Exploring how innovation self-efficacy measures relate to engineering internship motivations and outcomes

Amy Huynh, University of California, Irvine

Amy Huynh is a mechanical and aerospace engineering undergraduate student at the University of California, Irvine. She is interested in better understanding and supporting the experiences of female and underrepresented engineers in the classroom and in industry. She is a Brooke Owens Fellow and has interned at NASA Goddard, Made In Space, and NASA Ames.

Dr. Helen L. Chen, Stanford University

Helen L. Chen is a research scientist in the Designing Education Lab in the Department of Mechanical Engineering at Stanford University. She has been involved in several major engineering education initiatives including the NSF-funded Center for the Advancement of Engineering Education, National Center for Engineering Pathways to Innovation (Epicenter), as well as the Consortium to Promote Reflection in Engineering Education. Helen holds an undergraduate degree in communication from UCLA and a PhD in communication with a minor in psychology from Stanford University. Her current research and scholarship focus on engineering and entrepreneurship education; the pedagogy of portfolios and reflective practice in higher education; and redesigning how learning is recorded and recognized in traditional transcripts and academic credentials.

Dr. Krishnaswamy Venkatesh Prasad, Ford Motor Company

Dr. K. Venkatesh Prasad is the Senior Technical Leader for Corporate Strategy at Ford Motor Company.

Immediately prior to his current role, Dr. Prasad was responsible for influencing both transformative and organic innovation at Ford with a focus on scientific research and engineering of vehicle components and systems. His prior roles included the the research, architecture, standards, and proof-of-concepts development electronics and embedded software systems. His revolutionary thinking of a contemporary vehicle as an inter-networked platform-on-wheels in early 2000 has led to the successful development of the renowned Ford SYNC(R) system, which has directly impacted Ford's present vehicle production.

Before joining Ford Motor Company in 1996, Prasad worked as a senior scientist at RICOH Innovations in Menlo Park, Calif., developing automatic "lip reading" as a novel human-machine interface. In addition, he was at Caltech and the NASA Jet Propulsion Laboratory in Pasadena, Calif., where he worked on the world's first telerobotic visual surface inspection system to help design the International Space Station.

Attracted by an open-ended challenge to discover ways to integrate "intelligence" into cars and trucks, Prasad joined Ford to work with a small group of engineers in the development of adaptive headlamp and lane-mark detection technologies. In 2011, Prasad architected OpenXC, the industry's first open-source hardware and open-source software platform – an "innovator's toolkit" – which launched in 2013 and today is one of the tools used by Ford employee-innovators to design, test and release products and by researchers and experimenters the world over.

He also co-founded Ford's startup-lab in 2012 as a 5-person office; a year later it scaled to become Ford's Research & Innovation Center Palo Alto and today is a 150-person operation.

Dr. Sheri Sheppard, Stanford University

Sheri D. Sheppard, Ph.D., P.E., is professor of Mechanical Engineering at Stanford University. Besides teaching both undergraduate and graduate design and education related classes at Stanford University, she conducts research on engineering education and work-practices, and applied finite element analysis. From 1999-2008 she served as a Senior Scholar at the Carnegie Foundation for the Advancement of Teaching, leading the Foundation's engineering study (as reported in Educating Engineers: Designing for the Future of the Field). In addition, in 2011 Dr. Sheppard was named as co-PI of a national NSF innovation center (Epicenter), and leads an NSF program at Stanford on summer research experiences for

ASEE'S VIRTUAL CONFERENCE

At Home with Engineering Education

JUNE 22 - 26, 2020 #ASEEVC

Paper ID #29854

high school teachers. Her industry experiences includes engineering positions at Detroit's "Big Three:" Ford Motor Company, General Motors Corporation, and Chrysler Corporation.

At Stanford she has served a chair of the faculty senate, and recently served as Associate Vice Provost for Graduate Education.

Exploring how innovation self-efficacy measures relate to engineering internship motivations and outcomes

Abstract

In this evidence-based practice paper, it is recognized that experiential opportunities in the form of internships in industry represent significant experiences for engineering students to acquire knowledge about the professional workplace and gain insights into possible future careers. To optimize the benefits gained from internship programs for both students and companies, it is important to understand the specific motivations of interns in order to inform the design of effective programs, guidelines, and environments.

In this study, two cohorts of interns in 2017 (N=115) and 2018 (N=155) at a large global engineering company in the automotive industry completed exit surveys about their summer internship experiences. These surveys focused on innovation and engineering task self-efficacy measures as well as additional variables related to innovation interests and outcomes, postgraduate career goals and other influencing factors. The results were analyzed and interpreted in relation to the results from a separate dataset of 92 interns who completed a pre-internship survey in 2018 that included open-ended questions about their reasons for choosing to work at the company, the goals they hoped to accomplish, and what they hoped to learn during the internship.

The outcomes from this study explore the relationships among self-efficacy measures and various components and features of internship programs, such as interactions with supervisors and colleagues and the frequency and quality of feedback. These findings have the potential to inform and guide the development of recommendations for students seeking to optimize their internship experience as well as for industry partners, who are looking to innovate, transform and grow by providing insights into the design of engaging and compelling internship experiences for students and potential future employees.

1. Motivation and Background

Experiential opportunities in the form of internships in industry represent significant opportunities for engineering students to gain knowledge about the professional workplace and insights into potential future careers. While there appears to be no singular definition of internships in the literature or in practice [1], the National Association of Colleges and Employers describes an internship as "...a form of experiential learning that integrates knowledge and theory learned in the classroom with practical application and skills development in a professional setting. Internships give students the opportunity to gain valuable applied experience and make connections in professional fields they are considering for career paths; and give employers the opportunity to guide and evaluate talent." [2].

Undergraduate internships have been recognized as a high impact practice that is positively associated with increased persistence, retention and student engagement [3]-[4]. [5] notes some of the characteristics of these high impact practices that are particularly relevant to internships namely, helping students experiment and apply what they are learning in courses to new

situations, offering scenarios for rich feedback and experiencing diversity in environments, skills, and people, as well as providing opportunities for reflection and synthesis.

Working in an engineering environment as an intern is often a key component of the educational experience of today's engineering students [6]. A 2014 Gallup-Purdue University study of undergraduate alumni found that work and internship experiences in college increased the likelihood of post-graduate full-time employment and greater engagement at work [7]. Summer internships and the experience of working in a professional engineering environment are positively associated with increased self-confidence and interest in innovation and technical engineering tasks [8]-[10]. Compared to the focus on theoretical concepts in an academic setting, an internship focuses on real-life applications in industry. It can also provide students with professional engagement and guidance from early career engineers and experienced managers and supervisors. These industry perspectives are not as easily accessible in the classroom where students primarily engage with undergraduate peers, graduate teaching assistants, and professors in their classes.

For industry partners, internship programs can serve as opportunities for recruitment, allowing supervisors to "test-drive" the talent pool and identify potential hires through firsthand observations of their work and professional and interpersonal skills. Exposure to new working environments, interactions with supervisors and co-workers, as well as opportunities for learning and professional development may all contribute to the decision-making process about choice of employment after graduation. In order to optimize the benefits gained from internship programs for both students and companies, it is important to understand the specific motivations of interns and use that knowledge to inform the design of effective programs, guidelines, and environments.

This study takes a quantitative and qualitative approach to understanding the summer internship experience at a large global engineering company in the automotive industry, ranging from initial goals and motivations prior to starting the internship, self-efficacy and interest measures around innovation and engineering tasks, leading to the final decision of whether or not to accept an offer, if given. Specific features of the internship experience, such as attitudes towards the project or work assignment, interactions with supervisors and co-workers and opportunities for learning and professional development will be explored in relation to measures of innovation interests, innovation and engineering task self-efficacy, and career goals around innovative work.

2. Datasets and Descriptions of Variables

The primary dataset for this study is an exit survey conducted at the end of the summer in 2018 with a cohort of interns (N=155) working in the Product Development division at various sites in a large engineering company. This multinational Fortune 500 company employs about 25,000 engineers from all engineering majors. A pre-internship survey was administered at orientation to a cohort of interns at the beginning of summer 2018. There were 92 respondents including 30 females (32.6%) and 62 males (67.4%). Of this sample, 75 respondents (81.5%) were first year interns at the company and 17 respondents (18.5%) were returning interns. All of these surveys were anonymous and connecting responses between surveys was not possible.

Two additional datasets are included to help inform and benchmark the results from this study. The 2017 post-internship survey was also administered to product development interns at the end of the summer (N=115). The Engineering Majors Survey (EMS) developed by the NSF-funded Epicenter, the National Center for Pathways to Innovation, explored engineering students' interests and career goals related to entrepreneurship and innovation. This longitudinal study was first administered in 2015 to a nationally representative sample of 27 engineering schools and included over 30,000 undergraduate engineering students. The current study includes findings from EMS 1.0 and focuses on a subset of data from 3,235 engineering juniors and seniors who reported working in a professional engineering environment as an intern/co-op for at least one full academic or summer term. [11]

Survey	Timing	Interns N	Men N (%)	Women N (%)	Missing N (%)
Post-Internship Survey 2018	Summer 2018	155	111 (71.6%)	44 (28.4%)	
Pre-Internship Survey 2018*	Spring 2018	92	30 (32.6%)	62 (67.4%)	
Post-Internship Survey 2017	Summer 2017	115	22 (19.1%)	83 (72.2%)	7 (6.1%)
Engineering Majors Survey 1.0	Winter- Spring 2015	3,235	2027 (62.7%)	965 (29.8%)	243 (7.5%)

Table 1. Description of study datasets

*The 2018 pre- and post-internship students were administered independently and anonymously and are not longitudinally linked.

3. Methods

The quantitative analyses in this paper focus primarily on the 2018 Post-Internship Survey dataset which included standard evaluation questions about the interns' experiences applying for the internship, attitudes towards company-sponsored events, as well as additional items relating to innovation and engineering self-efficacy and their views of the company and their work assignment, their interactions with co-workers and supervisors, and future plans. It should be noted that several changes were made in the two post-internship survey instruments across the two administrations in 2017 and 2018 and as a result, there is no direct parity in several of the survey items and constructs.

3.1 Key Measures Across Datasets

This study focuses on four scales that were included in the Engineering Majors survey as well as the two Post-Internship Surveys. The scales are described in greater detail in [11]. A Cronbach's Alpha was calculated for each of the scales and an acceptable level of internal consistency was established for each dataset (Table 2).

The <u>Innovation Self-Efficacy (ISE)</u> scale represents an average of five items that measure confidence in one's ability to "ask a lot of questions," "experiment as a way to understand how things work," and "connect concepts and ideas that appear, at first glance, to be unconnected." ISE was measured on a five-point Likert scale ranging from "Not confident" (0) to "Extremely confident" (4).

<u>Engineering Task Self-Efficacy (ETSE)</u> also measures confidence in one's ability to "conduct experiments, build prototypes, or construct mathematical models to develop or evaluate a design," "design a new product or project to meet specified requirements," and "troubleshoot a failure of a technical component or system." ETSE consists of five items, each measured on a five-point Likert scale similar to the ISE scale.

<u>Innovation Interests (INI)</u> includes five items measuring interest in "finding resources to bring new ideas to life," "developing plans and schedules to implement new ideas," and "giving an elevator pitch or presentation to a panel." Each item is measured on a five-point Likert scale ranging from "Very low interest" (0) to "Very high interest" (4).

<u>Career Goals Innovative Work (CGIW)</u> measures the importance of being involved in innovative work activity in the first five years after graduation. Examples of these activities include "generating creative ideas," searching out new technologies, processes, techniques and/or product ideas" and "selling a product or service in the marketplace." This scale consists of an average of six items, each measured on a 5-point Likert scale ranging from "Not important" (0) to "Extremely important" (4).

Measure	EMS 1.0 Alpha	2017 Post- Internship Alpha	2018 Post- Internship Alpha
Innovation Self-Efficacy (ISE)	.79	.81	.80
Engineering Task Self-Efficacy (ETSE)	.88	.87	.88
Innovation Interests (INI)	.78	.74	.70
Career Goals Innovative Work (CGIW)	.86	.85	.83

Table 2. Cronbach's Alphas for Innovation Self-Efficacy, Engineering Task Self-Efficacy,Innovation Interests, and Career Goals Innovative Work for the EMS 1.0, 2017 and 2018Post-Internship Survey datasets

3.2 Additional 2018 Post-Internship Survey Items

The 2018 Post-Internship survey also included items about interns' work assignment, their interactions with their supervisor and colleagues, and opportunities for professional development. Survey respondents reported their level of agreement with each statement, with each item measured on a 5-point Likert scale ranging from "Strongly disagree" (0) to "Strongly agree" (4). These seven items are grouped under three general themes:

Opportunities for Feedback

- I received timely feedback about my work.
- I received sufficient feedback for my professional development.

Interactions with working professionals and colleagues

- My supervisor effectively facilitated my on-the-job learning.
- I learned from my coworkers during my internship.
- I had opportunities to network with professionals outside of my team.

Perceptions about the internship assignment

- My internship project was aligned with my learning interests.
- The internship provided me with valuable insight into the practical application of my field of study.

3.3 Coding the Open-ended Responses in the 2018 Pre-Internship Survey

In the 2018 Pre-Internship survey, there were two main groups of survey answers that were analyzed qualitatively: the interns' goals and learning during the internship and second, the interns' considerations about the organization if they received a job offer. The interns were asked to provide short answers to the following questions.

- What are your goals for your internship this summer?
- What are three things you hope to learn during your internship that you have not learned at school?
- What are three things you would want to know about an organization before deciding to work for them full-time?

The qualitative analyses included reading through the survey answers and determining the most frequently mentioned words or phrases and themes in the answers. Most of the interns' answers were in bullet point form and the length of the answers varied, though they were typically one to three sentences long.

Each word or phrase of the interns' answers were color-coded to reflect the theme it was coded for. The color coding provided consistency during the coding process and made it easy to reference the reasoning behind why an answer was coded a certain way. Two codebooks were created and the descriptions of each of the codes with corresponding examples of intern responses. Table 3 addresses the first two questions focusing on the interns' goals for their summer experience and for their learning more specifically. Table 4 describes the five codes

assigned to interns' answers about what they would want to know about a company before accepting an offer.

Code	Description	Examples of Intern Responses
Learn - Technical	Learn new technical knowledge, skills, and abilities	"Understanding Aerodynamics and from there determining how they design a car based off that information"
Learn - Fit	Learn how the intern's skills, abilities, values, and interests fit at the company	"Understand [the company's] values and learn where I could fit into the company."
Learn - Technical Process	Learn about the technical engineering process	"A more in depth understanding of manufacturing processes related to seatbelts."
Learn - Professional Process	Learn about the professional engineering processes	"How to program manage across platforms at a professional lever"
Network	Meet other engineers and interns at the company to grow the intern's professional network	"Overall networking and connections in industry."
Learn - School- related	Learn new things that relate to academic work or make connections back to academic work	"How to apply what I have learned in a classroom setting to a real world setting"
Learn - Company	Learn about the company, specifically their products and environment	"I hope to learn how [the company] operates, what the employees are like here, and more about [the company's] products."

Table 3. Codebook for analyzing internship aspirations and learning goals in the 2018 Pre-Internship Survey dataset

Code	Description	Example
Benefits	Various types of non-wage compensation for employees	"Also, I want to know the company will be able to financially be able to support me in the years to come. Such as with a 401(k), savings accounts, raises, bonusesetc."
Job	What exactly the job assignment will entail, scope of the work	"What will/can my role be in the organization/ What types of work/projects will I be doing."
Environment	The company's work environment, processes, work-life balance	"What the company culture is like how people act towards one another, how people regard the company, if there is honesty regarding the company's issues"
Organization	The company's culture, atmosphere, mission, and values	"What is their vision for moving forward and being a viable, healthy organization in the future."
Growth	Opportunities for employee growth and advancement	"Are there opportunities to grow within the company? How will they support my future endeavors?"

Table 4. Codebook for analyzing features of an organization influencing the acceptance of afull-time offer in the 2018 Post-Internship Survey dataset

Each intern's answers were assigned one to five codes. These codes were then grouped into three primary categories: learning technical/professional skills and processes, learning about the company and the interns' fit within the company, and learning how to transfer and apply what is learned in the classroom into the industry environment.

4. Results

4.1 How do the engineering company interns compare with the national engineering population interns?

Using the EMS 1.0 dataset as a benchmark, at the end of their internships, the 2017 and 2018 interns reported higher innovation and engineering task self-efficacy as well as interest in innovation and being involved in creative work activities after graduation. (Table 5)

Scale	EMS 1.0 <i>M (SD)</i>	2017 Post- Internship <i>M (SD)</i>	2018 Post- Internship <i>M (SD)</i>
Innovation Self- Efficacy (ISE)	2.72 (.69)	3.15 (.60)	3.14 (.59)
Engineering Task Self-Efficacy (ETSE)	2.54 (.79)	3.03 (.68)	2.96 (.79)
Innovation Interests (INI)	2.40 (.74)	2.88 (.63)	2.94 (.63)
Career Goals Innovative Work (CGIW)	2.54 (.76)	2.89 (.72)	3.00 (.67)

Table 5. Mean scores for Innovation Self-Efficacy, Engineering Task Self-Efficacy,Innovation Interests, and Career Goals Innovative Work for the EMS 1.0, 2017 and 2018Post-Internship Survey datasets

Tables 6-9 take a closer look at the gender differences in the mean scores for each of the four scales in the 2018 and 2017 Post-Internship and EMS 1.0 datasets. There were largely no significant gender differences in the 2018 and 2017 datasets with the exception of Engineering Task Self-Efficacy where females reported lower confidence than male interns in their abilities to perform integral technical engineering tasks. A similar trend was found in the EMS 1.0 dataset.

Scale	Females Mean (SD)	Males Mean (SD)	t	df	Sig.
Innovation Self-Efficacy (2018 Post-Internship Survey)	3.02 (.67)	3.19 (.55)	-1.35	112	NS
Innovation Self-Efficacy (2017 Post-Internship Survey)	3.11 (.74)	3.20 (.48)	52	25.97	NS

Scale	Females Mean (SD)	Males Mean (SD)	t	df	Sig.
Innovation Self-Efficacy (EMS 1.0, w/internships)	2.66 (.70)	2.76 (.69)	-3.68	2974	p<.001

Table 6. Gender differences in mean scores for Innovation Self-Efficacy in the 2018 Post-
Internship Survey and EMS 1.0 datasets

Scale	Females Mean (SD)	Males Mean (SD)	t	df	Sig.
Engineering Task Self- Efficacy (2018 Post- Internship Survey)	3.02 (.67)	3.19 (.55)	-3.85	111	p<.001
Engineering Task Self- Efficacy (2017 Post- Internship Survey)	2.60 (.83)	3.21 (.55)	-3.07	25.13	p<.01
Engineering Task Self- Efficacy (EMS 1.0, w/internships)	2.32 (.78)	2.65 (.78)	.3.68	2974	p<.001

Table 7. Gender differences in mean scores for Engineering Task Self-Efficacy in the 2018Post-Internship Survey and EMS 1.0 datasets

Scale	Females Mean (SD)	Males Mean (SD)	t	df	Sig.
Innovation Interests (2018 Post-Internship Survey)	3.02 (.67)	3.19 (.55)	23	112	NS
Innovation Interests (2017 Post-Internship Survey)	2.72 (.69)	2.94 (.58)	-1.50	101	NS
Innovation Interests (EMS 1.0, w/internships)	2.37 (.72)	2.41 (.74)	-1.31	2973	NS

Table 8. Gender differences in mean scores for Innovation Interests in the 2018 Post-
Internship Survey and EMS 1.0 datasets

Scale	Females Mean (SD)	Males Mean (SD)	t	df	Sig.
Career Goals Innovative Work (2018 Post- Internship Survey)	3.02 (.67)	3.19 (.55)	.64	112	NS
Career Goals Innovative Work (2017 Post- Internship Survey)	2.84 (.78)	2.95(.64)	66	100	NS
Career Goals Innovative Work (EMS 1.0, w/internships)	2.47 (.74)	2.57 (.77)	-3.36	2969	p<.05

Table 9. Gender differences in mean scores for Career Goals Innovative Work in the 2018Post-Internship Survey and EMS 1.0 datasets

4.2 How do specific internship components correlate with ISE, ETSE INI, and CGIW, and how do these experiences vary by population?

Pearson correlation analyses were conducted to investigate the relationships that innovation selfefficacy and engineering task self-efficacy have with specific components of the internship experience.

Internship Component	ISE	ETSE	INI	CGIW
I received sufficient feedback for my professional development.	NS	.203*	NS	NS
I received timely feedback about my work.	.255**	.225*	NS	.269**
My supervisor effectively facilitated my on- the-job learning.	NS	NS	NS	NS
I learned from my coworkers during my internship.	NS	NS	NS	NS
I had opportunities to network with professionals outside of my team.	.236*	NS	NS	NS

Internship Component	ISE	ETSE	INI	CGIW
My internship project was aligned with my learning interests.	NS	NS	NS	.248**
The internship provided me with valuable insight into the practical application of my field of study.	NS	NS	NS	.246**

Table 10. Correlations between Innovation Self-Efficacy (ISE), Engineering Task Self-Efficacy (ETSE), and Career Goals Innovative Work (CGIW) and key internship componentsin the 2018 Post-Internship Survey dataset

Table 10 shows that confidence in interns' reported ability to innovate and to perform engineering tasks is correlated with receiving timely feedback (p<.01 for ISE and p<.05 for ETSE) and sufficient feedback for professional development (p<.05 for ETSE). Interest in pursuing future job or work activities involving innovative work also appeared to be related to receiving timely feedback (p<.01), being assigned to a relevant and interesting project (p<.01), and learning about the practical applications of a major or field of study (p<.01).

Table 11 describes how the actions of supervisors and how often and when feedback is given can contribute to how male and female interns experience various components of the internship experience.

Variable	Females Mean (SD) N=44	Males Mean (SD) N=111	t	df	Sig.
My supervisor effectively facilitated my on-the-job learning.	2.93 (1.08)	3.45 (.83)	-3.18	153	.002**
I received sufficient feedback for my professional development.	2.56 (1.05)	3.05 (.85)	-2.75	64.35	.008**
I received timely feedback about my work.	2.70 (.96)	3.24 (.77)	-3.64	152	.000***

 Table 11. Significant gender differences in mean scores for the role of the supervisor and receiving of timely and sufficient feedback in 2018 Post-Internship Survey dataset

A number of internship programs also recognize that a formal or informal mentor or buddy can often support the learning and engagement of interns, Table 12 highlights some of the areas where having a buddy can have an impact.

Variable	No Buddy and/or Intern Mean (SD) N=50	Have Buddy and/or Intern Mean (SD) N=104	t	df	Sig.
My internship project was aligned with my learning interests.	2.86 (1.12)	3.24 (.87)	-2.29	152	.023*
My supervisor effectively facilitated my on-the-job learning.	3.08 (1.12)	3.41 (.83)	-2.07	152	.040*
I received timely feedback about my work.	2.80 (1.01)	3.23 (.75)	-2.96	152	.004**

Table 12. Differences in mean scores based on whether or not interns had a buddy and/ormentor in the 2018 Post-Internship Survey dataset

4.3 How is the internship experience represented in how interns articulate their goals for learning about their work assignment and the organization?

The results reported in Tables 10-12 describe the different contexts and interactions where interns experience learning during their summer work assignment. In order to gain a deeper understanding of the impact of these internship components, the qualitative analyses of the three open-ended questions recognize what interns hoped to gain from their summer experiences and how their learning goals can shape their future career choices at the organization.

In Figure 1, the intern responses to the questions about internship and learning goals from the 2018 Pre-Internship dataset were categorized by the code words provided in Table 3. The "percentage of total interns" represents the percentage of total intern responses for each code word out of the total number of 92 interns. The "percentage of female interns" shown in red represents the total number of female intern responses for each code word out of the 30 female intern participants from the dataset. Similarly, the "percentage of male interns" shown in blue represents the total number of male intern responses for each code word out of the 62 male intern participants.

Figure 1 shows that Technical Skills were the most desired learning goal from the internship experience as reported by both female and male interns. The second and third most desired learning goals for all interns were Contributing to the company and gaining Professional Skills. Figure 1 also shows that both female and male interns share approximately the same interest in

learning about the Technical engineering process, Professional skills, their Fit with the company, and Networking with others in the company.

There are also some disparities between goals of female and male interns. Male interns reported greater interest in Contributing to the company whereas female interns reported more interest in gaining Technical and Professional skills. One in four female interns expressed wanting to connect their summer experience in the industry environment back to their educational experiences (School) whereas one quarter of the male interns reported wanting to learn more about the company (Learn-Company).



Intern Responses Categorized by Code Words

Figure 1. Percentage of female and male intern responses by anticipated learning goals and internship takeaways code words in the 2018 Pre-Internship Survey dataset

The codes described in Table 4 from the open-ended questions about the top organizational factors that would influence an intern's decision to accept a full-time offer focused on Benefits, Job, Environment, Growth, and Organization. The survey responses identified more concrete and quantifiable items the interns were seeking, which were largely grouped under Benefits, Job, and Growth. In contrast, the Environment and Organization codes were typically assigned to responses were more abstract and unique to each intern.

Figure 2 shown below represents the intern responses from the 2018 Pre-Internship dataset were categorized by the code words provided in Table 4. Similar to Figure 1, Figure 2 describe the percentage of intern responses out of the total intern group of 92 interns, the percentage of the female intern responses out of the total number of 30 female interns, and the percentage of the male intern responses out of the total number of 62 male interns.

The qualitative analyses showed that the Organization and Environment of the company were the most critical factors for both female and male interns in their decision about whether or not to accept a job offer if provided. Female interns expressed greater interest in the specifics of the Job as compared to the male interns. Meanwhile, male interns were more likely to prioritize the Benefits of the job and the opportunities for career Growth.



Intern Responses Categorized by Code Words

Figure 2. Percentage of female and male intern responses by factors influencing the decision to accept a job offer code words in the 2018 Pre-Internship Survey dataset

The results from the 2018 Post-Internship survey provide additional quantitative insights into the Environment and Organization coded responses. Using an item indicating the intern's willingness to accept a job offer if provided to create two independent groups, the majority of respondents indicated they would accept an offer. However, the significant differences between the two groups do highlight areas for future intervention. As noted in Table 13 and supported by the findings from the 2017 Post-Internship dataset described in [10], the alignment of work assignment or internship project goals with the intern's interests, the importance of timely and sufficient feedback, and opportunities to interact with and learn from others within the organization are critical factors to be taken into consideration in the design of internship programs.

Variable	Not Accept Offer Mean (SD) N=19	Accept Offer Mean (SD) N=131	t	df	Sig.
My internship project was aligned with my learning interests.	2.21 (1.35)	3.24 (.84)	-3.20	20.09	.004**
My supervisor effectively facilitated my on-the-job learning.	2.47 (1.30)	3.42 (.83)	-3.06	20.16	.006**
I learned from my coworkers during my internship.	3.16 (.95)	3.70 (.57)	-3.48	148	.001**
I had opportunities to network with professionals outside of my team.	3.05 (.78)	3.24 (.70)	-1.05	148	.293
I received sufficient feedback for my professional development.	2.37 (1.06)	2.99 (.89)	-2.76	148	.006**
I received timely feedback about my work.	2.47 (1.12)	3.18 (.79)	-2.65	20.67	.015*
The internship provided me with valuable insight into the practical application of my field of study.	2.47 (1.17)	3.44 (.72)	-3.48	20.04	.002**

Table 13. Differences in mean scores based on whether or not interns would accept an offer ifprovided in the 2018 Post-Internship Survey dataset

5. Discussion and Limitations

The quantitative and qualitative findings about interns' attitudes, perceptions, and goals about their learning experiences across the three datasets in this study provide a multifaceted view of the internship experience and highlights several critical instances for further investigation. It should be acknowledged that one limitation of this research is the use of cross-sectional datasets,

particularly with the 2018 pre- and post-internship surveys. Longitudinal study designs with a standardized instrument to track change and growth over time in specific research variables would result in critical insights and a more nuanced understanding of these short-term and long-term and impact of these hands-on experiences for students.

While cross-sectional methodological approaches may result in useful but limited outcomes, this constraint was partially addressed by analyzing two datasets from interns at the same global engineering company across two years. The study findings were also benchmarked against a subset of comparable engineering students who had also completed an internship or co-op for at least one academic or summer term from the more representative and broadly generalizable Engineering Majors Survey (EMS 1.0) dataset.

The study results also reveal differences based on gender across these analyses. As noted in Table 7, in both the post-internship datasets and the EMS 1.0 dataset, female interns reported lower confidence in their ability to complete engineering tasks (ETSE). This is contextualized with the results of other aspects of the internship experience, including the 2018 female interns reporting lower mean scores than male interns with respect to having a supervisor who effectively facilitated their learning and receiving sufficient and timely feedback. These findings identify a potential opportunity for an intervention, both with respect to encouraging interns perhaps at orientation to be empowered to articulate their goals and to ask questions while also providing guidelines to supervisors on how to set expectations for their interns and schedule regular meetings for feedback and "temperature taking."

Lastly, it is important to note the differences in the learning goals of female and male interns and what they hope to learn about the organization as well as what they consider to be important things to know prior accepting a job offer. These gender differences in motivations may influence decisions to pursue careers in engineering as these students transition from their education into the workplace and graduate work. Further research on these gendered professional experiences may yield insights into how women in engineering experience the work environment and how these experiences may in turn influence female retention in engineering fields and professions.

APPENDIX: Research Implications and Prototypes for Stakeholders

The study findings represent an actionable understanding of how engineering students view engineering internships from the goals they articulate prior to starting their internship and to their academic and career plans upon completion of their internship and as they prepare to leave the company. The Appendix includes some possible directions and preliminary recommendations for how these findings could inform the development of recommendations and best practices for internship stakeholders

Giving and Requesting Feedback

The outcomes of this research suggest that how often and when feedback is given can have a differential impact on how males and females experience their internships. The supervisor plays a critical role in overseeing an intern's work assignment and supporting the intern in the

completion of their project. Therefore, it is crucial for interns to be proactive in communicating with their supervisors regarding their work and internship experience.

Recommendation for Interns

- 1. Know who you can approach to ask for help and address your questions or concerns.
- 2. If you are not provided a specific work plan, talk with your supervisor to understand the project and create a list of tasks and deadlines that will help you complete the project. Show this to your supervisor to confirm that this plan aligns with the project goals.
- 3. If you are unsatisfied with the work assignment, take the initiative to talk with your supervisors and others to explore your interests either through your current project or in other ways at the company.

Supervisors and co-workers are key people who can directly influence a student's internship experience. They have more professional experience and have the authority and credibility that interns can trust for advice and guidance during the internship. To encourage interns to reach their goals during the internship, recommendations for supervisors are provided below.

Recommendations for Supervisors

- 1. Ask your intern about their interests and try to create a good match between their interests and their work assignment.
- 2. Where possible, introduce interns to colleagues/groups who share their interests and/or areas they wish to explore.
- 3. Encourage interns to participate in corporate-sponsored events, social activities, mixers, hackathons, etc. as opportunities to meet and network with other Ford employees and interns.
- 4. Talk with your interns about the "big picture" and how their work contributes to the mission/vision of your group as well as the company.

Professional and Technical Skills

For many students, the internship experience may be the beginning of their career journey and is where they want to learn how to act as a professional in the work environment. Professional skills that interns seek include time management, technical communication (i.e. writing a work email), navigation through work bureaucracy, presentation and public speaking skills, and collaboration and socialization with co-workers in the work environment.

In addition, gaining technical skills are another top priority for students during their internship experience. Below are recommendations for interns as they pursue their internship project and work to reach their learning goals.

Recommendation for Interns

- 1. Tell your supervisor what technical and professional skills you hope to gain and develop a plan for how you can achieve them during your internship experience.
- 2. Know who to reach out to for help or questions (i.e., coworkers, mentors).
- 3. Actively seek out opportunities to learn new skills.

- 4. Seek out advice from your co-workers and supervisor about what the expectations are for professional behavior in meetings, email communication, etc.
- 5. Know that your coworkers understand that you are an intern and may need the first weeks of the internship to navigate through the work environment.

Supervisors know the professional and technical skills that are required of the employees in the company and the resources necessary to acquire and develop these skills. Below are recommendations for supervisors on how they can best help interns gain the skills that they want during the internship.

Recommendations for Supervisors

- 1. Ask your intern(s) about what technical skills and proficiencies they have, emphasizing that the internship experience where they can improve and learn new skills.
- 2. Clarify with your intern what their goals for the internship are and identify where they can apply specific technical and professional skills and also who they can learn from (co-workers, group members).
- 3. Help your intern recognize how what they have learned in school and extracurricular activities can be transferred and applied in the industry environment.
- 4. Inform the intern what your professional expectations are and provide feedback early and often for how they can improve and what they have done well.
- 5. Recognize that interns may not know how to give a presentation, write an email to a vendor, ask questions, etc.
- 6. Help model these skills for your interns and create an environment where they can practice developing these skills and feel comfortable asking questions.

These research-informed recommendations are drawn from Figures 1 and 2 based on the 2018 Pre-Internship Survey dataset coding intern learning goals and job offer considerations and Table 10 showing correlations between Innovation Self-Efficacy (ISE), Engineering Task Self-Efficacy (ETSE), and Career Goals Innovative Work (CGIW) in the 2018 Post-Internship Survey dataset. These recommendations can support the intern's ability to innovate and perform engineering tasks, learn about the applications of their work, gain the professional and technical skills sought, and to gain a better understanding of the company's organization and environment.

Using hypothetical narratives to demonstrate how these recommendations could be implemented

The following is a hypothetical narrative of Billie, a sophomore engineering student, navigating through an internship experience using the Recommendations for Interns. This example highlights the impact of the recommendations since they can provide interns with useful insights and advice on the actions that can be taken to ensure they are benefitting from the internship experience.

Billie is a sophomore engineering student and is excited to embark on a first internship experience. Billie is not sure of what to expect other than from what has been said by friends and peers who have	Challenge : Billie begins the internship and feels like the work assignment was different than what was expected and is uninterested in working on the project.
had previous internship experiences.	Action: Using the advice from the intern recommendations, Billie informs their supervisor
Reading the research-informed intern	of these concerns and shares additional technical
recommendations, Billie learns that many	skills and areas where they would be interested
previous interns seek a satisfactory work assignment, technical skills, and	in working on and developing.
professional skills out of their internship.	Result : The supervisor helps Billie explore other
This resonates with Billie's own goals and	areas within the current project and also
fuels Billie's excitement for the upcoming	introduces them to other employees and groups
internship experience.	who are working on projects closer aligned to Billie's interests.

The following is a hypothetical narrative of Robin, an engineering supervisor, using the Recommendations for Supervisors to help the team's intern continue to make successful progress with their work assignment and reach their personal goals during the internship experience.

Robin is an engineering supervisor and this is the first summer there will be an intern on Robin's team. He has experience guiding employees in the group, but has not experienced guiding a college student in	Challenge : The intern on Robin's team has never worked in an engineering company before and is having trouble interacting with other coworkers and is not making progress on her assigned project.
the work environment.	Action: Robin reads the supervisor recommendations and talks with the intern to
Robin reads the revised, research-informed supervisor recommendations and learns how to be more aware of the student's perspective on the internship experience. He reads about the ways he can be proactive in shaping an enjoyable	inform the intern that everyone on the team is willing to help shape an enjoyable internship experience. Robin encourages the intern to communicate openly to the team and ask for help when needed.
internship and learning experience for the student.	Result : The intern feels more comfortable in the work environment and asks her co-workers questions about the project. With Robin's help, she is able to solve the problems she had been struggling with at the beginning of the internship.

Acknowledgments

This research is supported by the Ford-Stanford Research Alliance. The Engineering Majors Survey research 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 has also been supported with funding from the National Science Foundation (grant number 1636442). The authors also thank the study participants and the members of the Designing Education Lab. We especially appreciate the Ford Human Resources Recruitment team for their invaluable assistance facilitating this research.

References

[1] M.T. Hora, M. Wolfgram, & S. Thompson. "What do we know about the impact of internships on student outcomes? (Research Brief #2)." Center for Research on College-Workforce Transitions, Wisconsin Center for Education Research, University of Wisconsin-Madison, 2017. Retrieved from <u>http://ccwt.wceruw.org/documents/CCWT-report-Designing-Internship-Programs.pdf</u>.

[2] National Association of Colleges and Employers. "Position Statement: U.S. Internships," July 2011. Retrieved from <u>https://www.naceweb.org/about-us/advocacy/position-statement-us-internships/.</u>

[3] National Survey of Student Engagement. Retrieved from http://nsse.indiana.edu/.

[4] G. Kuh, *High-impact educational practices: What they are, who has access to them, and why they matter.* Washington, DC: Association of American Colleges and Universities, 2008.

[5] N. O'Neill, Internships as a high-impact practice: Some reflections on quality. *Peer Review* 12 (4): 4–8, 2010.

[6] M. Schar, S. Gilmartin, B. Rieken, S. Brunhaver, H. Chen, and S. Sheppard, "The Making of an Innovative Engineer: Academic and Life Experiences that Shape Engineering Task and Innovation Self-Efficacy," in *Proceedings of the ASEE Annual Conference & Exposition*, Columbus, Ohio, 2017.

[7] S. Seymour & J. Ray. Useful Internships Improve Grads' Chances of Full-Time Work, Gallup, November 20, 2014. Retrieved from <u>https://news.gallup.com/poll/179516/useful-internships-improve-grads-chances-full-time-work.aspx</u>.

[8] K. Powers, H.L. Chen, K.V. Prasad, S.K. Gilmartin, and S.D. Sheppard, "Exploring how engineering internships and undergraduate research experiences inform and influence college

students' career decisions and future plans," in *Proceedings of the ASEE Annual Conference & Exposition*, Salt Lake City, UT, 2018.

[9] H.L. Chen, K. Powers, K.V. Prasad, M. Anderson, A. Royalty, M. Aquino, S. Gilmartin, and S.D. Sheppard, "A mixed methods approach to understanding how colleges, universities, and employers prepare and support undergraduates in engineering internships," in *Proceedings of the ASEE/IEEE Frontiers in Education Conference*, San Jose, CA, 2018.

[10] M. Trego, H.L. Chen, K.V. Prasad, and S.D. Sheppard, "Exploring the Relationships between Engineering Internships and Innovation and Engineering Task Self-Efficacy," in *Proceedings of the ASEE/IEEE Frontiers in Education Conference*, Cincinnati, Ohio, 2019.

[11] S.K. Gilmartin, H.L. Chen, M.F. Schar, Q. Jin, G. Toye, A. Harris, E. Cao, E. Costache, M. Reithmann, & S.D. Sheppard, "Designing a Longitudinal Study of Engineering Students' Innovation and Engineering Interests and Plans: The Engineering Majors Survey Project. EMS 1.0 and 2.0 Technical Report," Stanford, CA: Stanford University Designing Education Lab, 2017.