# SHOULD I STAY OR SHOULD I GO? INTERESTS, VALUES, FIT, AND RETENTION OF ENGINEERING STUDENTS

BY

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DISSERTATION

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# ABSTRACT

With dropping numbers of high school students interested in pursuing engineering degrees and an increasing demand for engineering graduates in the workforce, it is extremely problematic that an estimated forty to seventy percent of undergraduate engineering students switch to non-engineering majors or drop out entirely. The areas of interests, values, and fit together have not been examined within the engineering population despite a wealth of research pointing to their importance; therefore, the present study assesses engineering students at two time points to examine their interests, values, and various measures of fit as they relate to retention and career plans. A total of 199 engineering students at a large, midwestern university completed surveys during both data collections. Analyses revealed that Holland's (1997) broad model of interests was out-performed by the domain-specific Engineering Interest Intrinsic Value measure when predicting retention-related intentions. Results indicated that value profiles are more informative than interest profiles when predicting engineering students' retention-related intentions early on in their academic careers. Similarly, stability of value profiles rather than stability of interest profiles led to increased intentions to stay in one's engineering major and plans to pursue an engineering-related career. Additionally, higher fit scores strongly related to plans to stay in one's engineering major and to pursue a career in engineering after graduation. Over all, the present study's results indicate that the traditional method of using interest inventories to help determine a student's major, and, in turn, career, should be modified, at least for engineering students. Over all, the present study's results suggest a shift away from the use of broad interest inventories and toward the use of domain-specific interest measures, value profiles, and fit measures to promote retention-related outcomes for engineering students.

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TABLE OF CONTENTS

# CHAPTER 1: INTRODUCTION

Although nationwide efforts have been made to encourage students to pursue majors in scientific, technological, engineering, and mathematical (STEM) fields (National Science Foundation, 2011), a serious problem exists in retention of students with some studies indicating up to 40% of students leave STEM majors for non-STEM alternatives (Daempfle, 2003; Seymour & Hewitt, 1997; Strenta, Elliot, Adair, Matier, & Scott, 1994). Specifically, retention in engineering students has become a national problem (Anderson-Rowland, 2001; French, Immekus, & Oakes, 2003). With dropping numbers of high school students interested in pursuing engineering degrees and an increasing demand for engineering graduates in the workforce, it is extremely problematic that an estimated forty to seventy percent of undergraduate engineering students switch to non-engineering majors or drop out entirely (Hartman & Hartman, 2006; Marra, Rodgers, Shen, & Bogue, 2012; National Research Council, 2007).

Research has identified several potential reasons for this phenomenon including perceived lack of talent, lack of knowledge of science, and a perception of science as an overly-competitive field to pursue (Seymour & Hewitt, 1997; Strenta et al., 1994); most strikingly, loss of interest is the most common reason cited by students explaining their decision to leave STEM majors (Seymour & Hewitt, 1997). Research has also identified the importance of value fit and its relationship with organizational outcomes such as one's decision to stay with an organization; however, value fit as it relates to engineering students has not been extensively examined. Therefore, the present study investigates students' interests and perceived value fit to examine the phenomenon of loss of interest and, ultimately, students' departure from engineering majors and engineering career plans.

The present study assesses engineering students at two time points to examine engineering students' interests, values, and various measures of fit. Plans to stay in one's engineering major, intentions to continue into an engineering-related career, and retention of students in the university are investigated. Analytic procedures to address the present study's hypotheses include structural equation modeling (SEM), correlational analyses, paired *t*-tests, regression analysis, and tests of mediation and moderation. Descriptive analyses are conducted separately by gender and by year in engineering program as well as for the entire sample as a whole.

The areas of interests, values, and fit together have not been examined within the engineering population despite a wealth of research pointing to their importance. Perhaps most strikingly, the phenomenon of "loss of interest"-- despite its prominence in the retention literature-- is not well-defined and, thus, it warrants a closer look. Undergraduate engineering retention across universities is also poorly understood; therefore, the present paper aims to further investigate influences on engineering students' retention-related decisions. It is important to note that the present study was conducted at a university well-renowned for engineering. As a result, the university has a relatively high retention rate so the results of this study may not be generalizable to universities that are not similar top-tier engineering programs with higher than average retention rates.

# CHAPTER 2: LITERATURE REVIEW

In this chapter, I summarize the literature on undergraduate engineering retention. I review interests, values, and fit as they relate to engineering undergraduate students, minority students, and engineering education research pointing toward the importance of interests and values. Reviewing this literature is important to understand the nationwide, unsolved, and ongoing problem of retention in undergraduate engineering majors.

*Undergraduate Engineering Retention Problem*

Retention of engineering students has become a national problem, and thus, a central concern in engineering education (Anderson-Rowland, 2001; French, Immekus, & Oakes, 2003). Research shows that depending on the institution, between forty and seventy percent of students who enter in engineering majors either switch to a non-engineering major or drop out of the university entirely (Hartman & Hartman, 2006). A simultaneous pattern exists of increasing demands for engineers in the workforce and decreasing numbers of students interested in entering universities as engineering majors. Even in institutions with engineering retention rates that are similar to retention rates of other majors, colleges of engineering are motivated to investigate why high achieving, academically thriving students sometimes choose to leave for an alternate major (Gibbons, 2005; Marra, et al., 2012; Min, Zhang, Long, Anderson, & Ohland, 2011; National Science Board, 2006; NSF, 2004). Additionally, retention research is beneficial as it is considerably more cost-effective for universities to retain current engineering students rather than to recruit new ones (Cromley, Perez, & Kaplin, 2015). Given this information, it is not surprising that much research has been dedicated to understanding engineering persistence and retention.

Research shows a surprising lack of consensus concerning *when* students tend to leave engineering. For example, Min et al (2012) found the majority of students who leave engineering exit the major during their first or second semester at the university while Alting and Walser (2007) noted that attrition from engineering is highest during the second and third years of study. Demel, Gustafson, Fentiman, Freuler, and Merrill (2002) found the highest amount of attrition in the most senior students, with attrition numbers increasing as students progress each year through the engineering major. Anderson-Rowland and Urban (2001) cited the first few *weeks* of freshmen year to be the most critical in determining whether a student will choose to stay or leave his or her engineering major. The question of when students are most likely to leave their engineering major has been a focus in research so educators could hypothetically modify educational approaches in attempt to pinpoint, understand, cater to, and ultimately attempt to retain the students most at risk to leave.

Not only is there a lack of consensus about when engineering students are most likely to leave their engineering majors, but there is a problem with the use of the terms “persistence” and “retention,” with many studies not operationally defining these terms. Other researchers have chosen to use the terms differently; for example, Lichtenstein, Chen, Smith, and Maldonado (2014) defined retention as completing an engineering degree and persistence as the process of progressing from one career to another (e.g., transitioning from undergraduate student to graduate student) while Honken and Ralston (2013) defined retention as the percent of students pursuing an engineering degree after one year. Being consistent in the use of the terms “retention” and “persistence” is important so as to get an accurate depiction of how many students are leaving engineering as opposed to transferring or dropping out altogether.

*Previous Research on Retention and Persistence*

Perhaps even more important than *how many* or *when* students choose to leave engineering, is the question of *why* engineering students do not continue with their engineering majors. Considerable research has been conducted to investigate this phenomenon; however, the research does not yet tell a clear story about why so many engineering students choose to leave engineering for other majors (Lichtenstein, et al., 2014). Entry characteristics of students have been cited as potential predictors of retention in engineering. For example, Alting and Walser (2007) found that 31% of the variance in a discriminant analysis was explained by students' total number of credits obtained through completing courses in the first two years of engineering and students' grade obtained in their first college math course together with the criterion being retention after two years. Research has shown time and time again that high school GPA and academic ability of students is not reliably predictive of preparation or retention of engineering students (Bernold, Spurlin & Anson, 2007).

Researchers have moved toward looking at both academic and non-academic factors when trying to solve the puzzle of engineering attrition (Marra, Rodgers, Shen, & Bogue, 2012). Some of these characteristics include gender, students' attitudes toward engineering, self-efficacy, commitment toward getting a degree in engineering, considering other majors before choosing engineering, MBTI scores, grade point average (GPA) after the first year, and ratings of perceived ability (Besterfield-Sacre, Atman, & Shuman, 1997; Borrego, Padilla, Zhang, Ohland, & Anderson, 2005; Felder, Gelder, Mauney, Hamrin, & Dietz, 1994; Honken & Ralston, 2013; Matusovich, Streveller, & Miller, 2010; Seymour & Hewitt, 1997; Zhang, Anderson, Ohland, & Thorndyke, 2004; Veenstra, 2009). Additionally, researchers investigated student-faculty integration, parental influence, rural versus urban backgrounds, confidence in math skills, belongingness, quality of teaching and advising, teaching methods, and perceived difficulty of engineering courses (Besterfield-Sacre, Alman, & Schuman, 1997; Cromley, Perez, & Kaplin, 2015; Demel, Gustafson, Fentiman, Freuler, & Merrill, 2002; Hartman & Hartman, 2006; Honken & Ralston, 2013; Lichtenstein et al., 2014). Despite the wealth of studies and topics investigated, there is still an inadequate understanding of the retention problem in engineering (Marra, et al., 2012). For the purpose of the present study, an extensive review of literature concerning past engineering retention research is important to identify patterns and themes that lead to this paper's focus on interests, values, and fit.

*Women and Minorities in Engineering*

It is well established that retention remains a problem in engineering, especially for women and minority students. For example, of men and women who earned bachelor's degrees in 2009, 8.2% of men compared to only 1.3% of women completed a B.S. in engineering. In response to this, the United States government introduced an initiative to increase women and minorities in engineering (Lichtenstein, et al., 2014). Despite this, retention of women and minorities in engineering remains a problem with two thirds of minority students not earning engineering degrees while two thirds of non-minority students do (Hargrove & Burge, 2002).

Several reasons have been uncovered that may potentially contribute to the disproportionate number of minority students leaving engineering majors. Unsupportive institutional policies, negative classroom environments, importance placed on positive relationships with coworkers, and feelings of isolation have been investigated as likely candidates (Anderson-Rowland & Urban, 2001; Felder et al., 1994; Lichtenstein, et al., 2014). Anderson-Rowland and Urban (2001) made recommendations to improve retention of minority students. These recommendations include promoting positive attitudes toward retention of minorities among faculty and staff, monitoring allocation of resources, focusing on success of freshmen, and providing special programming pointed at promoting a supportive atmosphere.

*Interests in Engineering*

An increasing number of universities have been seeing a pattern of declining enrollment in engineering colleges, which may point to career interests moving away from engineering and toward business (Besterfieled-Sacre et al., 1997). In a study by Felder, Hohr, Dietz, & Baker-Ward (1998), engineering students were asked what motivated them to choose engineering as a major. The most frequent reasons engineering students cited were that they were interested in the field and that they identified with an aptitude in math and science. A quarter of the participants listed an interest in working on socially important issues, but less than 10% of participants listed their decision being influenced by a summer engineering program or friend. In a study by Felder et al. (1994), more male (65%) than female student respondents (44%) noted that interest in the field was an influential factor in choosing an engineering major. Interestingly, although interest in the field of engineering is one of the top reasons students choose engineering majors, loss of interest is also the most common reason cited by students explaining their decision to leave (Seymour & Hewitt, 1997).

With interests playing a central role in students' decisions both to join and to leave engineering majors, it is important to understand vocational interests. Vocational interests are defined as "trait-like preferences to engage in activities, contexts in which activities occur, or outcomes associated with preferred activities that motivate goal-oriented behaviors and orient individuals toward certain environments" (Rounds & Su, 2014, p. 98). Previous reviews of stability of interests over time have all confirmed the trait-like nature of interests (Campbell, 1971; Strong, 1943; Swanson, 1999). For example, a meta-analysis conducted by Low, Yoon, Roberts, and Rounds (2005) found interests increase in stability as individuals age and then change very little after age twenty-five or thirty. In a study by Su et al. (2009), results showed sex differences in interests were smaller for engineering and Social interests in older participants; however, general preferences of men and women toward things and people, respectively, remained. Research also shows that aspects of the environment such as family, culture, or education play a role in shaping interests (Eccles, 1993). Given the national problem of retaining engineering students, it is important to investigate patterns, changes, and stability of interests of these students.

*Expectancy-Value Theory*

Expectancy-Value Theory (EVT) proposes that individuals choose to engage in activities they value and activities in which they expect to succeed. EVT has been applied to various contexts related to achievement such as academics and career choice (Eccles et al., 1983; Matusovich, Paretti, McNair, & Hixon, 2014; Wigfield & Eccles, 2000). Considered a motivation theory, EVT examines beliefs, values, and goals in order to understand people's actions and choices (Matusovich et al., 2014). In EVT, ability-related beliefs and success expectancies are conceptualized as one construct rather than two as suggested by a CFA using data on students grades one through twelve (Eccles and Wigfield, 1995; Eccles et al., 1993). The theory has been empirically tested with results indicating that student performance (e.g., GPA) is affected strongly by students' expectancies for success while student intentions and activity choices (e.g., choice of college courses) are strongly influenced by their "achievement task values" (Jones, Paretti, Hein, & Knott, 2010, p. 321).

A study by Jones et al. (2010) defined three types of EVT values: interest, attainment, and utility values and defined these values to specifically apply to engineering students. First, interest value was defined as "the enjoyment one experiences from engaging in engineering activities, or the interest one has in engineering activities" (p. 320). Second, attainment value was defined as having to do with performing well in engineering. Third, utility value was defined as relating to the usefulness of engineering in terms of long- and short-term goals (Jones et al., 2010). Other values outlined in Eccles et al.'s (1983) description of EVT include intrinsic value, attainment value (importance), and cost value (engaging in one task limits involvement in others) (Jones, et al., 2010).

Two important implications can be garnered from EVT research in engineering. First, EVT considers student interests to be an important type of value. Second, examining values, an understudied area in engineering, is an important step in understanding students' career plans. This is evidenced by the study's finding that when investigating students' plans to be employed in a career in engineering, most of the variance was explained by the value-related constructs (Eccles, 1984a, 1984b; Eccles et al., 1983; Jones, et al., 2010; Meece, Wigfield, and Eccles, 1990). Therefore, in the present study, interests and values are examined individually and extensively as separate constructs. Consistent with vocational psychological measures, this approach captures a broader domain of interests and values and is a route not yet taken in engineering retention research. The present study compares the broader interests approach (i.e., Holland's Theory) to engineering discipline-specific items used in EVT by Jones et al (2010).

**Summary**

The current study will address the lack of research on interests, values, and fit as they relate to undergraduate engineering students and retention. The present study assesses engineering students at two time points to examine engineering students' interests, values, and various measures of fit. By analyzing the understudied areas of student interests, values, and perceived fit concerning the engineering population, a richer understanding of the problematic phenomenon of attrition of engineering students will be gained. Understanding the factors that contribute to loss of engineering students, and conversely, understanding factors that contribute to their retention is important to promote increased diversity and the number of engineers in the workforce post-graduation.

Measuring interests and comparing broader and narrower approaches allow for a more complex look at the stability of interests within the engineering student population; it will also shed light upon interests' potential effects on outcomes such as grades, retention, and plans to pursue a career in engineering post-graduation. Investigating work values— not just the value of engineering— through a(n) vocational/ occupational lens as in the Work Importance Locator is important to identify what persisting and successful engineering students value. Similarly, work values that directly apply to the engineering student experience are examined to identify which students may be at risk to leave engineering as a major or career plan.

Various measures of perceived fit are included to directly examine a student's perception of fit within their environment. These areas of fit have not been specifically applied to an engineering population and include abilities-demands, culture, and person-vocation fit. Understanding patterns of perceptions of fit or lack of fit will help to illuminate problem areas within engineering majors' experiences that may lead to eventual departure from the major or field of engineering. Specific student characteristics such as participation in early experience project-based courses will also be addressed to paint a clearer picture of engineering student retention and career plans.

Due to the importance of increasing diversity and retaining more women in engineering, analyses for male and female engineers are investigated both separately and combined so that both overall patterns and any noteworthy gender differences may be noted. Also, analyses are conducted separately by race/ethnicity and year in engineering to better understand minority experiences and potential cohort effects. Given the aforementioned findings, it hypothesized that student interests, values, and fit play a key role in unraveling the complex mystery of engineering student retention. Therefore, the current study aims to explore interests, values, and perceived fit to better understand retention of engineering students.

*Holland's Theory of Interests*

The model used frequently in vocational interest research is Holland's *theory of vocational personalities and work environments* (Holland, 1997). In this model, Holland organized interests into six types: realistic (R), investigative (I), artistic (A), social (S), enterprising (E), and conventional (C). The ACT Interest Inventory (ACT, 2009) uses more intuitive, alternative titles that map on to Holland's original terminology to describe each interest type. The modified titles are as follows: technical (TE), science and technology (ST), arts (AR), social service (SS), administration and sales (AS), and business operations (BO). For the remainder of the paper, the abbreviation from the ACT Interest Inventory will be used. See Table 2 for each Holland type and its corresponding ACT names and abbreviations.

Each interest type can be characterized in depth; however, for the purpose of this paper, only a brief summary of the interest types will be provided to create a basis for understanding the concept of person-environment fit. Individuals with TE interests are generally focused on working with things rather than people; ST interests tend to go along with enjoyment of research, reading, and discussion to investigate scientific phenomena; individuals with AR interests tend to gravitate toward creative expression and patterns. SS interests are focused on helping people through areas such as education, social work, and counseling; individuals with AS interests enjoy business, leadership, and management positions, and individuals with interests in BO prefer highly structured environments. Just as Holland's (1997) model uses interests to describe people, the theory also uses the six types of interests to depict specific environments. For example, individuals with SS interests are likely to be found in a social environment in which their social needs are met and their interests are fostered (Holland, 1997).

*Work Values*

Work values are defined as particular expressions of values in a work environment. Logically, they refer to values in the workplace; therefore, they are broad in nature. Work values are broad because they aim to answer the question of what an individual values in the workplace in general. Instead of focusing on specific outcomes of particular occupations, work values encompass a wide domain of values. Also, work values relate to desirable outcomes such as promotion or behaviors such as collaboration with teams (Ros, Schwartz & Surkiss, 1999). Work values were chosen for use in this study as they pertain most closely to the sample's work and career plans as an engineering student and future working engineer. In the present study, the Work Importance Locator, which studies a spectrum of work values, is modified to specifically relate to the engineering student population.

**Hypotheses**

As little is known about changes in engineering students' interests and values, part of the current study is descriptive in nature. I develop interest and values profiles for engineering students by year in school. These profiles provide a cross-sectional description of how interests and values change across four years of engineering. I provide a "snapshot" of various groups of students, their interests, values, fit, and other characteristics that may influence their career intentions and plans to remain in or leave engineering as a major.

First, I make predictions about characteristics of the engineering student sample. A composite interest profile is calculated for engineering students in their $4^{th}$ year or above (students who have persisted through their engineering major) and who have indicated that they plan to pursue an engineering-related career, post-graduation. This group is operationally defined as a "persisting engineering group." I hypothesize that when comparing interest profiles of first year engineering students to this persisting engineering group, first year students' whose profiles have a closer fit to the persisting engineering group will be more likely to plan to stay in their engineering major and to plan to pursue an engineering-related career.

Based on the general pattern of interests of those in engineering careers as reported in the O*NET (O*NET Online, 2010), I hypothesize that engineering students will have strong ST and TE interests. In terms of gender, research has shown that female students have lower confidence in their abilities than male students; as such, I hypothesize that male engineering students will have higher abilities-demands fit scores than female engineering students. Due to the abysmal retention rates of minority students reported in the literature, it is unsurprising that minorities may feel a lack of belongingness or "chilly classroom climate" (Lichtenstein et al., 2014). Because fit involves a perceived match between an individual and his or her environment, I hypothesize that minority students will have lower abilities-demand fit and lower culture-fit scores than their non-minority peers.

I predict that students who have taken an IEFX project-based course will be more likely to have career intentions to remain in engineering as a major and as a career post-graduation. The project-based nature experienced early on may better mimic "what it is to be an engineer" than students who take a more traditional course selection in their first year; thus, it may be predicted that the IEFX project-based course may promote intentions to stay in an engineering major and, ultimately, plans to remain in the engineering field post-graduation.

*Hypothesis 1:* When comparing interest profiles of first year engineering students to a persisting engineering group, first year students' whose profiles have a closer fit to persisting engineers will be more likely to plan to stay in their engineering major and to plan to pursue an engineering-related career.

*Hypothesis 1a:* Engineering students will have strong ST and TE interests.

*Hypothesis 1b:* Male engineering students will have higher abilities-demands fit scores than female engineering students.

*Hypothesis 1c:* Racial-ethnic minority students will have lower abilities-demands and culture-fit scores than their non-minority peers.

*Hypothesis 1d:* Students who have taken an IEFX project-based course will have stronger intentions to remain in engineering as a major and as a career post-graduation than students who have not taken an IEFX project-based course.

The loss of interest is cited as the most common reason students decide to leave their engineering major, suggesting a need for a closer look at patterns and changes in interests (Seymour & Hewitt, 1997). Theories like EVT have looked at engineering interests, using two-item "value" measures. These items use a narrow approach, investigating interest in engineering assignments and the general liking of the discipline of engineering (Jones et al., 2010). In contrast, Holland's Theory (1997) uses a broader approach, assessing an array of interests that are not necessarily specific to engineering. By using Holland's Theory to investigate interests, a broad domain of interests can be assessed and a richer understanding of interests may be gained; therefore, I hypothesize that measures using a broader approach to interests (i.e., Mini-IP;

Rounds, et al., 2016) will be more predictive of student major and career intentions than measures with a narrower, more specific approach (i.e., Engineering Intrinsic Interest Value) (Jones et al., 2010).

*Hypothesis 2:* Measures of interest using a broad approach (i.e., Mini-IP; Rounds, et al., 2016) will be more predictive than interest measures with a narrow approach (i.e., Engineering Intrinsic Interest Value).

Third, I hypothesize that interest profiles of students who plan to leave their engineering major or pursue non-engineering careers will be less stable. As individuals working in engineering fields generally have strong ST or TE interests, it stands to reason that students with strong ST or TE interests may be likely to stay in their engineering major and to have engineering-related career plans (O*NET Online, 2010). Thus, I hypothesize that students who have "non-ST" or "non-TE" interests (i.e., AR, SS, AS, or BO) will be more likely to endorse plans to have a career in a non-engineering field and to leave their engineering major.

Various fit measures have been acknowledged in the research as important factors that help determine whether individuals choose to remain in an organization; however, fit has not been extensively examined in terms of engineering students and retention. In this case, "fit" is part of a structural equation model, combining various measures of fit (e.g., culture, person-vocation, etc.) into a larger construct called "fit." I hypothesize that for students who have strong ST or TE interests, fit will mediate the relationship between interests and retention plans. Similarly, I predict that when students have strong ST or TE interests, fit will mediate the relationship between interests and GPA.

*Hypothesis 3:* Interest profiles will be more stable for students who decide to stay in engineering majors and plan to pursue an engineering career. In particular, students who choose to leave their engineering majors will have shifts in their ST and TE interests.

*Hypothesis 3a:* Students who have strong non-ST or non-TE interests will be more likely to endorse plans to have a career in a non-engineering field and to leave their engineering major.

*Hypothesis 3b:* When students have strong ST or TE interests, fit will mediate the relationship between interests and retention. Similarly, when students have strong ST or TE interests, fit will mediate the relationship between interests and GPA.

Fourth, I make predictions about the values of the engineering student sample. Similar to the procedure with interest profiles, a composite value profile is calculated of a persisting engineering group (operationally defined as before). I hypothesize that when comparing value profiles of first year engineering students to this persisting engineering group, first year students' whose value profiles have a closer fit to the values of the persisting engineering group will be more likely to plan to stay in their engineering major and to plan to pursue an engineering-related career. I next hypothesize that engineering students' values will change over the two time points for students who plan to leave engineering majors and those who do not have career intentions to stay in engineering after time point two. Although research shows that work values are highly stable individual differences, work values tend to become more stable after the age of twenty-two (Jin & Rounds, 2012). As the majority of the engineering students in my sample are younger than twenty-two, it is logical to predict that students' values may more subject to change at this younger age. Shifts in values in undergraduate engineering students may shed light on shifting career plans and decisions about leaving engineering majors.

The next hypotheses are based on three values: independence, working conditions, and support. Specifically, I predict that students who are more advanced in academic years will report higher importance of independence and working conditions values. Ideally, engineering students' educations prepare them to be well-equipped to enter the engineering workforce. It logically follows that as students progress, importance placed on the value of independence may also develop. As students continue through their engineering education and approach graduation into the workforce, they may gain a higher awareness of their own preferences for work environments; therefore, they may place more importance on the value of working conditions. Additionally, I predict that valuing support will moderate the relationship between culture-fit and intentions to leave one's engineering major. Students who feel they fit in with the culture may choose to stay within engineering if they value being supported in their engineering major.

*Hypothesis 4:* First year students' whose value profiles have a closer fit to the values of the persisting engineering group will be more likely to plan to stay in their engineering major and to plan to pursue an engineering-related career.

*Hypothesis 4a:* Value profiles will change more over two time points for students who plan to leave engineering and those who plan to pursue non-engineering careers.

*Hypothesis 4b:* Students who are more advanced in academic years will report higher independence and working conditions values.

*Hypothesis 4c:* Support value will moderate the relationship between culture-fit and intention to leave one's engineering major.

Fifth, using the same definition of "fit" as in Hypothesis 2, I predict that as students continue through their academic years, their fit will increase on all three fit measures. As fit has been shown in the literature to relate to choices of individuals to stay in or leave organizations, I predict that fit will function similarly within the engineering student population with fit correlating strongly with plans to stay in engineering majors and engineering career plans. If fit does indeed function similarly, and due to the person-vocation fit measures involving the role of interests, I also hypothesize that person-vocation fit will mediate the relationship between ST or TE interests, and ultimately student major retention and career plans.

*Hypothesis 5*: As students advance through academic years, their fit will increase on all 3 fit measures (i.e., abilities-demands, culture, and person-vocation fit).

*Hypothesis 5a*: High levels of fit on all three measures (abilities-demands, culture, and person-vocation fit) will be strongly related to plans to continue in engineering and engineering employment plans.

*Hypothesis 5b*: Person-vocation fit will mediate the relationship between ST or TE interests and student retention.

# CHAPTER 3: METHOD

The following chapter describes the participants, procedures, and measures involved in the current study.

## Participants

The participants are students who attend a large Midwestern research university and are enrolled as engineering majors in the Colleges of Engineering, Agriculture, or Liberal Arts and Sciences. Students who attend this selective university have a median ACT score greater than 30. Participants must also be eighteen years of age or older. Students were aware that participation in this study is completely voluntary and their decisions to participate will not affect their relationship with the university or future involvement in their respective colleges.

During the first data collection, 586 students responded with completed surveys; during the second data collection, 231 students completed the survey. Surveys that were left blank other than e-mail address to be entered in the lottery to win a prize were not counted in either analysis due to excessive missing data. A total of 199 students completed surveys during both data collections and were able to have their surveys matched. A small number of students (32) during the second data collection were unable to be matched to their time one data collection information due to providing incorrect, non-matching ID numbers, or leaving the survey blank other than their e-mail address. Students were largely from the College of Engineering with 178 students represented, while only 6 students participated from Chemical and Biomolecular Engineering (ChBE) in the College of Liberal Arts and Sciences (LAS). Information about specific majors was not collected.

Participants who completed both surveys identified mainly as White (51.76%), Asian (32.66%), or Multiracial (10.55%). Students who identified as non-White were categorized as minority students for all analyses. The general population of engineering students is composed of around 79% male and 21% female students. In the present study, the participants identified mostly as male (58.29%), female (39.70%), and 2% identified as transgender or "not listed." Thus, female students are overrepresented in these data. See Table 3 for more details on demographic information provided by participants.

**Procedures**

*Consent Procedures and Confidentiality*

Consent was acquired from the students electronically before students could continue with the online survey. Written consent forms were also available upon request. No student from whom I did not have consent took the survey. Individual survey results were held as confidential data and were kept in a password-protected University Box account.

Once participants provided consent, Qualtrics, an online survey software tool, assigned each participant a random four-digit code. The participants were then presented with another link that enabled them to complete the survey. Upon clicking this link, participants were asked to enter their four-digit code. The four-digit code is only to be used to match surveys from data collection at time one to data collection at time two. This procedure ensures that both databases (consent with names and scales) remain separate.

*Survey Administration*

IRB approval was obtained that ensured all guidelines set forth by the APA Ethic's Code (2002) were followed. An email informing engineering students about the importance of the present study, an invitation to participate, and a link to the survey was sent to students in engineering majors in Colleges of Engineering, Agriculture, or Liberal Arts and Sciences. For the first time point of data collection, participants completed their surveys online via Qualtrics toward the end of the second semester of the 2015- 2016 academic year. The survey takes approximately ten minutes to complete.

The second time point for data collection is also an online survey to be completed via Qualtrics and was administered toward the end of the fall semester of the 2016-2017 academic year. Students who provided consent for the first wave of data collection were e-mailed, invited to participate in the second wave of the study. During the second data collection, the participants were presented with the same measures as in data collection wave one to assess change in interests, value fit, and intentions to stay in engineering over time. Several demographic questions (e.g., age verification, race/ethnicity, international student status) were omitted. One demographic question was added to assess potential influence of summer internship/ engineering working experiences. Additionally, two questions were added to assess for satisfaction with success and progress within engineering. The resulting survey takes about eight minutes to complete. At the end of the survey, participants were debriefed with contact information in case they had more questions about the nature of the study.

**Measures**

The survey at wave one consists of demographic/ descriptive questions, an abilities-demand fit measure (3 items), culture-fit measure (1 item), vocation-fit measure (6 items), short vocational interest inventory (30 items), an engineering intrinsic interest measure (2 items), and a short values measure (7 items). Wave two excluded several demographic questions and included two additional questions pertaining to satisfaction within engineering. See appendices for items.

*Demographic Variables*

To complete the survey, participants had to respond “yes” to the questions, “Are you an engineering major?” and “Are you 18 years or older?” as the aim of this study is to solely focus on adult engineering students at a large Midwestern research university. Questions about race/ ethnicity, year in engineering, participation in an Engineering First-Year Experience (IEFX) project-based course, international student status, plans to continue in or leave the College of Engineering, and plans for employment post-graduation were also asked. For race/ethnicity, participants were given the following options of which they could select all that apply: (1) Black/ African American, (2) Latino/ Hispanic, (3) Asian, (4) Native American or Alaska Native, (5) Pacific Islander or Native Hawaiian, (5) White/Caucasian, or (6) Not Listed.

*Abilities-Demands Fit*

Abilities-demands fit measures the perceived fit between an individual's perception of his or her ability level and the perceived demands of the job. A three-item measure of abilities-demands fit (Cable & DeRue, 2002) was edited to apply specifically to the engineering student experience. For example, the phrase "demands of my job" was replaced with "demands of my major" to better describe abilities-demands fit for an undergraduate student population. Students are asked to respond to each item on a 7-point scale with a response of 1 indicating "Not at All" and a response of 7 signifying "Totally." Reliability for Cable and DeRue (2002) abilities-demand fit measure is reported at $\alpha = .89$.

*Culture Scale*

For the purpose of this study, a modified version of Cable and Judge's (1996) one-item measure of perceived culture-fit was used. The original measure (Cable & Judge, 1996) of perceived culture-fit was used as part of the concept of person-organization fit; however, in the present study, modifications were made to directly apply the question to undergraduate engineering students. For example, the phrase "organization and employees" was replaced with the name of the university the students currently attend. Response options span across a 5-point scale ranging from 1 (“Not at All”) to 5 (“Completely”). To verify the reliability of the single-item measure, Cable and Judge (1996) used an extended version of the Culture Scale with two additional items, yielding an estimated internal consistency of α = .87. Additionally, the single-item and three-item Culture Scales were compared with results indicating identical ability of each measure to predict work outcomes (Cable & Judge, 1996).

*Person-Vocation Fit*

The Person-Vocation Fit scale (Vogel & Feldman, 2009) measures perceived fit between interests and skills and the perceived characteristics and requirements of the occupation (Holland, 1985). In an analysis by Vogel and Feldman (2009), the person-vocation fit scale was reported as having an α of .65. A modified, six-item version of the Person-Vocation Fit scale was used to assess person-vocation fit as it relates to engineering students’ perceived fit between their interests and the courses provided by the engineering departments. Students were asked to respond to items such as, “When I think about my interests, I sometimes wonder whether I chose the right department (engineering)” on a 7-point scale with response options ranging from 1 (“Not at all”) to 7 (“Totally”).

*Vocational Interests*

Interests were measured according to Holland’s (1997) six interest types (scale names come from the ACT Interest Inventory; ACT, 2009): technical (TE), science and technology (ST), arts (AR), social services (SS), administration and sales (AS), and business operations (BO). To assess Holland’s interest types, I used the O*NET Mini Interest Profiler (Mini-IP; Rounds et al., 2016) a shortened, 30-item version of the O*NET Interest Profiler Short Form (Short-IP) (Rounds, Su, Lewis, & Rivkin, 2010). For the Interest Profiler students respond to how they would feel about doing various types of work activities; for example, students are prompted with items such as “conduct chemical experiments” or “do volunteer work at a non-profit organization” and are asked to respond on a five point-scale with a response options of 1 (“Strongly dislike”), 2 (“Dislike”), 3 (“Unsure”), 4 (“Like”), and 5 (“Strongly like”). In a psychometric study conducted by Rounds, et al. (2016), the Mini-IP yielded acceptable internal consistencies. Convergent validity was evidenced by high correlations found between scales from the Short-IP and the Mini-IP. According to a cross-classification analysis of the Mini-IP and Short-IP, seventy-three percent of participants would be assigned identical first-letter RIASEC codes. Reported Cronbach’s alphas for the Mini-IP RIASEC scales were between .70 and .75 ($M$ = .73) (Rounds, et al., 2016).

*Engineering Intrinsic Interest Value* (Jones, et al., 2010)

Expectancy-Value Theory (EVT), a motivation theory that examines beliefs, values, and goals, has been applied to academic and career choice outcomes (Eccles et al., 1983; Matusovich, et al., 2014; Wigfield & Eccles, 2000). In a study by Jones et al (2010), EVT values of interest, attainment and utility were defined to specifically apply to engineering students. To examine the domain-specific approach taken in EVT to measure interests in engineering students, a 2-item measure of “interest value” was included. Both items have response options on 7-point scales. For item one, “In general, I find working on engineering-related assignments…” options range from either “very boring” to “very interesting.” For item two, “How much do you like engineering?” options range from “not very much” to “very much.”

*Work Importance Locator* (McCloy, et al., 1999)

The Work Importance Locator (WIL) is a tool used in career counseling to help determine an individual’s profile of work values (i.e., achievement, independence, recognition, relationships, support, and working conditions). Originally developed as a card-sort, individuals rank their work values by organizing paper cards with work-related statements on them. In the present study, the WIL was modified to be administered via online survey; therefore, the original card-sort format was abandoned and an online survey format was adopted with a list of work-related value statements accompanied by response options on a seven-point scale ranging from 1 (“Not important at all”) to 7 (“Totally important”). Each item in the WIL was prefaced by the prompt, “As an engineering student, it is important that…” Individual items such as “I could make decisions on my own” and “I could do something different every day” followed the prompt.

In a study by McCloy, Waugh, Medsker, Wall, Rivkin, & Lewis (1999), the WIL was compared to the well-established Minnesota Importance Questionnaire (MIQ; Weiss, Dawis, & Lofquist, 1967) and found that the instruments identified identical top-two value combinations, on average, around 57% of the time. Additionally, the top value calculated by the WIL was one of the top two values identified by the MIQ 79% of the time (McCloy et al., 1999). For the purpose of this study, the WIL was shortened to 7 items. One item was selected per work value with the exception of “working conditions value” which uses two items to reflect intrinsic and extrinsic aspects of working conditions. Item selection was based upon factor analyses as outlined in McCloy et al.’s (1999) manual on the development of the WIL.

*Subjective Career Success*

In data collection wave two, two items were added to assess for subjective career success. A shortened version of Greenhous et al’s (1990) Subjective Career Success five-item measure was edited to pertain directly to engineering students. For example, the item, “I am satisfied with the success I have achieved in my career” was changed to be “I am satisfied with the success I have achieved in engineering.” Reponses options span across a five-point scale, ranging from

“Strongly Disagree” to “Strongly Agree.” A study by Judge et al. (1995) yielded a Cronbach’s alpha of .74, indicating acceptable internal consistency for Greenhous et al.’s (1990) Subjective Career Success.

### Data Analysis

The present study assesses engineering students at two time points to examine engineering students’ interests, values, and various measures of fit. Plans to stay in one’s engineering major, intentions to continue into an engineering-related career, and retention of students in the university are investigated. Analytic procedures to address the present study’s hypotheses include structural equation modeling (SEM), correlational analyses, paired *t*-tests, regression analysis, and tests of mediation and moderation. Descriptive analyses will be conducted separately by gender and by year in engineering program as well as for the entire sample as a whole. With adequate sample size and few missing cases, listwise deletion was used in the event of missing data.

## CHAPTER 4: RESULTS

The following chapter includes the results of the current study, organized by hypothesis.

*Hypothesis 1:* When comparing interest profiles of first year engineering students to a persisting engineering group, first year students' whose profiles have a closer fit to persisting engineers will be more likely to plan to stay in their engineering major and to plan to pursue an engineering-related career.

To test this hypothesis, I computed the average interest profile for first year students and for the persisting engineering group. Using linear regression (regressing interests of various groups of students on retention-related outcome variables) my hypothesis was not supported. First year students whose profiles had closer fit to persisting engineering students showed no significant differences from first year students with poorer fit in their intentions to leave their engineering major (B = .41, SE = .23, $p$ = .07), continue as an engineering student (B = -.12, SE = .19, $p$ = .53), have a summer internship (B = .20, SE = .19, $p$ = .30), or be employed as an engineer after graduation (B = -.11., SE = .16, $p$ = .50). Holland's (1997) interest types yielded Cronbach's alphas showing acceptable to good reliability (Technical = .81, Science and Technology = .87, Arts = .82, Social Services = .84, Administration and Sales = .82, and Business Operations = .75) during data collection time one and Cronbach's alphas showing acceptable reliability (TE = .72, ST = .78, AR = .79, SS = .74, AS = .73, and BO = .73) at data collection time two.

*Hypothesis 1a:* Engineering students will have strong Science and Technology and Technical interests.

Hypothesis 1a was tested by calculating the average interest scores of all participants. A Tukey HSD multiple comparisons of means test with a 95% family-wise confidence level was used to identify any means that were significantly different from each other. My hypothesis was partially supported with engineering students showing significantly stronger ST interests ($M$ = 3.36) as compared to AR, AS, and BO interests ($p < .05$). Surprisingly, there was not a significant difference between ST interests and SS interests with the engineering students showing an uncharacteristically high interest in SS activities with a mean of 3.24. Furthermore, using a Tukey HSD multiple comparison test, TE interests were found to be significantly different than BO interests, but there were no significant differences between TE interests and AR, SS, or AS interests. See Table 4.

*Hypothesis 1b:* Male engineering students will have higher abilities-demands fit scores than female engineering students.

Using Welch's *t*-test to compare means, my results were consistent with Hypothesis 1b with male engineering students showing significantly higher abilities-demands fit scores ($M$ = 5.80, $SD$ = 1.05) compared to their female engineering student peers ($M$ = 5.57, $SD$ = 0.98); $t(427.43) = 2.57$, $p = .01$, $d = 0.23$. Welch's *t*-test was used for all comparisons made in cases of unequal sample sizes or unequal variances due to Welch's *t*-test's higher reliability compared to Student's *t*-test. See Table 5.

*Hypothesis 1c:* Racial-ethnic minority students will have lower abilities-demands and culture-fit scores than their non-minority peers.

Hypothesis 1c was partially supported by the data with Welch's *t*-tests indicating that racial-ethnic minority students display significantly lower culture-fit scores ($M$ = 4.77, $SD$ = 1.45) than their non-minority peers ($M$ = 5.00, $SD$ = 1.41); $t(576.60) = 1.97$, $p = 0.05$, $d = 0.16$, but not abilities-demands fit scores. Minority students' abilities-demands scores ($M$ = 5.79, $SD$ = 0.98) were significantly *higher* than their non-minority peers ($M$ = 5.63, $SD$ = 1.09); $t(575.67)$ =

-1.94, $d = 0.15$, $p = 0.05$. Students who identified as non-White were categorized as minority students for all analyses. See Tables 6 and 7.

*Hypothesis 1d:* Students who have taken an IEFX project-based course will have stronger intentions to remain in engineering as a major and as a career post-graduation than students who have not taken an IEFX project-based course.

Using Welch's *t*-tests, no significant differences were found between engineering students who have taken an IEFX project-based course and those who have not in terms of their intentions to remain in their engineering majors and plans to remain in an engineering-related field post-graduation. See Table 8.

*Hypothesis 2:* Measures of interest using a broad approach (i.e., Mini-IP; Rounds, et al., 2016) will be more predictive than interest measures with a narrow approach (i.e., Engineering Intrinsic Interest Value).

Findings do not support Hypothesis 2. The Engineering Interest Intrinsic Value measure consistently correlated more highly with intention to stay in engineering (in both data collections time 1 and time 2) than the ST-TE composite scores. For example, during second data collection, the Engineering Interest Intrinsic Value measure correlated with intention to continue as an engineering student at $r = .46$ ($p < .01$), while the ST-TE composite score only correlated at $r = .15$ ($p < .05$).

*Hypothesis 3:* Interest profiles will be more stable for students who decide to stay in engineering majors and plan to pursue an engineering career. In particular, students who choose to leave their engineering majors will have shifts in their ST and TE interests.

Rank order stability, one method of measuring fit, was calculated using correlation to determine whether profiles were similar or not. Specifically, rank order stability is the profile similarity calculated as Pearson's r between the two time points for each participant. No significant differences were found using a Welch two sample *t*-test between engineering students who indicated they are likely to leave and those who indicated they are unlikely to leave their engineering major in terms of the stability of their interest profiles, $t(29.97) = -0.19$, $p = 0.85$.

*Hypothesis 3a:* Students who have strong non-ST or non-TE interests will be more likely to endorse plans to have a career in a non-engineering field and to leave their engineering major.

The data do not support Hypothesis 3a, with Welch's two sample *t*-tests indicating that no significant differences in intention to leave were detected no matter the interest type. Non-significant *p*-values ranged from 0.16 to 0.86. The Welch's *t*-test method was chosen for its increased reliability in the case of two samples that have unequal variances and sample sizes.

*Hypothesis 3b:* When students have strong ST or TE interests, fit will mediate the relationship between interests and retention. Similarly, when students have strong ST or TE interests, fit will mediate the relationship between interests and GPA.

To test mediation, a standard mediation procedure was used and a Bootstrapping approach chosen to test the indirect effect (Baron & Kenny, 1986; Shrout & Bolger, 2002). No significant mediating effect of fit was found between strong ST or TE interests and retention, $\beta = .20$, $p > .05$. Similarly, no significant indirect effects of fit were found mediating the relationship between strong ST or TE interests and GPA, $\beta = -0.16$, $p > .05$.

*Hypothesis 4:* First year students whose value profiles have a closer fit to the values of the persisting engineering group will be more likely to plan to stay in their engineering major (and to plan to pursue an engineering-related career).

Results confirmed Hypothesis 4 with linear regression (regressing value scores on various retention-related outcomes) showing first year students whose value profiles have a closer fit to the values of the persisting engineering group are significantly more likely to stay in their engineering major ($R^2 = .07$, $F(1, 135) = 10.79$, $p < .05$) and plan to pursue an engineering related career ($R^2 = .07$, $F(1, 135) = 9.53$, $p < .05$). See Table 9.

*Hypothesis 4a:* Value profiles will change more over two time points for students who plan to leave engineering and those who plan to pursue non-engineering careers.

Correlations between rank order stability of value profiles (calculated using the same method described in Hypothesis 3) and different measures of intention to stay in engineering were calculated, supporting Hypothesis 4a. Results indicate that students who had more stability in their value profiles over two time points are less likely to leave their engineering major ($r = -0.23$, $p < .05$) and more likely to continue as an engineering student ($r = .29$, $p < .05$). See Table 10.

*Hypothesis 4b:* Students who are more advanced in academic years will report higher independence and working conditions values.

Hypothesis 4b was not supported by these data, with linear regression of year in school on value scores showing no significant differences in independence or working conditions value levels regardless of academic year (adjusted $p > .05$).

*Hypothesis 4c:* Support value will moderate the relationship between culture-fit and intention to leave one's engineering major.

Support value was examined as a moderator of the relationship between culture-fit and intentions to leave engineering. First, support value and culture-fit were entered into the regression analysis. The direct effect of support value yielded $\beta = -.01$ and the direct effect of culture-fit yielded $\beta = -.20$ with $R^2 = .04$. Next, the interaction term was added into the analysis; support value was not confirmed as a moderator of the relationship between culture-fit and intentions to leave engineering ($\beta$ = -.60, $R^2$ = .05, $\Delta R^2$ = .01, $p$ > .05), thus Hypothesis 4c was not supported.

*Hypothesis 5*: As students advance through academic years, their fit will increase on all 3 fit measures (i.e., abilities-demands, culture, and person-vocation fit).

Pairwise comparisons were made using *t*-tests with pooled SD to investigate if levels of abilities-demand, culture, and person-vocation fit increase as students progress in academic years. Tukey HSD multiple comparisons of means found no significant differences in abilities-demands fit or person-vocation fit among academic years. Due to the small number of students who responded in academic years five or six, they were included with those in their fourth year for analysis. Bonferoni was the method chosen for the adjustment of p-values. Using an identical testing procedure, significant differences were found in culture-fit between academic years one and four as well as between academic years two and four [F(3, 191) = 3.77, $p$ < .05]; therefore, Hypothesis 5 was only partially supported by these data.

*Hypothesis 5a*: High levels of fit on all three measures (abilities-demands, culture, and person-vocation fit) will be strongly related to plans to continue in engineering and engineering employment plans.

SEM was the chosen method to test Hypothesis 5a. The model did not converge; thus, an alternative method for testing the hypothesis was employed. Regressing fit on plans to continue in engineering and plans to pursue an engineering-related career, results showed that higher levels of fit predict engineering students' plans to continue in engineering ($\beta = .40$, t(196) = 5.51, $p$ < .05) and plans to be employed in an engineering-related field after graduation ($\beta = .54$, t(196) = 6.94, $p$ < .05).

*Hypothesis 5b*: Person-vocation fit will mediate the relationship between ST or TE interests and student retention.

The mediating effect of person-vocation fit on the relationship between ST or TE interests and student retention was not tested. Because initial analysis of the relationship between ST or TE interests on a student's likelihood to continue in engineering resulted in a negative rather than a positive coefficient (-.38), the mediation model was not tested. In sum, my mediation hypothesis was not tested as a negative relationship between ST or TE interests and likelihood to continue in engineering negated the relevance of the proposed SEM mediation model.

See Tables 12-15 for correlation and intercorrelation tables for relevant variables.

Table 1

*Summary of Hypotheses and Results*

| **Hypotheses** | **Result** | **Explanation of Partially Supported Results** |
|---|---|---|
| Hypothesis 1: When comparing interest profiles of first year engineering students to a persisting engineering group, first year students' whose profiles have a closer fit to this group will be more likely to plan to stay in their engineering major and to plan to pursue an engineering-related career. | Not Supported | |
| Hypothesis 1a: Engineering students will have strong Science and Technology (ST) and Technical (TE) interests. | Partially Supported | ST interests were significantly higher than AR, AS, and BO interests<br><br>No significant differences between ST and SS interests<br><br>TE interests significantly different than BO interests<br><br>No significant differences between TE and AR, SS, or AS interests |
| Hypothesis 1b: Male engineering students will have higher abilities-demands fit scores than female engineering students. | Supported | |
| Hypothesis 1c: Racial-ethnic minority students will have lower abilities-demands and culture fit scores than their non-minority peers. | Partially Supported | Racial-ethnic minority students display significantly lower culture fit scores than their non-minority peers, but not abilities-demands fit scores. |
| Hypothesis 1d: Students who have taken an IEFX project-based course will have stronger intentions to remain in engineering as a major and as a career post-graduation than students who have not taken an IEFX project-based course. | Not Supported | |

Table 1 Continued

| Hypotheses | Result | Explanation of Partially Supported Results |
|---|---|---|
| Hypothesis 2: Measures of interest using a broad approach (i.e., Mini-IP) will be more predictive than interest measures with a narrow approach (i.e., Engineering Intrinsic Interest Value). | Not Supported | |
| Hypothesis 3: Interest profiles will be more stable for students who decide to stay in engineering majors and plan to pursue an engineering career. In particular, students who choose to leave their engineering majors will have shifts in their Science and Technology (ST) and Technical (TE) interests. | Not Supported | |
| Hypothesis 3a: Students who have strong non-Science and Technology (ST) or non-Technical (TE) interests will be more likely to endorse plans to have a career in a non-engineering field and to leave their engineering major. | Not Supported | |
| Hypothesis 3b: When students have strong Science and Technology (ST) or Technical (TE) interests, fit will mediate the relationship between interests and retention. Similarly, when students have strong ST or TE interests, fit will mediate the relationship between interests and GPA. | Not Supported | |
| Hypothesis 4: First year students' whose value profiles have a closer fit to the values of the persisting engineering group will be more likely to plan to stay in their engineering major and to plan to pursue an engineering-related career. | Supported | |
| Hypothesis 4a: Value profiles will change more over two time points for students who decide to leave engineering and those who plan to pursue non-engineering careers. | Supported | |
| Hypothesis 4b: Students who are more advanced in academic years will report higher independence and working conditions values. | Not Supported | |

Table 1 Continued

| **Hypotheses** | **Result** | **Explanation of Partially Supported Results** |
|---|---|---|
| Hypothesis 4c: Support value will moderate the relationship between culture-fit and intention to leave one's engineering major. | Not Supported | |
| Hypothesis 5: As students advance through academic years, their fit will increase on all 3 fit measures (i.e., abilities-demands, culture, and person-vocation fit). | Partially Supported | No significant differences found in abilities-demands fit or person-vocation fit among academic years.<br><br>Significant differences were found in culture-fit between academic years one and four as well as between academic years two and four [$F(3, 191) = 3.77$, $p < .05$] |
| Hypothesis 5a: High levels of fit on all three measures (abilities-demands, culture, and person-vocation fit) will be strongly related to plans to continue in engineering and engineering employment plans. | Supported | |
| Hypothesis 5b: Person-vocation fit will mediate the relationship between Science and Technology (ST) or Technical (TE) interests and student retention. | Not Supported | |

# CHAPTER 5: DISCUSSION

This chapter expands upon the results reported in Chapter Four with a focus on the most salient findings related to engineering students' interests, values and fit. Possible explanations of findings, limitations, and implications for research are discussed.

The comparison of two interest measures, Holland's (1997) RIASEC model and the Engineering Interest Intrinsic Value measure, yielded surprising results in favor of the latter domain-specific interest measure when predicting retention-related intentions (i.e., intentions to stay in one's engineering major and intentions to pursue an engineering-related career post-graduation). After comparing first year students to a group of "persisting engineers," results indicated that value profiles are more informative than interest profiles when predicting engineering students' retention-related intentions early on in their academic careers. Similarly, stability of value profiles rather than stability of interest profiles over two time points led to increased intentions to stay in one's engineering major and plans to pursue an engineering-related career. Additionally, when combining three types of fit (abilities-demands, person-vocation, and culture- fit) into one construct of "fit," higher fit scores strongly related to plans to stay in one's engineering major and plans to pursue a career in engineering post-graduation.

Over all, the present study's results suggest a shift away from the use of broad-band interest inventories and toward the use of domain specific interest measures, value profiles, and fit measures that should be adopted by career counselors and engineering educators who seek to promote positive retention-related outcomes. This study's findings also suggest the need for future research in the following areas: (1) clarification regarding the "loss of interest" phenomenon by using engineering-specific rather than broad interest measures (2) investigation of the emerging importance of values profiles and fulfillment of values via the use of qualitative study (e.g., focus groups), and (3) examination of different types of fit with special attention paid to women and minority students.

*Interests*

A lack of knowledge exists concerning changes in engineering students' interests and values; thus, a descriptive approach was first taken to create a "snapshot" of engineering students across academic years, at two time points. First, testing to see if first year students whose interest profiles were more similar to "persisting engineers" in their fourth year yielded no significant differences in their intentions to stay in engineering or to pursue engineering-related careers post-graduation. The present study's findings do not support Taylor and Hanson's (1972) assertion that decisions to persist or to transfer out of engineering are directly related to interest scores. These results suggest that interest profiles alone are not enough to predict engineering students' plans early on in their academic careers.

As expected, the participating engineering students showed interest codes with high Science and Technology (ST) and Technical (TE) interests, similar to the profiles provided on the O*NET (O*NET Online, 2010); however, the participants showed unexpectedly high levels of Social Services (SS) interests. In fact, their SS interests showed no significant difference from their levels of ST interests. This result is contrary to Taylor and Hanson's (1970) finding that individuals who persist in engineering reject social service interests. It has been consistently shown that females tend to have higher SS interests compared to males (Su & Rounds, 2015). Although female engineering students were overrepresented in the sample, male engineering students also showed unexpectedly high SS interests. A look at SS interest scores by item showed that no one item skewed the data for male nor female students; in other words, SS interests were high across every SS interest item for both male and female engineering students.

It is possible that selection practices at the university influences the type of students in its engineering majors, preferring students who have more SS interests.

Another explanation could be that engineering *students'* interests differ from *working engineers.* It may be the case that factors such as status as a student or age may account for the unexpectedly high level of SS interests in the university engineering student population. Finally, participation bias may affect the "snapshot" of interests found in this study. For example, students who chose to participate may have stronger "helping" tendencies, wanting to contribute to research or aid in improving others' experiences in engineering: both wishes fitting with high SS interests.

Perhaps the most surprising finding in the present study is that the Engineering Interest Intrinsic Value measure (Jones, et al., 2010) consistently correlated more highly with intention to stay in engineering than the Mini-IP's (Rounds, et al., 2016) "ST and TE composite scores" based upon Holland's (1997) theoretical formulations. The Engineering Interest Intrinsic Value measure (Jones, et al., 2010), based upon Expectancy-Value Theory (EVT), may have correlated more highly with intentions to stay in engineering due to its engineering-specific nature, directly assessing how much students like their engineering major in general and how boring or interesting they find their engineering assignments. In contrast, Holland's theory assesses for a broad domain of interests that do not necessarily directly apply to engineering. The results indicate that discipline-specific items should be used. In addition, the results show support Jones et al.'s (2010)'s, Li et al.'s (2008), and Matusovich et al. (2008)'s hypothesis that items derived from EVT may help us better understand persistence and career choices, especially within an engineering population.

As the phenomenon of loss of interest in engineering is cited as the most common reason students decide to leave their STEM major (Seymour & Hewitt, 1997), stability of interests over two time points was investigated. Despite research by Rynes et al. (1988) that asserted occupational choice is an outcome of stable attitudes and beliefs solidified before a college student's graduation, the present study's results indicated that stability of interests did not play a statistically significant role in students' intentions to leave their engineering majors or in their intentions to pursue engineering-related careers. These results point to the possibility that students who claim a "loss of interest" as their reason to leave their engineering major are not describing a shift in their interest profiles as described by psychologists; conversely, they may be referring to another construct entirely such as an increase in boredom or perhaps a shift in work values. More research is needed to investigate this phenomenon.

*Values*

The present study examined engineering students' work values. As shown in Table 11, the average engineering student's top three values are support (being treated fairly by the engineering department), extrinsic working conditions (having good working conditions in a future job), and achievement (making use of one's abilities). Analysis of value preferences by gender revealed that women showed a statistically significant difference in their support value, ranking support more highly important than their male peers. Intrinsic working conditions (variety each day) was consistently ranked among the bottom two work values of engineering students.

According to the O*NET (O*NET Online, 2010), most engineering occupations list achievement and working conditions in their top three values, consistent with the findings of this study; however, the majority of engineering occupations listed on the O*NET (O*NET Online,

2010) also have recognition as one of their top three values which was not consistent with the results of the present study. Due to the literature's lack of agreement on the definition of "values," its use of values as a construct synonymous with "interests," and the variety of ways values have been measured, there is a lack of research pertaining to engineering students' work values as opposed to other types of values (life values, group-oriented values, universal values, culture values, etc.) of engineers already in the workforce. More research is needed to validate the findings in the present study about the work value profiles of undergraduate engineering students.

The results of this study showed that values are more informative than interest profiles in terms of predicting plans to stay in engineering majors or plans to pursue engineering as a career. When first year students' value profiles are similar to the values of a persisting group of engineers, they are likely to endorse plans to stay in their engineering major and plans to pursue an engineering-related career. Similarly, stability of value profiles over two time points leads to increased intentions to stay in one's engineering major and plans to pursue an engineering-related career. These findings are in line with previous research asserting that values are important influences in career decision-making, satisfaction, and exploration (Dawis & Lofquist, 1984; Judge & Bretz, 1992). Values and career decisions have been explored by Brown and Crace (1996) who state that values' role in career decisions depend upon the priority level of values (high or low) of the value; however, Dobson et al.'s (2014) research purports the role of values on decisions remains unclear and that an alternate method of measuring values should be pursued in future research.

Studies have shown that over time, individuals tend to accept the values of their employing organization (e.g., Hall, Schneider, & Nygren, 1975; Hinrichs, 1964). It is possible that engineering students experience the same phenomenon of assimilation of work values after persisting in their chosen major. In sum, drastic shifts in an engineering student's value profile could be seen as an indicator that the student is more likely to leave their major and pursue a non-engineering career. The finding that values have an important role in predicting retention-related intentions is consistent with previous research that linked the correspondence of values and attitudes of students and those of the institution with an increased likelihood to persist at the institution (Hoffman & Woehr, 2006; Pantages & Creedon, 1978; Taylor & Whetstone, 1983).

*Fit*

Recent research suggests that the match between a student and their academic environment is vital for achieving positive student outcomes (Porter & Umbach, 2006). When investigating the role of various types of fit pertinent to an academic environment (abilities-demands, culture, and person-vocation fit) in relation to years spent in one's engineering major, there were no significant differences observed in students' abilities-demands fit nor differences for their person-vocation fit year to year; however, fit became salient in terms of cohort when investigating culture-fit. Fourth year engineering students showed significantly higher culture-fit than students in their first or second years. In other words, the longer a student persists in their engineering major, the more fit they tend to feel with the engineering department culture. Attending to culture-fit is important because research in organizational psychology shows the match between culture and value preferences of employees is a predictor of turnover (O'Reilly, Chatman, & Caldwell, 1991; Vandenberghe, 1999). It is important to note that the purpose of investigating culture-fit is not to change the student nor influence admission procedures for engineering students; rather, its purpose is to inform the potential creation of ways to change the engineering environment to better serve students by increasing feelings of inclusion and acceptance and to promote retention.

Previous research shows that person-organizational fit (related to abilities-demands fit, person-vocation fit, and culture-fit) is predictive of job turnover (Kristof, 1996; Schneider, 1987). As expected, the present study showed fit does indeed function similarly in terms of its predictability within organizations as it does in the engineering setting. Higher fit scores (combining all three measures into the construct of “fit”) are strongly related to plans to stay in one’s engineering major and plans to pursue a career in engineering post-graduation. Logically, further review of culture-fit and work values as they relate to undergraduate retention may heed similar results, helping to uncover the complex puzzle of engineering student retention.

Research shows that male engineering students tend to attribute subpar academic performance to being treated unfairly or to lack of hard work while female students link their poor performance to a perception of lack of ability (Felder, et al., 1994). Unsurprisingly, the present study found, as expected, that men have higher abilities-demands fit scores compared to their female peers. Consistent with the literature that states that female students tend to have lower confidence in their math abilities than male students (Marra et al., 2012; Ridgeway, 2009; Ridgeway & Correll, 2004) the results indicate that female students perceive less fit between their abilities and the demands of their engineering major. This finding highlights a problematic phenomenon represented in STEM disciplines across the country, showing a particular dearth in female interest and retention of female students in engineering. As abilities-demands fit has been linked to job turnover, building confidence in female students’ abilities as they relate to the demands of their engineering majors may be key in promoting female student retention and success (Jui-Chen, Yin Ling, & Mei-Man, 2014).

It has also been reported that rates of retention for minority students in engineering are very low (Anderson-Rowland & Urban, 2001; Felder et al., 1994; Hargrove & Burge, 2002); they may feel a lack of belongingness or a "chilly classroom climate," dissuading them from pursuing or persisting in an engineering major (Lichtenstein, et al., 2014). Previous research suggests increasing culture-fit by emphasizing values and goals, seeking to reduce turnover (Kristof, 1996). The results of the present study indicate that minority students have lower culture-fit than their non-minority peers. This brings to light the question, "How can the culture surrounding engineering majors shift to be more inclusive and welcoming to minority students?"

Although minority students reported lower culture-fit, they did not show lower abilities-demands fit when compared with non-minority engineering student peers. In other words, minority students do not necessarily doubt the match between their abilities and the demands of their engineering majors, but they do perceive a lack of culture-fit. As almost 33% of the participants in the present student identified as Asian, it is possible that this finding may be rooted in the "model minority" stereotype, a stereotype that Asians are successful in science and technology, hard-working, studious, and smart (Sue, 2003). In sum, it is possible that internalized stereotypes within the minority student sample may have affected levels of abilities-demands fit. More research is necessary to investigate other potential causes of this result.

*Limitations*

A limitation of this study is that it included only two time points for data collection. Without the limitation of time restriction, data could be collected over the span of each cohort's journey from freshmen year until senior year, providing a richer understanding of patterns and changes in interests, values, and fit. Another limitation in this study lies in the phenomenon of participation bias. It is possible that students who chose to participate in the study share certain characteristics in common. For example, the results showed unexpectedly high levels of Social Services (SS) interests among participants. One possible explanation is that those with "helping interests" were more likely to participate than their engineering peers with lower levels of SS interests.

When working with engineering students, I realized that the brevity of the survey is of the utmost importance. On average, engineering students at the university do not fill out surveys longer than 5 minutes in length. To ensure adequate participation, full measures and some follow-up questions were simply unable to be included for the sake of brevity.

*Implications for Research and Future Directions*

After this preliminary investigation of engineering students' interests, values, and fit over two time points, several areas in need of additional study emerged. First, the central role of interests in engineering students' decisions to leave engineering needs further research. The results of this study did not show large loss of interest in ST or TE interest types as would be expected, given the engineering retention literature. Before eliminating the use of interest inventories to study engineering students, future research should investigate the role of basic interests rather than the broad interest types presented in this study. By researching specific rather than broad interests (e.g., interests that directly relate to engineering), important information may be gathered, shedding light on the phenomenon of "loss of interest."

Simultaneously, the Engineering Intrinsic Interest Value measure should again be put to the test. Used by researchers in engineering as an "interest" measure, it colludes what researchers in psychology would consider two separate constructs: interests and values. Future research should investigate engineering students' description of "losing interest." Based upon the two items in the Engineering Intrinsic Interest Value measure, it could be hypothesized that students may in fact be describing increased boredom and distaste for engineering homework rather than shifts in their interest profiles as defined by Holland's Theory of Vocational Interests.

Second, further research should be conducted concerning values within engineering. The results of this study show that stability of values and similarity of values to a persisting group are predictive factors in retaining engineering majors and maintaining students' interests in pursuing engineering-related careers. Due to the "snapshot" approach of the present study, information has not been obtained concerning specific actions faculty can take to promote the *fulfillment* of engineering students' values. This information could be obtained via focus groups.

For example, engineering students should be asked what it means to them to have good working conditions, to be treated fairly by their department, and to make use of their abilities. These questions represent the top three values of engineering students (extrinsic working conditions, support, and achievement, respectively). Responses to these questions could provide increased insights into values held within the engineering student community; thus, educators may use their results to adjust curriculum, policies, departmental goals, or department-student relations to better fit the values of their students.

Third, a deeper study of fit should be pursued to identify implications for practice for engineering faculty as well as career counselors. Three types of fit were selected in the present study (abilities-demands, culture, and person-vocation fit). When all three types of fit were combined into a larger construct of "fit," students with higher fit indicated they were more likely to stay in their engineering majors and to pursue a career in engineering. Future research should investigate different types of fit with special attention paid to women and minority students.

Researchers should identify ways in which faculty and career counselors could promote fit within the engineering student body. For example, research is needed to depict what students mean by "the engineering culture." By gathering this information, important insights may be gained by deconstructing the concept of "engineering culture," establishing a campus-wide "engineering identity," and understanding decision-making related to perceived fit or identification with membership in "the engineering culture." Alternatively, future research could benefit from focusing on a more specific view of "engineering culture" by investigating facets of engineering microenvironments; for example, how may the environment of the type of engineer (e.g., chemical, nuclear, civil, electrical, etc.) affect interests, values, and fit to the department? Each engineering discipline may hold important insights into patterns of interests, values, fit, and retention based upon their distinct engineering subcultures.

Fourth, further investigation of the first year experience is warranted. In the present study, the role of the IEFX projects-based course was investigated as it relates to intentions to stay in one's engineering major and plans to pursue a career in an engineering field post-graduation. Results suggest that the IEFX projects-based course was not influential in terms of staying in one's engineering major nor did it influence plans to remain in the engineering field post-graduation. Two possible explanations include: (1) the IEFX projects-based course does not effectively mimic "what it is to be an engineer," especially with an audience of inexperienced, first year students or (2) *enrollment* in the IEFX projects-based course is not sufficient to influence career plans of plans to stay or leave one's major, but *enjoyment* of the course may be more predictive. Future research should collect data on levels of enjoyment of the IEFX projects-based course as well as students' and faculty members' perceptions of "what it is to be an engineer." Qualitative analysis could highlight similarities and differences between student and faculty perceptions of "what it is to be an engineer" which may provide useful information for improving engineering students' first year experience courses.

Fifth, modifying the present study to follow cohorts over the span of their entire academic careers will provide a deeper understanding of trends in the engineering student population. Data collection should expand to include participants who are graduated students during their first year in the working world. By investigating shifts in values and fit within an academic environment versus values and fit expressed in a job setting, both engineering educators and career counselors could obtain useful information about how to help prepare and guide students for the transition from academia to the working world.

Finally, there is an opportunity for researchers to investigate a subpopulation of engineering students: the "persisting engineers." Much attention has been paid to students who have decided to leave their engineering majors. More research is needed to understand what characteristics are shared by students who persist in their majors and pursue engineering-related careers.

## TABLES

Table 2

*Interest Types and Abbreviations*

| Original Holland Type | Holland Type Abbreviations | Corresponding ACT Interest Type | ACT Interest Type Abbreviations |
|---|---|---|---|
| Realistic | R | Technical | TE |
| Investigative | I | Science and Technology | ST |
| Artistic | A | Arts | AR |
| Social | S | Social Services | SS |
| Enterprising | E | Administration and Sales | AS |
| Conventional | C | Business Operations | BO |

Table 3

*Participant Demographic Information*

| Characteristics | *n* | % |
|---|---|---|
| Sex | | |
| Male | 116 | 58.29 |
| Female | 79 | 39.70 |
| Transgender | 2 | 1 |
| Not Listed | 2 | 1 |
| Race/ Ethnicity | | |
| Black/ African American | 3 | 1.51 |
| Latino/ Hispanic | 6 | 3.02 |
| Asian | 65 | 32.66 |
| Native American or Alaska Native | 0 | - |
| Pacific Islander or Native Hawaiian | 0 | - |
| White/ Caucasian | 103 | 51.76 |
| Multiracial | 21 | 10.55 |
| Not Listed | 1 | 0.50 |
| International Status | | |
| International | 15 | 7.54 |
| Domestic | 184 | 92.46 |
| Year | | |
| First Year | 57 | 28.64 |
| Second Year | 52 | 26.13 |
| Third Year | 54 | 27.14 |
| Fourth Year | 33 | 16.58 |
| Fifth Year | 2 | 1.01 |
| Sixth Year | 1 | 0.50 |

*Note*. $N$ = 199.

Table 4

*Average Holland (1997) Interest Scores at Time 1*

| Interest Type | *M* | *SD* | Skewness | Kurtosis | *SE* |
|---|---|---|---|---|---|
| TE | 3.14 | 0.74 | -0.43 | 0.03 | 0.03 |
| ST | 3.36 | 0.78 | -0.31 | -0.32 | 0.03 |
| AR | 2.97 | 0.82 | 0.02 | -0.33 | 0.03 |
| SS | 3.24 | 0.72 | -0.33 | -0.03 | 0.03 |
| AS | 3.01 | 0.71 | -0.15 | -0.27 | 0.03 |
| BO | 2.82 | 0.68 | 0.12 | -0.17 | 0.03 |

*Note*. *N* = 583. TE = Technical, ST = Science and Technology, AR = Arts, SS = Social Services, AS = Administration and Sales, BO = Business Operations.

Table 5

*Gender Differences in Abilities-Demands Fit*

| | *M* | *SD* | Difference | *t* | *d* | *df* | *p* |
|---|---|---|---|---|---|---|---|
| Male | 5.80 | 1.05 | 0.23 | 2.57 | 0.23 | 427.43 | 0.01 |
| Female | 5.57 | 0.98 | | | | | |

*Note*. *N* = 141 (n female = 51, n male = 90).

Table 6

*Racial Ethnic Minority Students and Abilities-Demands Fit*

| | *M* | *SD* | Difference | *t* | *d* | *df* | *p* |
|---|---|---|---|---|---|---|---|
| Majority | 5.63 | 0.98 | -0.17 | -1.94 | 0.15 | 575.67 | 0.05 |
| Minority | 5.79 | 1.09 | | | | | |

*Note*. *N* = 141 (n non-minority students = 79, n minority students = 62).

Table 7

*Racial Ethnic Minority Students and Culture-Fit*

| | *M* | *SD* | Difference | *t* | *d* | *df* | *p* |
|---|---|---|---|---|---|---|---|
| Majority | 5.00 | 1.41 | 0.23 | 1.97 | 0.16 | 576.60 | 0.05 |
| Minority | 4.77 | 1.45 | | | | | |

*Note.* *N* = 141 (n non-minority students = 79, n minority students = 62).

Table 8

*IEFX Projects-Based Course Participants and Retention-Related Outcomes*

| Outcome | IEFX | | No IEFX | | Difference | *t* | *df* | *p* |
|---|---|---|---|---|---|---|---|---|
| | *M* | *SD* | *M* | *SD* | | | | |
| Leave major | 1.41 | 0.86 | 1.41 | 0.87 | 0.00 | 0.00 | 259.02 | 1.00 |
| Continue | 4.66 | 0.79 | 4.58 | 0.91 | 0.08 | 1.03 | 293.95 | 0.30 |
| Internship | 4.12 | 1.17 | 4.03 | 1.24 | 0.09 | 0.80 | 271.91 | 0.42 |
| Employed | 4.17 | 1.13 | 4.25 | 1.05 | -0.08 | -0.73 | 239.47 | 0.47 |

*Note.* N = 141 (n IEFX = 39, n No IEFX = 102).

[a.] All outcomes are based on self-reported intentions with the question stem, "How likely do you believe you are to…"

[b.] Leave Major= leave your engineering major before you graduate; Continue = continue as an engineering student; Internship= have a summer internship; Employed= be employed as an engineer after graduation.

[c.] IEFX = have taken or are now taking an IEFX projects-based course; No IEFX = have NOT taken and are not now taking an IEFX projects-based course.

Table 9

*Retention-Related Outcomes of First-Year Students with Value Profiles Similar to Persisting Engineering Students*

| Outcome | Regression results | | | | |
|---|---|---|---|---|---|
| | B | *SE* | R^2 | F | *p* |
| Leave major | 0.45 | 0.31 | 0.01 | 2.02 | 0.16 |
| Continue | 0.83 | 0.25 | 0.07 | 10.79 | 0.00 |
| Internship | 0.31 | 0.26 | 0.01 | 1.49 | 0.22 |
| Employed | 0.95 | 0.31 | 0.07 | 9.53 | 0.00 |

*Note. N* = 137. All outcomes are based on self-reported intentions with the question stem, "How likely do you believe you are to…"

[a.] Leave Major= leave your engineering major before you graduate; Continue = continue as an engineering student; Internship= have a summer internship; Employed= be employed as an engineer after graduation.

Table 10

*Correlation of Rank Order Stability of Values and Measures of Intention to Leave*

| Time 1 | r | *p* | *N* |
|---|---|---|---|
| Leave Major | -0.17 | 0.03 | |
| Continue | 0.03 | 0.68 | 167 |
| Internship | -0.05 | 0.49 | |
| Employed | 0.01 | 0.93 | |
| **Time 2** | **r** | ***p*** | ***N*** |
| Leave Major | -0.23 | 0.00 | |
| Continue | 0.29 | 0.00 | 168 |
| Internship | 0.10 | 0.22 | |
| Employed | 0.05 | 0.51 | |

*Note.* All outcomes are based on self-reported intentions with the question stem, "How likely do you believe you are to…"

[a.] Leave Major= leave your engineering major before you graduate; Continue = continue as an engineering student; Internship= have a summer internship; Employed= be employed as an engineer after graduation.

Table 11

*Average Value Profile for Engineering Students and Corresponding Items*

| | | |
|---|---|---|
| 1 | Support | I would be treated fairly by the engineering department |
| 2 | WC_Extrinsic | My future job would have good working conditions |
| 3 | Achievement | I make use of my abilities |
| 4 | Independence | I could make decisions on my own |
| 5 | Relationships | My engineering classmates would be easy to get along with |
| 6 | Recognition | I could receive recognition for the work I do. |
| 7 | WC_Intrinsic | I could do something different every day. |

*Note.* n = 199; WC = Working Conditions

Table 12

*Correlations Matrix for Key Variables Time 1*

| Variable | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Gender | - | | | | | | | | | | | |
| 2. IEFX | 0.00 | - | | | | | | | | | | |
| 3. GPA | -0.08 | 0.02 | - | | | | | | | | | |
| 4. TE | -0.13** | -0.05 | -0.11** | - | | | | | | | | |
| 5. ST | 0.07 | -0.02 | 0.02 | 0.18** | - | | | | | | | |
| 6. AR | 0.14** | 0.03 | -0.09* | 0.17** | 0.24** | - | | | | | | |
| 7. SS | 0.17** | 0.03 | -0.03 | 0.20** | 0.30** | 0.34** | - | | | | | |
| 8. AS | -0.02 | -0.03 | -0.19** | 0.05 | 0.08* | 0.21** | 0.35** | - | | | | |
| 9. BO | 0.05 | -0.06 | -0.10* | 0.52** | 0.17** | 0.13** | 0.12** | 0.16 | - | | | |
| 10. Abilities-Demands Fit | -0.12** | 0.04 | 0.33** | 0.08 | 0.02 | -0.07 | -0.02 | 0.01 | -0.01 | - | | |
| 11. Person- Vocation Fit | -0.06 | 0.04 | 0.24** | 0.08 | 0.10* | 0.01 | 0.03 | -0.05 | 0.05 | 0.65** | - | |
| 12. Culture-Fit | -0.02 | -0.06 | 0.24** | 0.11* | 0.08 | -0.11** | -0.04 | -0.02 | 0.02 | 0.56** | 0.49 | - |
| 13. Achievement | -0.06 | 0.02 | 0.12** | 0.11** | 0.12** | 0.07 | 0.03 | 0.04 | -0.04 | 0.31** | 0.34** | 0.23** |
| 14. Independence | -0.09* | 0.02 | 0.06 | 0.07 | 0.07 | 0.07 | 0.05 | 0.15** | -0.09* | 0.25** | 0.20** | 0.16** |
| 15. Recognition | 0.04 | 0.05 | 0.10* | -0.06 | -0.01 | 0.02 | 0.00 | 0.15** | -0.05 | 0.16 | 0.20** | 0.15 |
| 16. Relationships | 0.04 | 0.00 | 0.08 | 0.01 | 0.08 | 0.10* | 0.17** | 0.08 | 0.00 | 0.06 | 0.18** | 0.15** |
| 17. Support | 0.11* | 0.01 | 0.10* | 0.04 | 0.08 | 0.04 | 0.11** | -0.04 | 0.01 | 0.23* | 0.22** | 0.20** |
| 18. WC_Intrinsic | 0.06 | 0.02 | 0.01 | 0.02 | 0.08 | 0.13** | 0.12** | 0.17** | -0.02 | 0.01 | 0.12** | 0.12** |
| 19. WC_Extrinsic | 0.05 | 0.04 | 0.04 | -0.02 | 0.10* | 0.01 | 0.12** | 0.02 | -0.02 | 0.20** | 0.23** | 0.17** |
| 20. Engineering Intrinsic Interest Value | -0.04 | 0.03 | 0.11** | 0.19** | 0.11** | -0.07 | -0.02 | -0.05 | 0.11** | 0.59** | 0.66** | 0.54** |
| 21. Leave Major | 0.07 | 0.00 | -0.13** | 0.01 | 0.04 | 0.12** | 0.06 | 0.07 | 0.07 | -0.32** | -0.13** | -0.20** |
| 22. Continue | -0.12** | -0.04 | 0.13** | 0.02 | 0.00 | -0.10* | 0.00 | 0.07 | 0.00 | 0.35** | 0.22** | 0.28** |
| 23. Internship | 0.02 | -0.03 | 0.08 | -0.03 | -0.05 | -0.06 | 0.11* | 0.15** | -0.05 | 0.25** | 0.17** | 0.22** |
| 24. Employed | -0.08* | 0.03 | 0.12** | 0.14** | -0.03 | -0.10* | 0.00 | 0.03 | 0.03 | 0.42** | 0.25** | 0.37** |

Table 12 Continued

| Variable | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *M* | 1.37 | 1.74 | 3.39 | 15.71 | 16.82 | 14.86 | 16.18 | 15.07 | 14.08 | 16.59 | 29.90 | 4.89 |
| *SD* | 0.51 | 0.44 | 0.45 | 3.69 | 3.89 | 4.11 | 3.59 | 3.57 | 3.41 | 3.56 | 6.23 | 1.43 |

*Note*. $N$ = 569-586. ** $p < .05$ (two-tailed). ** $p < .01$ (two-tailed). IEFX = have taken or are now taking an IEFX projects-based course, TE = Technical, ST = Science and Technology, AR = Arts, SS = Social Services, AS = Administration and Sales, BO = Business Operations, WC = Working Conditions, Leave Major= leave your engineering major before you graduate; Continue = continue as an engineering student; Internship= have a summer internship; Employed= be employed as an engineer after graduation.

Table 12 Continued

| Variable | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 13. Achievement | - | | | | | | | | | | | |
| 14. Independence | 0.55** | - | | | | | | | | | | |
| 15. Recognition | 0.19** | 0.27** | - | | | | | | | | | |
| 16. Relationships | 0.11** | 0.14** | 0.32** | - | | | | | | | | |
| 17. Support | 0.24** | 0.23** | 0.26** | 0.34** | - | | | | | | | |
| 18. WC_Intrinsic | 0.17** | 0.19** | 0.27** | 0.22** | 0.21** | - | | | | | | |
| 19. WC_Extrinsic | 0.26** | 0.26** | 0.32** | 0.39** | 0.50** | 0.24** | - | | | | | |
| 20. Engineering Intrinsic Interest Value | 0.31** | 0.20** | 0.07 | 0.12** | 0.21** | 0.06 | 0.18* | - | | | | |
| 21. LeaveMajor | -0.07 | -0.06 | -0.01 | 0.04 | -0.05 | 0.09* | -0.06 | -0.19* | - | | | |
| 22. Continue | 0.12** | 0.07 | 0.01 | 0.01 | 0.04 | -0.04 | 0.04 | 0.27** | -0.44** | - | | |
| 23. Internship | 0.12** | 0.12** | 0.09* | 0.09* | 0.10* | 0.09* | 0.06 | 0.22** | -0.04 | 0.22 | - | |
| 24. Employed | 0.20** | 0.17** | 0.06 | 0.05 | 0.17** | -0.07 | 0.16** | 0.43** | -0.25** | 0.35** | 0.34** | - |
| *M* | 8.17 | 8.12 | 7.31 | 7.31 | 8.40 | 7.07 | 8.39 | 14.19 | 1.41 | 4.60 | 4.05 | 4.23 |
| *SD* | 0.93 | 0.97 | 1.56 | 1.38 | 0.97 | 1.40 | 0.86 | 3.76 | 0.87 | 0.88 | 1.22 | 1.07 |

*Note*. $N$ = 569-586. ** $p$ < .05 (two-tailed). ** $p$ < .01 (two-tailed). IEFX = have taken or are now taking an IEFX projects-based course, TE = Technical, ST = Science and Technology, AR = Arts, SS = Social Services, AS = Administration and Sales, BO = Business Operations, WC = Working Conditions, Leave Major= leave your engineering major before you graduate; Continue = continue as an engineering student; Internship= have a summer internship; Employed= be employed as an engineer after graduation.

Table 13

*Correlations Matrix for Key Variables Time 2*

| Variable | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Gender | - | | | | | | | | | | | | |
| 2. IEFX | 0.05 | - | | | | | | | | | | | |
| 3. GPA | -0.30** | -0.04 | - | | | | | | | | | | |
| 4. TE | -0.02 | 0.02 | -0.11 | - | | | | | | | | | |
| 5. ST | 0.18* | 0.03 | -0.07 | 0.17* | - | | | | | | | | |
| 6. AR | 0.17* | 0.09 | -0.11 | 0.26** | 0.31** | - | | | | | | | |
| 7. SS | 0.26** | 0.14 | -0.20** | 0.14 | 0.35** | 0.33** | - | | | | | | |
| 8. AS | -0.03 | 0.07 | -0.15* | 0.08 | 0.13 | 0.41** | 0.33** | - | | | | | |
| 9. BO | 0.22** | -0.05 | -0.08 | 0.54** | 0.20** | 0.23** | 0.20** | 0.18* | - | | | | |
| 10. Abilities-Demands Fit | -0.22** | 0.13 | 0.16* | 0.20** | 0.05 | 0.05 | -0.02 | 0.02 | 0.03 | - | | | |
| 11. Person- Vocation Fit | -0.02 | 0.12 | 0.14 | 0.18* | 0.10 | 0.00 | 0.01 | -0.06 | 0.13 | 0.54** | - | | |
| 12. Culture-Fit | -0.08 | -0.02 | 0.22** | 0.17* | 0.05 | 0.04 | -0.04 | 0.00 | 0.14 | 0.56** | 0.38** | - | |
| 13. Achievment | 0.06 | -0.07 | -0.01 | 0.05 | 0.54* | -0.01 | 0.03 | -0.02 | -0.04 | 0.25** | 0.33** | 0.30** | - |
| 14. Independence | 0.04 | -0.03 | 0.02 | 0.13 | 0.13 | 0.09 | 0.09 | 0.02 | -0.06 | 0.30** | 0.21** | 0.33** | 0.63** |
| 15. Recognition | -0.05 | 0.14 | 0.03 | -0.01 | 0.14 | 0.11 | 0.04 | 0.21** | -0.09 | 0.14 | 0.07 | 0.16* | 0.32** |
| 16. Relationships | 0.07 | 0.00 | 0.02 | 0.06 | 0.05 | 0.09 | 0.16* | 0.07 | 0.14 | 0.10 | 0.21** | 0.21* | 0.30** |
| 17. Support | 0.22** | -0.07 | 0.01 | 0.12 | 0.15* | 0.10 | 0.13 | -0.01 | 0.08 | 0.18 | 0.25** | 0.22** | 0.39** |
| 18. WC_Intrinsic | 0.18* | -0.02 | -0.07 | 0.17* | 0.17* | 0.16* | 0.21** | 0.25** | 0.16* | 0.00 | 0.17* | 0.17* | 0.24** |
| 19. WC_Extrinsic | 0.12 | -0.06 | -0.09 | 0.07 | 0.18* | 0.01 | 0.07 | -0.09 | -0.04 | 0.21** | -0.24** | 0.12 | 0.25** |
| 20. Engineering Intrinsic Interest Value | -0.01 | 0.13 | 0.02 | 0.25** | 0.14* | -0.04 | -0.06 | -0.07 | 0.10 | 0.54** | 0.68** | 0.43** | 0.26** |
| 21. LeaveMajor | -0.07 | 0.03 | -0.12 | 0.72 | 0.01 | 0.14 | 0.16* | 0.17* | 0.14 | -0.25** | -0.06 | -0.31** | -0.12 |
| 22. Continue | 0.06 | 0.05 | 0.12 | 0.09 | 0.12 | -0.04 | -0.03 | -0.15* | 0.05 | 0.28** | 0.29** | 0.38** | 0.20** |
| 23. Internship | -0.02 | 0.03 | 0.11 | -0.03 | -0.08 | 0.00 | 0.16* | 0.15* | -0.03 | 0.22** | 0.27** | 0.34** | 0.11 |
| 24. Employed | -0.17* | 0.03 | 0.08 | 0.14 | -0.03 | -0.07 | -0.01 | -0.11 | 0.00 | 0.30** | 0.24** | 0.39** | 0.12 |
| 25. Subjective Career Success | -0.09 | 0.11 | 0.25** | 0.23** | 0.13 | -0.02 | 0.07 | -0.09 | 0.21** | 0.56** | 0.61** | 0.46** | 0.27** |

Table 13 Continued

| Variable | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *M* | 1.45 | 1.75 | 3.42 | 15.76 | 16.76 | 14.83 | 16.00 | 15.13 | 13.93 | 16.94 | 30.02 | 4.99 | 8.08 |
| *SD* | 0.57 | 0.43 | 0.46 | 3.77 | 4.12 | 4.44 | 3.89 | 3.86 | 3.77 | 3.74 | 6.92 | 1.44 | 1.11 |

*Note*. *N* = 193-199. ** *p* < .05 (two-tailed). ** *p* < .01 (two-tailed). IEFX = have taken or are now taking an IEFX projects-based course, TE = Technical, ST = Science and Technology, AR = Arts, SS = Social Services, AS = Administration and Sales, BO = Business Operations, WC = Working Conditions, Leave Major= leave your engineering major before you graduate; Continue = continue as an engineering student; Internship= have a summer internship; Employed= be employed as an engineer after graduation.

Table 13 Continued

| Variable | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 14. Independence | - | | | | | | | | | | | |
| 15. Recognition | 0.27** | - | | | | | | | | | | |
| 16. Relationships | 0.23** | 0.44** | - | | | | | | | | | |
| 17. Support | 0.37** | 0.18* | 0.29** | - | | | | | | | | |
| 18. WC_Intrinsic | 0.31** | 0.37** | 0.36** | 0.18* | - | | | | | | | |
| 19. WC_Extrinsic | 0.40** | 0.12 | 0.16* | 0.52** | 0.18* | - | | | | | | |
| 20. Engineering Intrinsic Interest Value | 0.25** | 0.10 | 0.15* | 0.24** | 0.08 | 0.19 | - | | | | | |
| 21. LeaveMajor | -0.14 | -0.06 | -0.11 | -0.17* | -0.08* | -0.20** | -0.27** | - | | | | |
| 22. Continue | 0.23** | 0.06 | 0.13 | 0.22** | 0.05 | 0.18 | 0.45** | -0.58** | - | | | |
| 23. Internship | 0.09 | 0.05 | 0.04 | 0.08 | 0.15* | 0.04 | 0.25** | -0.16* | .29** | - | | |
| 24. Employed | 0.10 | 0.07 | 0.13 | 0.06 | 0.04 | 0.06 | 0.38** | -0.37** | 0.35** | 0.40** | - | |
| 25. Subjective Career Success | 0.25** | 0.16* | 0.13 | 0.18* | 0.11 | 0.12 | 0.64** | -0.23** | 0.35** | 0.40** | .44** | - |
| *M* | 8.00 | 7.15 | 7.2 | 8.45 | 7.05 | 8.44 | 14.07 | 1.51 | 4.48 | 3.94 | 4.07 | 7.16 |
| *SD* | 1.11 | 1.57 | 1.54 | 0.89 | 1.38 | 0.78 | 3.70 | 1.07 | 1.00 | 1.25 | 1.18 | 2.25 |

*Note*. *N* = 193-199. ** *p* < .05 (two-tailed). ** *p* < .01 (two-tailed). IEFX = have taken or are now taking an IEFX projects-based course, TE = Technical, ST = Science and Technology, AR = Arts, SS = Social Services, AS = Administration and Sales, BO = Business Operations, WC = Working Conditions, Leave Major= leave your engineering major before you graduate; Continue = continue as an engineering student; Internship= have a summer internship; Employed= be employed as an engineer after graduation.

Table 14

*Intercorrelations Matrix for Key Variables Time 1 and Time 2*

| *M* | *SD* | Variable | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.45 | 0.57 | 1. Gender | 1.00 | 0.05 | -0.30** | -0.02 | 0.18* | 0.17* | 0.26** | -0.03 | 0.22** | -0.22** | -0.02 | -0.08 | 0.06 |
| 1.75 | 0.43 | 2. IEFX | 0.03 | 0.76** | -0.04 | 0.02 | 0.03 | 0.09 | 0.14 | 0.07 | -0.05 | 0.13 | 0.12 | -0.02 | -0.07 |
| 3.42 | 0.46 | 3. GPA | -0.25** | -0.06 | 0.89** | -0.11 | -0.07 | -0.11 | -0.20** | -0.15* | -0.08 | 0.16* | 0.14 | 0.22** | -0.01 |
| 15.76 | 3.77 | 4. R | -0.02 | -0.04 | -0.16* | 0.65** | 0.17* | 0.26** | 0.14 | 0.08 | 0.54** | 0.20** | 0.18* | 0.17* | 0.05 |
| 16.76 | 4.12 | 5. I | 0.12 | 0.01 | -0.06 | 0.35** | 0.69** | 0.31** | 0.35** | 0.13 | 0.20** | 0.05 | 0.1 | 0.05 | 0.54* |
| 14.83 | 4.44 | 6. A | 0.19** | 0.08 | -0.19** | 0.38** | 0.44** | 0.71** | 0.33** | 0.41** | 0.23** | 0.05 | 0.00 | 0.04 | -0.01 |
| 16 | 3.89 | 7. S | 0.13 | 0.13 | -0.06 | 0.31** | 0.50** | 0.48** | 0.62** | 0.33** | 0.20** | -0.02 | 0.01 | -0.04 | 0.03 |
| 15.13 | 3.86 | 8. E | -0.09 | 0.11 | -0.15* | 0.24** | 0.31** | 0.37** | 0.51** | 0.65** | 0.18* | 0.02 | -0.06 | 0 | -0.02 |
| 13.93 | 3.77 | 9. C | 0.17* | -0.09 | -0.13 | 0.66** | 0.36** | 0.30** | 0.27** | 0.31** | 0.61** | 0.03 | 0.13 | 0.14 | -0.04 |
| 16.94 | 3.74 | 10. Abilities-Demands Fit | -0.21** | 0.06 | 0.35** | 0.31** | 0.22** | 0.09 | 0.23** | 0.28** | 0.22** | 0.38** | 0.54** | 0.56** | 0.25** |
| 30.02 | 6.92 | 11. Person- Vocation Fit | -0.1 | 0.1 | 0.29** | 0.33** | 0.32** | 0.17* | 0.23** | 0.21** | 0.29** | .70** | 0.17* | 0.38** | 0.33** |
| 4.99 | 1.44 | 12. Culture Fit | -0.10 | -0.09 | 0.27** | 0.19** | 0.03 | -0.19** | -0.08 | -0.02 | 0.07 | 0.57** | 0.42** | 0.61** | 0.30** |
| 8.08 | 1.11 | 13. Achievment | -0.09 | 0.04 | 0.10 | 0.16* | 0.15* | -0.02 | -0.03 | -0.06 | -0.06 | 0.36** | 0.45** | 0.29** | 0.33** |
| 8 | 1.11 | 14. Independence | -0.12 | 0.10 | 0.03 | 0.12 | 0.05 | -0.01 | -0.01 | 0.12 | -0.17* | 0.34** | 0.16* | 0.16* | 0.47** |
| 7.15 | 1.57 | 15. Recognition | -0.04 | 0.09 | 0.00 | 0.03 | -0.08 | 0.03 | -0.01 | 0.19** | -0.04 | 0.06 | 0.07 | -0.05 | 0.11 |
| 7.2 | 1.54 | 16. Relationships | 0.02 | -0.04 | 0.11 | 0.05 | 0.01 | 0.21** | 0.13 | 0.17* | 0.05 | 0.03 | 0.05 | 0.04 | 0.05 |
| 8.45 | 0.89 | 17. Support | 0.11 | 0.04 | 0.02 | 0.07 | 0.05 | 0.09 | 0.12 | -0.03 | 0.12** | 0.20** | 0.09 | 0.16* | 0.16* |
| 7.05 | 1.38 | 18. WC_Intrinsic | 0.05 | 0.03 | -0.03 | 0.06 | 0.04 | 0.07 | 0.15* | 0.16* | -0.01 | -0.01 | 0.03 | 0.03 | 0.13 |
| 8.44 | 0.78 | 19. WC_Extrinsic | 0.02 | 0.00 | 0.10 | 0.08 | 0.12 | 0.06 | 0.14 | 0.18* | 0.11 | 0.27** | 0.14 | 0.16* | 0.14 |
| 14.07 | 3.70 | 20. Engineering Intrinsic Interest Value | -0.10 | 0.12 | 0.13 | 0.36** | 0.27** | 0.06 | 0.18** | 0.21** | 0.31** | 0.65** | 0.71** | 0.56** | 0.40** |
| 1.51 | 1.07 | 21. LeaveMajor | 0.12 | -0.06 | -0.08 | 0.06 | 0.14 | 0.11 | 0.04 | 0.00 | 0.07 | -0.27** | -0.02 | -0.13 | 0.10 |
| 4.48 | 1.00 | 22. Continue | -0.18* | 0.00 | 0.08 | -0.01 | -0.11 | -0.14 | -0.01 | 0.09 | 0.04 | 0.40** | 0.23** | 0.29** | -0.03 |
| 3.94 | 1.25 | 23. Internship | 0 | 0.04 | -0.02 | -0.06 | -0.09 | -0.1 | 0.07 | 0.26** | -0.08 | 0.30** | 0.16* | 0.26** | 0.09 |
| 4.07 | 1.18 | 24. Employed | -0.18* | 0.13 | 0.01 | 0.14* | -0.14* | -0.16* | 0.01 | 0.16* | 0.04 | 0.44** | 0.20** | 0.38** | 0.10 |
| - | - | 25. Subjective Career Success | -0.09 | 0.11 | 0.25** | 0.23** | 0.13 | -0.02 | 0.07 | -0.09 | 0.21** | 0.56** | 0.61** | 0.46** | 0.27** |

Table 14 Continued

| Variable | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *M* | 1.37 | 1.74 | 3.39 | 15.71 | 16.82 | 14.86 | 16.18 | 15.07 | 14.08 | 16.95 | 29.90 | 4.89 |
| *SD* | 0.51 | 0.44 | 0.45 | 3.69 | 3.89 | 4.11 | 3.59 | 3.66 | 3.41 | 3.56 | 6.23 | 1.43 |

Table 14 Continued

| *M* | *SD* | Variable | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.45 | 0.57 | 1. Gender | 0.04 | -0.05 | 0.07 | 0.22** | 0.18* | 0.12 | -0.01 | -0.07 | 0.06 | -0.02 | -0.17* | -0.09 |
| 1.75 | 0.43 | 2. IEFX | -0.03 | 0.14 | 0 | -0.07 | -0.02 | -0.06 | 0.13 | 0.03 | 0.05 | 0.03 | 0.03 | 0.11 |
| 3.42 | 0.46 | 3. GPA | 0.02 | 0.03 | 0.02 | 0.01 | -0.07 | -0.09 | 0.02 | -0.12 | 0.12 | 0.11 | 0.08 | 0.22** |
| 15.76 | 3.77 | 4. R | 0.13 | -0.01 | 0.06 | 0.12 | 0.17* | 0.07 | 0.25** | 0.72 | 0.09 | -0.03 | 0.14 | 0.12 |
| 16.76 | 4.12 | 5. I | 0.13 | 0.14 | 0.05 | 0.15* | 0.17* | 0.18* | 0.14* | 0.01 | 0.12 | -0.08 | -0.03 | -0.03 |
| 14.83 | 4.44 | 6. A | 0.09 | 0.11 | 0.09 | 0.1 | 0.16* | 0.01 | -0.04 | 0.14 | -0.04 | 0 | -0.07 | -0.17* |
| 16 | 3.89 | 7. S | 0.09 | 0.04 | 0.16* | 0.13 | 0.21** | 0.07 | -0.06 | 0.16* | -0.03 | 0.16* | -0.01 | -0.04 |
| 15.13 | 3.86 | 8. E | 0.02 | 0.21** | 0.07 | -0.01 | 0.25** | -0.09 | -0.07 | 0.17* | -0.15* | 0.15* | -0.11 | -0.17* |
| 13.93 | 3.77 | 9. C | -0.06 | -0.09 | 0.14 | 0.08 | 0.16* | -0.04 | 0.1 | 0.14 | 0.05 | -0.03 | 0 | 0.1 |
| 16.94 | 3.74 | 10. Abilities-Demands Fit | 0.30** | 0.14 | 0.1 | 0.18 | 0 | 0.21** | 0.54** | -0.25** | 0.28** | 0.22** | 0.30** | 0.29** |
| 30.02 | 6.92 | 11. Person- Vocation Fit | 0.21** | 0.07 | 0.21** | 0.25** | 0.17* | -0.24** | 0.68** | -0.06 | 0.29** | 0.27** | 0.24** | 0.25** |
| 4.99 | 1.44 | 12. Culture Fit | 0.33** | 0.16* | 0.21* | 0.22** | 0.17* | 0.12 | 0.43** | -0.31** | 0.38** | 0.34** | 0.39** | 0.33** |
| 8.08 | 1.11 | 13. Achievment | 0.63** | 0.32** | 0.30** | 0.39** | 0.24** | 0.25** | 0.26** | -0.12 | 0.20** | 0.11 | 0.12 | 0.23** |
| 8 | 1.11 | 14. Independence | 0.27** | 0.27** | 0.23** | 0.37** | 0.31** | 0.40** | 0.25** | -0.14 | 0.23** | 0.09 | 0.1 | 0.06 |
| 7.15 | 1.57 | 15. Recognition | 0.27** | 0.32** | 0.44** | 0.18* | 0.37** | 0.12 | 0.1 | -0.06 | 0.06 | 0.05 | 0.07 | -0.09 |
| 7.2 | 1.54 | 16. Relationships | 0.20** | 0.31** | 0.11 | 0.29** | 0.36** | 0.16* | 0.15* | -0.11 | 0.13 | 0.04 | 0.13 | -0.12 |
| 8.45 | 0.89 | 17. Support | 0.14 | 0.05 | 0.33** | 0.21** | 0.18* | 0.52** | 0.24** | -0.17* | 0.22** | 0.08 | 0.06 | 0.17* |
| 7.05 | 1.38 | 18. WC_Intrinsic | 0.11 | 0.19** | 0.18* | 0.20** | 0.44** | 0.18* | 0.08 | -0.08* | 0.05 | 0.15* | 0.04 | 0.13 |
| 8.44 | 0.78 | 19. WC_Extrinsic | 0.19** | 0.18* | 0.32** | 0.45** | 0.32** | 0.33** | 0.19 | -0.20** | 0.18 | 0.04 | 0.06 | 0.1 |
| 14.07 | 3.70 | 20. Engineering Intrinsic Interest Value | 0.28** | -0.04 | 0.03 | 0.26** | -0.02 | 0.22** | 0.45** | -0.27** | 0.45** | 0.25** | 0.38** | 0.32** |
| 1.51 | 1.07 | 21. LeaveMajor | -0.02 | 0.08 | 0.08 | -0.1 | 0.04 | -0.18* | -0.17* | 0.34** | -0.58** | -0.16* | -0.37** | -0.14* |
| 4.48 | 1.00 | 22. Continue | 0.01 | -0.06 | -0.06 | -0.05 | -0.16* | 0.15* | 0.30** | -0.40** | 0.35** | .29** | 0.35** | 0.25** |
| 3.94 | 1.25 | 23. Internship | 0.18* | 0.12 | 0.01 | 0 | 0.05 | 0.01 | 0.25** | -0.09 | 0.18* | 0.49** | 0.40** | 0.19** |
| 4.07 | 1.18 | 24. Employed | 0.21** | -0.03 | -0.05 | 0.11 | 0.01 | 0.21** | 0.45** | -0.24** | 0.36** | 0.34** | 0.52** | 0.36** |
| - | - | 25. Subjective Career Success | 0.25** | 0.16* | 0.13 | 0.18* | 0.11 | 0.12 | 0.64** | -0.23** | 0.35** | 0.40** | .44** | - |

Table 14 Continued

| Variable | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *M* | 8.12 | 7.31 | 7.31 | 8.40 | 7.07 | 8.39 | 14.19 | 1.41 | 4.60 | 4.05 | 4.23 | 7.16 |
| *SD* | 0.97 | 1.56 | 1.38 | 0.97 | 1.40 | 0.86 | 3.76 | 0.87 | 0.88 | 1.22 | 1.07 | 2.25 |

Table 15

*Intercorrelations  Between Time 1 and Time 2 Variables*

| | |
|---|---|
| IEFX | 0.76** |
| GPA | 0.89** |
| TE | 0.65** |
| ST | 0.69** |
| AR | 0.71** |
| SS | 0.62** |
| AS | 0.65** |
| BO | 0.61** |
| Abilities-Demands Fit | 0.38** |
| Person- Vocation Fit | 0.17* |
| Culture-Fit | 0.61** |
| Achievement | 0.33** |
| Independence | 0.27** |
| Recognition | 0.32** |
| Relationships | 0.11 |
| Support | 0.21** |
| WC Intrinsic | 0.44** |
| WC Extrinsic | 0.33** |
| Engineering Intrinsic Interest Value | 0.45** |
| Leave Major | 0.34** |
| Continue | 0.35** |
| Internship | 0.49** |
| Employed | 0.52** |

*Note.* ** $p$ < .05 (two-tailed). ** $p$ < .01 (two-tailed).

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## APPENDIX A: Demographic and Descriptive Questions

### Demographic and Descriptive Questions

*Data Collection Time 1*

1. Are you one (or more) of the following:
   - an engineering major in the College of Engineering
   - an Agricultural and Biological Engineering (ABE) student in the College of Agricultural, Consumer, and Environmental Sciences (ACES)
   - a Chemical and Biomolecular Engineering (ChBE) student in the College of
   
   Liberal Arts and Sciences (LAS)? (yes or no)
2. Are you 18 years old or older? (yes or no)
3. Race (Please choose all that apply):
   - Black
   - Latino/ Hispanic
   - Asian
   - Native American or Alaska Native
   - Pacific Islander or Native Hawaiian
   - White
   - Not listed
4. Gender
   - Male
   - Female
   - Transgender
   - Not listed
5. Are you an international student? (yes or no)
6. What year are you in engineering? (1st year, 2nd year, 3rd year, 4th year, 5th year, 6th year or more)
7. Have you either previously taken or are you currently enrolled in the IEFX projects-based course?
8. What is your GPA ____________?
9. How likely do you believe you are to... (very unlikely… very likely)
   - leave your engineering major before you graduate
   - continue as an engineering student
   - have a summer internship
   - be employed as an engineer after graduation
10. I have to drop my engineering major due to my academic standing. (true or false)

*Data Collection Time 2*

1. Please select the option that <u>currently</u> describes you:
   - engineering major in the College of Engineering
   - Agricultural and Biological Engineering (ABE) student in the College of Agricultural, Consumer, and Environmental Sciences (ACES)
   - Chemical and Biomolecular Engineering (ChBE) student in the College of Liberal Arts and Sciences (LAS)
   - None of the above

2. What year are you in engineering? (1st year, 2nd year, 3rd year, 4th year, 5th year, 6th year or more)
3. Have you either previously taken or are you currently enrolled in the IEFX projects-based course? (yes or no)
4. What is your GPA ____________?
5. I switched majors after April 20, 2016. (true or false)
    - If true→ I am still in an engineering major (true or false)
    - If true→ After switching majors, which college are you in?
        - College of Agricultural, Consumer and Environmental Sciences
        - College of Applied Health Sciences
        - College of Business
        - College of Education
        - College of Fine and Applied Arts
        - Division of General Studies
        - School of Labor and Employment Relations
        - College of Law
        - College of Liberal Arts and Sciences
        - College of Media
        - Carle-Illinois College of Medicine
        - School of Social Work
        - College of Veterinary Medicine
6. How likely do you believe you are to... (very unlikely… very likely)
    - leave your engineering major before you graduate
    - continue as an engineering student
    - have a summer internship
    - be employed as an engineer after graduation
7. I have to drop my engineering major due to my academic standing. (true or false)
8. I had an internship this past summer or a co-op this fall. (true or false)
    - If true→ This internship or co-op was related to engineering (true or false)
    - If true→ This internship or co-op has influenced my decision to stay or leave my engineering major. (true or false)

## APPENDIX B: Mini Interest Profiler

**O*NET Mini Interest Profiler (Mini-IP)**
(Rounds, Ming, Cao, Song, & Lewis, 2016)

Read each question carefully and decide how you would feel about doing each type of work:
*Strongly Dislike*
*Dislike*
*Unsure*
*Like*
*Strongly Like*

1. Build kitchen cabinets
2. Develop a new medicine
3. Write books or plays
4. Help people with personal or emotional problems
5. Manage a department within a large company
6. Install software across computers on a large network
7. Repair household appliances
8. Study ways to reduce water pollution
9. Compose or arrange music
10. Give career guidance to people
11. Start your own business
12. Operate a calculator
13. Assemble electronic parts
14. Conduct chemical experiments
15. Create special effects for movies
16. Perform rehabilitation therapy
17. Negotiate business contracts
18. Keep shipping and receiving records
19. Drive a truck to deliver packages to offices and homes
20. Examine blood samples using a microscope
21. Paint sets for plays
22. Do volunteer work at a non-profit organization
23. Market a new line of clothing
24. Inventory supplies using a hand-held computer
25. Test the quality of parts before shipment
26. Develop a way to better predict the weather
27. Write scripts for movies or television shows
28. Teach a high-school class
29. Sell merchandise at a department store
30. Stamp, sort, and distribute mail for an organization

## APPENDIX C: Measures of Fit

**Modified Abilities-Demands Fit**
(Cable & DeRue, 2002)

| **1** | **2** | **3** | **4** | **5** | **6** | **7** |
|---|---|---|---|---|---|---|
| **Not at all** | | | | | | **Totally** |

1. I believe that my personal skills are a good match for the demands of my major.
2. My abilities are a good fit for the academic requirements of my major.
3. I believe that I have the competencies, that is, what I can do well to succeed in my desired major.

**Modified Culture Scale**
(Cable & Judge, 1996)

How well do you think you fit into the engineering culture at the University of Illinois?

| **1** | **2** | **3** | **4** | **5** | **6** | **7** |
|---|---|---|---|---|---|---|
| **Not at all** | | | | | | **Totally** |

**Modified Person-Vocation Fit**
(Vogel, 2009)

| **1** | **2** | **3** | **4** | **5** | **6** | **7** |
|---|---|---|---|---|---|---|
| **Not at all** | | | | | | **Totally** |

1. There is a good fit between my personal interests and the types of courses that I take at UIUC.
2. When I think about my interests, I sometimes wonder whether I chose the right department (engineering).
3. My skills and abilities are well suited for the kinds of courses I take in engineering.
4. The kinds of courses that I take at this university match what I can do well.
5. A lot of the activities that I plan to do at UIUC match my interests.
6. I will have the opportunity to study topics that I am interested in at UIUC.

## APPENDIX D: Measures of Work Values

**Work Importance Locator** (modified from WIL online card sort)
(McCloy, et al., 1999)

Modified WIL Stem:

- As an engineering student, it is important that…

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| **Not at all Important** | | | | | | **Totally Important** |

Modified WIL Items:

1. I make use of my abilities
2. I could make decisions on my own
3. I could receive recognition for the work I do
4. My engineering classmates would be easy to get along with
5. I would be treated fairly by the engineering department
6. I could do something different every day
7. My future job would have good working conditions

**Engineering Intrinsic Interest Value**
(Jones, Paretti, Hein & Knott, 2010)

1. In general, I find working on engineering-related assignments (very boring… very interesting)

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| **Very Boring** | | | | | | **Very Interesting** |

2. How much do you like engineering? (not very much… very much)

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| **Not Very Much** | | | | | | **Very Much** |

## APPENDIX E: Subjective Career Success

**Subjective Career Success**
(Greenhaus et al., 1990)

*Strongly Disagree*
*Disagree to some extent*
*Uncertain*
*Agree to some extent*
*Strongly Agree*

1. I am satisfied with the success I have achieved in engineering
2. I am satisfied with the progress I have made towards meeting my overall academic/ career goals.