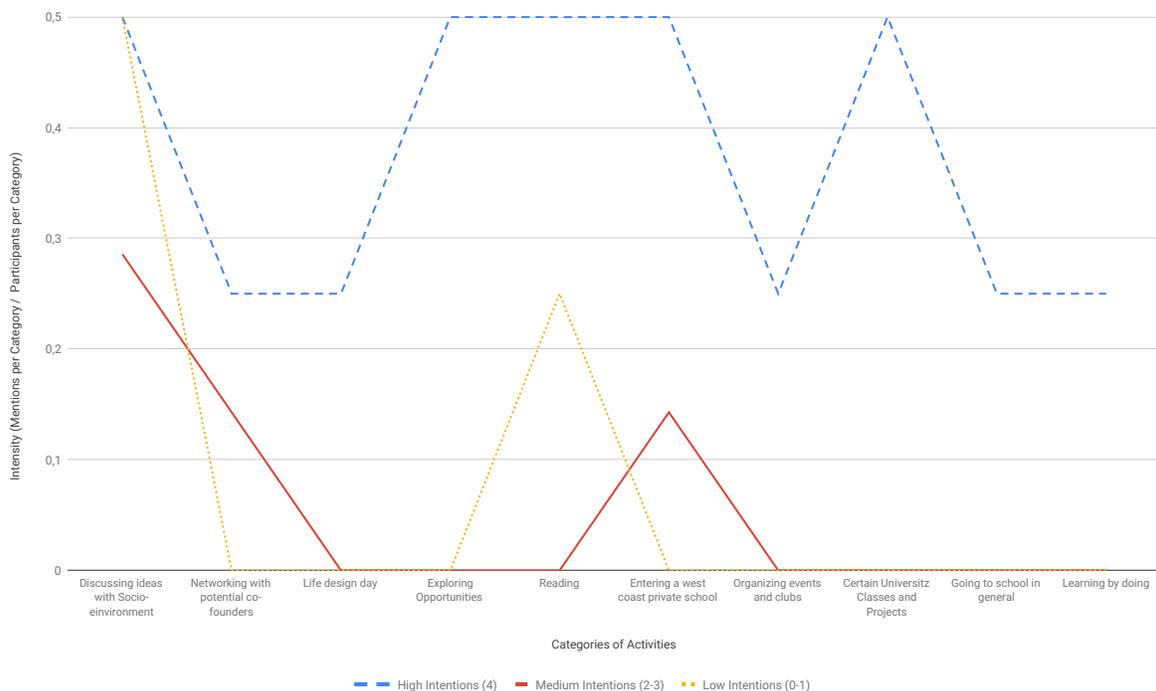


Figure 1: Engagement with various Types of Activities with level of Entrepreneurial Intentions, as shown in Table 1.

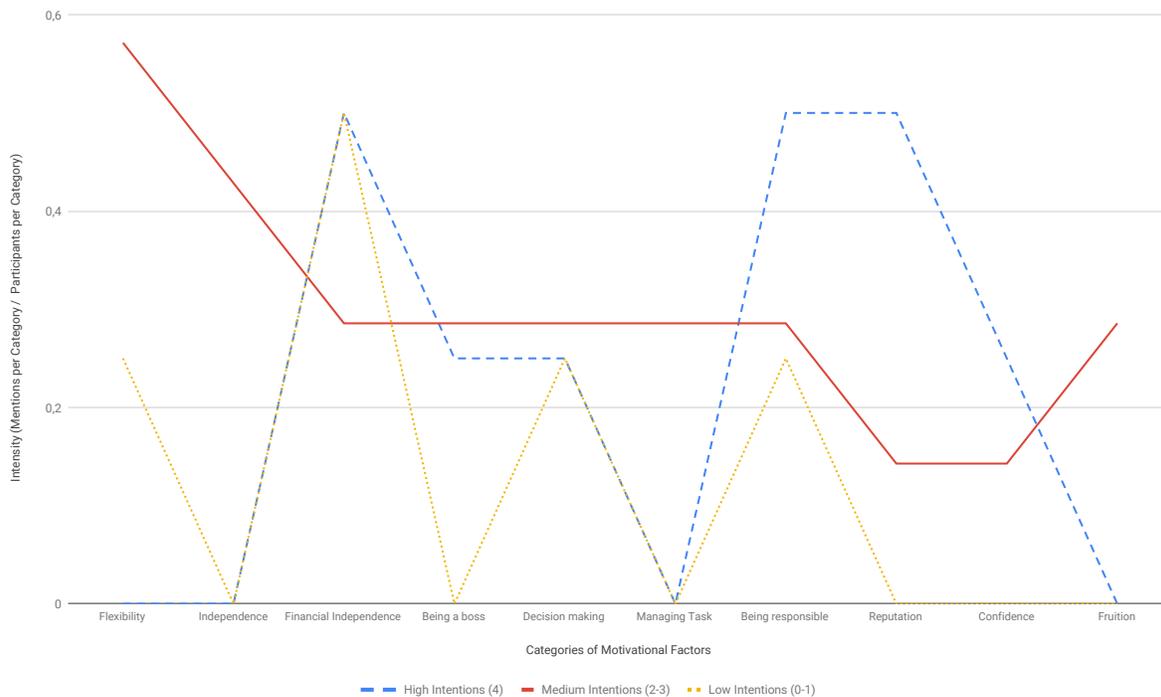


Figure 2: Type of Motivation, as related to Entrepreneurial Intentions, as shown in Table 1.

Figure 1 describes the mentions of activities for each of the three groups (low, medium, high). It is not surprising to see that participants of the high Entrepreneurial Intentions group have the most mentions per activity. This suggests that people who are aware of their Entrepreneurial Intentions (consciously or unconsciously) tend to act more in Entrepreneurial Activities.

In contrast to Figure 1 is Figure 2. While it is clear that high Entrepreneurial Intentions lead to higher entrepreneurial activities, it is different for motivations. Motivations are difficult to cluster or connect with the different intensities of Entrepreneurial Intentions. Only the two motivational codes "Responsibility" and "Reputation" seem to be stronger among participants with high intentions to start a business.

Analyzing the motivational factors of the three participants who indicated that they already started a company (Emil, Gustav and Norbert), it is interesting that they are among the respondents who most frequently mentioned motivational factors while belonging to the high intentions category. In particular, Emil has named up to three times more factors that motivate him to start his own business, compared to the average of interview participants. A similar picture emerges when focusing on activities that respondents are currently doing or have done. With a total of 14 activities, Emil mentioned more than three times as many activities as Gustav (4) and Norbert (3) representing the

interviewees who mentioned the activities second and third most frequently. It is also interesting that Emil and Gustav share almost the same opinion about activities as they have invested time in 75% of the same activities, such as participating in certain university classes and projects. By comparison, Norbert does not all agree with Emil, because he rather believes that focus on learning by doing is helpful becoming a founder.

5 Discussion and Implications

The objective of this research is to better understand activities and motivations that impact Entrepreneurial Intentions among engineering graduates, particular early in their careers. We analyzed 15 interviews with young professionals who graduated in the last three years. The analysis of the transcripts and codes is separated in activities and motivations. The three overarching themes for the activities that are detailed in the paper "Community Interaction", "Personal Development" and "Create Knowledge". People with high Entrepreneurial Intentions can be identified by their activities and the frequency of the activities compared to participants with lower Entrepreneurial Intentions. We identified that graduates spend time above all for their personal development. They also interact with their communities such as friends, family and co-workers, and actively create knowledge in order to get the right skill-set a founder needs.

The three overarching themes we highlighted for motivations are "Advantages of being Self-employed", "Having Power" and "Self-fulfillment". In contrast to activities, it is difficult to see motivational themes that have a stronger impact on Entrepreneurial Intentions than others. Similar to our findings, Barba-Sánchez et al. [33] identified Financial Motivation as one of the leading motivational factors for industrial and computer engineering students. They further elaborate that money is seen as a synonym for well-being, and reflects safety and a good standard of living for the society. Having the power to act seems to be a strong factor for engineering graduates. The graduates value the power to make their own decisions but also to take responsibility. Previous research from Barba-Sánchez (2012)[12] identified "do things my way" as one of the factors, representing the possession and execution of power. The participants talked about the reputation of starting a company and could appreciate additional visibility. A similar factor has been elaborated in the literature [33].

A closer look at the three interviewees Emil, Gustav and Norbert who have already founded some kind of a company, enables us to begin to link their Entrepreneurial Intentions with their actions. All of the three interview participants have indicated high entrepreneurial intentions in the past and have founded a company within the period of the longitudinal study of Engineering Major Survey.

5.1 Implications for Engineering Education

The aim of this paper is to increase understanding of engineers who are especially interested in entrepreneurship. We focused on motivational factors that might lead to Entrepreneurial Intentions, and identified factors such as perceived Advantages of being self-employed, Power to Act, ability to Change the World and Self-fulfillment. At the very least universities and colleagues should make students aware that these are career possibilities in being a founder. We note that one of the study schools seems particularly effective in fostering awareness (and interest in) entrepreneurship among engineering students.

We also looked at the activities among engineering graduates with regards to moving from intentions to realization. Here we identified Community Interaction, Personal Development, Extracurricular Activities, Gathering Experience and Creating Knowledge. These too are activities that engineering students can learn how to do and be involved with, either in their formal coursework or in their extra-curricular endeavors. A number of engineering schools and universities have developed centers with this particular emphasis [34].

5.2 Limitations and Outlook for Future Engineering Research

Despite the contributions, this study has some limitations which future research should keep in mind. First, the small sample size of 16 recently graduated engineers from six American universities does not represent all graduates in the United States or even the rest of the world. Furthermore, seven of the interviewees had graduated from a west coast university, which is well-known for its outstanding entrepreneurial spirit. The remaining nine students represent five other universities, which means there is an average of 1.8 graduates per university. Furthermore, our dataset consists of three people who have founded either a startup or a non-profit. Having a small number of founders in our dataset, showed the limits of the study as we could just begin to link specific motivational factors with actual Entrepreneurial Actions. Therefore, we highly recommend the use of a similar approach with a bigger dataset that includes a greater number of founders. Additionally, it would be interesting to get a better understanding of the activities and motivations by applying further longitudinal data points in combination with constructs like self-efficacy or innovation interest. Quantitative analysis based on this research would help to make findings more generalized like the preliminary approach we took to differentiate between participants with low and high intentions in regards to their activities and motivation.

6 Acknowledgements

The EMS study was conducted with support from the National Center for Engineering Pathways to Innovation (Epicenter), a center funded by the National Science Foundation (grant number DUE-1125457) and directed by Stanford University and VentureWell, formerly the National Collegiate Inventors and Innovators Alliance (NCIIA). The EMS research continues with funding support from the National Science Foundation (grant number 1636442).

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