DECISION SUPPORT FOR CIVIL ENGINEERING STUDENTS: AN ANALYSIS OF ALUMNI CAREER PATHS

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ABSTRACT

Undergraduate students in engineering face many important decisions in the last two years of their degree program that impact long-term career choices, such as specialization area, career role of interest, and whether to apply to graduate school. Unfortunately, uninformed decisions can lead to missed opportunities as well as potentially the student leaving STEM due to choosing a specialization that is not well-aligned with their interests. This survey-based study assists students by analyzing the personality types, demographics, and career paths of 567 alumni that have earned an undergraduate degree in Civil and Environmental Engineering and are no longer enrolled in a university. Study findings include that certain demographics, personality types, and job preferences are significant predictors of the final outcome of an alumni's career when choosing between the different technical areas within Civil and Environmental Engineering and professional roles. Family history of having an engineer in the immediate family did not prove to be a significant factor in these decisions. Also, little significance was found between the data captured in the survey with whether or not someone would go on to earn a graduate degree in CEE. Given where significant relationships were found, it is recommended that future studies focus on testing additional personality types (e.g. is enthusiastic) and job traits (e.g. likes a desk job) in order to provide even greater distinctions between the technical areas and roles.

INTRODUCTION

To remain internationally competitive and account for evolving workforce needs, there has been a focus to promote STEM (science, technology, engineering, and mathematics) education and make it more accessible in the United States, even at an early age (*1*). Student recruitment for these fields has been of upmost focus in the education system as the Bureau of Labor Statistics found a 10.5% growth in the number of STEM occupations from 2009-2015 compared to 5.2% growth of non-STEM occupations (*2*). Professionals in STEM fields are also expected to be highly competitive for non-STEM openings due to their critical-thinking, analysis, and problem-solving skills with recent findings showing a "... deeper understanding of STEM is tied to a more productive overall workforce — not just STEM industries" (*3*).

In order to evaluate the success of STEM education outreach, current literature has predominately evaluated factors that affect recruitment (e.g. *4*), persistence (e.g. *5*), and attrition (e.g. *6*). These studies analyze not only the rates, but also how equitable the rates are among different groups, for example as with respect to gender, race, or income. While these findings help realign future investment strategies from a government standpoint, these findings are not as useful from a student's perspective. That is, these results become diagnostic tests, informing students how more or less likely they are to succeed in STEM given characteristics about themselves. To minimize attrition rates, students arguably would benefit more from a prescriptive study. That is, given a student's history and characteristics, where in engineering would they be predicted to have a career best aligned with their interests? In which STEM field do alumni in the workforce most similar to them end up?

A prescriptive study benefits students in several ways. First, it could help students dealing with career indecisiveness. As stated in Cantrell and Ewing-Taylor (*7*), "when adolescents explore their own traits along with the characteristics of career options they are considering, they tend to avoid problems later on such as career indecision or prematurely making a poorly founded career decision." This indecisiveness can be especially costly if it occurs later on in a college student's degree program (e.g. the last two years) when they face questions about which area to specialize in within the major and whether or not to pursue a graduate degree before entering the workforce. Second, this type of study would recommend an alternative STEM field for students to try before changing to a non-STEM major, therefore potentially reducing the attrition rate. Third, a study based on alumni that have worked several years in the field could help indicate which area a student may have a long-term career with a reduced chance of burnout. For example, previous studies in the medical field have found that "although the causes of burnout are multifactorial, individual characteristics play an important role" (*8*).

The purpose of this study is to provide current undergraduate students specifically in Civil and Environmental Engineering (CEE) with decision support during their undergraduate careers. CEE degree programs typically encourage students to specialize through required technical electives in their junior and senior years. These specialization decisions for CEE majors are complex as it is known to be a very diverse field, training students in anything from designing concrete with a specific strength to forecasting multimodal demand in ten years. Therefore, this study analyzes career paths of CEE alumni to provide guidance to current students in the final years of pursuing their undergraduate degrees in the field. This study was motivated by evident indecisiveness of students enrolled in 3000- and 4000-level courses taught by the authors.

METHODOLOGY

Using the online survey software Qualtrics®, CEE alumni were questioned on their demographics, family and educational background, and personality traits. The survey solicitation was distributed via email to Virginia Tech's CEE alumni as well as posted to the group's social media page. The alumni were allowed to forward the survey link to other professionals in their network that also met the study's two inclusion criteria: 1) must have earned an undergraduate CEE degree, 2) cannot currently be enrolled at a university. The second criterion prevents current CEE graduate students from participating as the goal of this study was to analyze the professional careers and permanent placement of those with an undergraduate degree in CEE. In addition, the authors reached out to contacts at private companies to specifically ask that the survey be sent to all graduates with Civil Engineering degrees, not just from Virginia Tech.

Table 1 lists the information collected from each respondent. The survey first asked alumni questions that current undergraduate CEE students could answer about themselves. These predictor variables included demographic information, personality type tested through likert scale questions, and a description of the circumstances at the beginning of their undergraduate degree program. For example, at what age did the alumni begin their undergraduate CEE degree and even was either their mother, father, or any immediate family member working in the engineering field at the time of their admittance to the CEE degree program. Alumni were then asked about their current careers to provide the dependent variables, such as the technical area in CEE they currently work in, what job role they have, and whether they completed a graduate-level CEE degree after completing their undergraduate studies. Alumni were also asked questions about their preferred career in order to indicate if their current career matches their interests.

TABLE 1 Information captured in survey

Category	Variable
Demographics	Ethnicity Gender (Female=0, Male=1)
Status at start of undergraduate CEE degree	Father engineer (No=0, Yes=1) Mother engineer (No=0, Yes=1) Engineer in family (No=0, Yes=1) Country of citizenship In/out state status Year Age
Personality statements using the likert scale (0= Disagree, 1= Neutral, 2= Agree)	I like to take risks I prefer to work alone over working in groups I prefer a desk job over working out in the field I tend to procrastinate I work well under pressure I am enthusiastic I am a critical thinker I am dependable I am anxious I am open to new experiences I am reserved, quiet I am sympathetic, warm I am disorganized

	I am calm
Earned CEE degree information	Undergraduate CEE degree university Highest CEE degree obtained
Current career	Current technical area (e.g. structures, geotechnical, etc.). Select up to 2. Current role (e.g. managing, practice/design, etc.). Select up to 2.
Preferred career	Preferred technical area (e.g. structures, geotechnical, etc.). Select up to 2. Preferred role (e.g. managing, practice/design, etc.). Select up to 2. I believe my current job fits my interests. Uses likert scale.

DATA

The survey was fully completed by a total of 567 Civil Engineering alumni. The majority of responses were received from Virginia Tech alumni (52.2%) due to the alumni association solicitation channel. Responses from other universities were possible by Virginia Tech alumni forwarding the online survey link to their professional network that met the survey criteria. The second most common university was Texas A&M with 3.6% of respondents.

Of the respondents, 68.4% were male. The ethnical affiliations of respondents were 87.8% white, 5.6% hispanic, 4.2% asian, and 1.4% black/African American. This means that the study oversampled females and whites, which in 2015 were 24.2% and 66.8% of bachelor's degrees in CEE, respectively (*9*). At the start of their undergraduate CEE degree, 97.5% of respondents were U.S. citizens, 91.7% were between the ages of 17-19 years old, 68.8% were considered in-state at the university they attended. The majority of respondents were somewhat new in their careers, where 69.5% began their undergraduate degree in CEE in 2000 or later. The highest degree earned in CEE for respondents was 80.4%, 0.2%, 17.5%, and 1.9% for B.S., M.E. (Master's in Engineering with a CEE focus), M.S., and PhD, respectively.

Figure 1 presents the distribution of the careers reported by the alumni. The technical areas were based on the divisions of the American Society of Civil Engineering (*10*). Alumni that responded "other" cited careers in for example information technology, tax accounting, legal services, finance, and facility management. Participants were allowed to select up to two technical areas, where 19% of respondents selected two (i.e. "multiple"). It is important to note that 93.8% of responses agreed that their current job fits their interests and 4.6% were neutral.

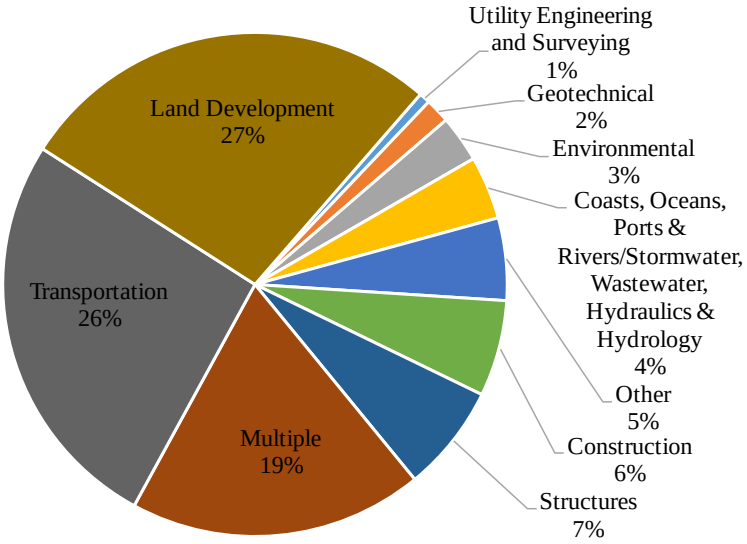

FIGURE 1 Current technical areas of study participants

Figure 2 outlines the role each of the respondents fill at their current position. Half of respondents were in the practice/design side of CEE followed by 29% who selected two roles. Most teaching responses were coupled with another role, therefore putting the samples in the multiple category. Also, these roles were not evenly distributed by the different technical areas as earning a CEE degree opens up different opportunities in each area. For example, 74% of respondents in construction cited having a managing-only role, but management was only 13% of all 567 responses. Similarly, geotechnical, land development, structures, and transportation had increased responses of practice/design.

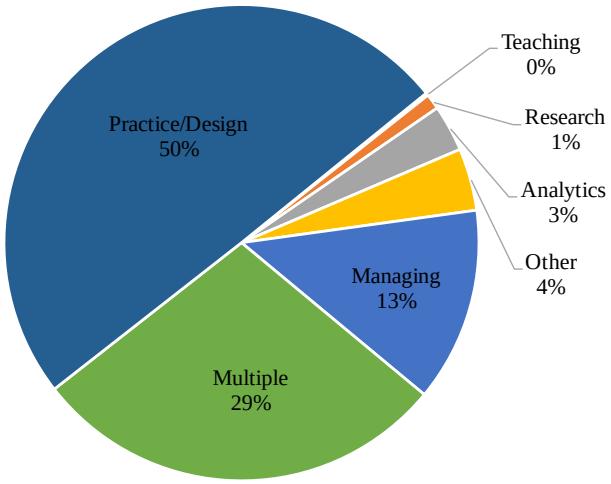

FIGURE 2 Current roles of study participants

RESULTS

Table 2 shows the Spearman correlations between 18 of the variables collected in the survey, also indicating which relationships are at least 95% significant. Spearman correlations were used as many of the variables are likert scale responses (i.e. are ordinal) and this method should be used when comparing variables that have "violations of normality, a non-linear relationship or when ordinal variables are being used" (*11*). The highest correlation is between having a father in engineering and having any immediate family member in engineering when starting one's CEE undergraduate degree. This means that the majority of the time, when there was an engineer in the family, it was the respondent's father. While most of the remaining variables are not as highly correlated, those that are follow logical trends. For example, someone who is reserved and quiet is more likely to want to work alone while those who claim to be enthusiastic are more likely to prefer to work in a group setting. Likewise, respondents who agreed to being calm were less likely to agree to being anxious. Also, those who work well under pressure are more likely to agree to procrastination tendencies than those who do not work well under pressure.

TABLE 2 Correlations between respondent characteristics

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1. Gender	1																	
2. Father engineer	-0.06	1																
3. Mother engineer	-0.07	0.22*	1															
4. Engineer in family	-0.08	0.82*	0.31*	1														
5. Likes to take risks	0.08	-0.02	-0.00	-0.02	1													
6. Likes to work alone	0.09	0.06	-0.11*	0.03	-0.12*	1												
7. Likes desk job	-0.06	0.02	-0.04	0.03	-0.18*	-0.06	1											
8. Tends to procrastinate	0.07	0.09	0.04	0.09*	-0.03	0.02	-0.00	1										
9. Works well under pressure	0.07	0.01	0.05	0.02	0.18*	-0.06	0.02	0.15*	1									
10. Enthusiastic	-0.18*	0.01	0.06	0.04	0.14*	-0.21*	0.06	-0.00	0.07	1								
11. Is a critical thinker	0.02	0.03	-0.11*	0.02	0.09	-0.01	0.02	-0.05	0.09	0.06	1							
12. Is dependable	-0.07	-0.01	-0.12*	0.00	0.04	-0.02	0.08	-0.01	0.07	0.10*	-0.02	1						
13. Is anxious	-0.17*	0.10*	0.07	0.11*	-0.12*	0.05	0.08	0.07	-0.10*	-0.01	-0.14*	0.02	1					
14. Open to new experiences	-0.02	-0.10*	-0.01	-0.14*	0.21*	-0.18*	-0.15*	-0.06	0.04	0.13*	0.11*	0.03	-0.11*	1				
15. Is reserved/quiet	0.12*	0.04	-0.08	0.01	-0.29*	0.31*	0.07	-0.02	-0.02	-0.28*	0.03	-0.03	0.14*	-0.13*	1			
16. Is sympathetic/calm	-0.15*	0.08	0.02	0.13*	-0.05	-0.10*	-0.00	-0.01	-0.02	0.27*	0.04	0.05	0.16*	0.10*	0.01	1		
17. Is disorganized	0.06	0.08	0.03	0.12*	0.03	0.03	0.04	0.39*	0.00	0.01	-0.05	0.06	0.11*	-0.01	-0.04	0.01	1	
18. Is calm	0.19*	-0.03	-0.03	-0.05	0.03	0.02	-0.07	-0.08	0.05	-0.01	0.08	-0.03	-0.38*	0.11*	0.18*	0.08	-0.16*	1

*P-value < 0.05

The survey responses were then tested for significance and odds ratios were defined between different cross-cuts of the data, comparing two variables at a time. For each comparison, the first variable was something that a current CEE student would know about themselves (e.g. gender, if their father or mother is an engineer, personality trait). The second variable would be something they would like to find out (e.g. technical area of interest, role of interest). Tests for significance were run multiple times to check the relationship between two variables. For example, Pearson chi-squared tests were used to indicate if the current technical area of alumni was significantly different by gender. The first test compared structures alumni to non-structures alumni by gender. The second test compared transportation alumni to non-transportation alumni by gender. The other technical areas were compared with gender using an identical set up. This goodness of fit test "measures how well the observed distribution of data fits with the distribution that is expected if the variables are independent" (*12*). Groups that significantly reject the independence assumption (i.e. there is no relationship between the two variables) with 95% confidence are further analyzed using odds ratios.

It is important to note that these comparison tests require at least 5 samples in each cell of the chi-square matrix (*12*), which some of the smaller groups did not meet at all times. The technical field of utility engineering and surveying only had 4 respondents, so all of its subgroups with gender had less than 5 samples. Therefore, technical areas and roles with less than 5% of the samples were not compared for significance as these groups consistently missed this minimum requirement for many of the tests. However, these observations were kept in the other analyses. That is, there is not a comparison of utility engineering and surveying with non-utility engineering and surveying, but the utility engineering and surveying observations are included in the other tests (e.g. transportation with non-transportation).

While the Pearson chi-squared test was used for many of the cross-cuts, it was not appropriate for testing significance in the responses to the likert scale personality questions. For those 14 questions, the Mann-Whitney (MW) non-parametric test, also known as the Wilcoxon rank-sum test, was used instead as it can account for ordinal responses to surveys when respondents are asked if they agree, are neutral, or disagree with the statement (*13*). The test used for each comparison is specified in the results section.

Technical Area

Table 3 shows how alumni survey responses correlated with their technical area of interest. The p-values from the statistical tests are shown where significant values at the 95% level are highlighted. The table footnotes contain the odds ratio statements attributed to these tests returning a significant p-value of 0.05 or lower. For example, when the Pearson chi-squared test was performed on transportation versus non-transportation alumni responses by gender, the test returned a 0.02 p-value. Using odds ratios on this significant relationship, it was found that females in the study's sample were 1.4 times or 40% more likely to go into transportation than males.

These findings suggest that gender and personality traits may be better predictors of the technical field a person ultimately works in than their background, such as their father's or mother's profession at the beginning of the undergraduate CEE degree. Even having an engineer in the immediate family at the beginning of one's CEE degree proved to be insignificant. The significance of personality trait impact on technical area is consistent with literature. Logue et al. (*14*) conducted a study on 164 business majors and found that "49% of the variance in major

satisfaction could be accounted for by a combination of vocational interest themes and personality traits."

The most distinct finding is that construction alumni have a strong preference of not wanting a desk job, whereas transportation is the most likely to want a desk job. The only other personality trait found to be significant was that transportation alumni tended to be more reserved/quiet while structures alumni were less reserved/quiet. The number of tests returning insignificant show how civil engineers share many of the same traits even though the technical areas are very diverse. However, the results highlight that transportation alumni may be the most unique, as three of the five significant results were with regard to comparing transportation verses non-transportation alumni.

It is also interesting that these findings overcome many limitations that university records would be unable to show when comparing technical area with gender. First, many universities do not have undergraduate students officially designate their technical track and only know that each student completed their degree program in CEE. Technical tracks are only recorded for graduate students. Second, this survey is able to find the ultimate placement of alumni which debatably is more valuable over the technical focus while pursuing their degree. A student can specialize in one technical area, but then work for several decades in a different technical area. This is common as several respondents working in land development commented in the survey they did not know that technical area in CEE existed until post-graduation. Also, as evident by the "other" category, not everyone uses their college degree in the traditional way, such as applying the analytical skills learned in CEE to the field of finance.

TABLE 3 Chi-squared P-values and odds ratio statements for technical area

	Statistical Test	Construction	Land Development	Multiple	Structures	Transportation
Gender	Pearson	0.13	0.85	0.38	0.91	0.02[a]
Father engineer	Pearson	0.95	0.74	0.72	0.92	0.17
Mother engineer	Pearson	1.00	0.70	0.18	0.87	0.10
Engineer in family	Pearson	0.51	0.49	0.44	0.68	0.43
Likes to take risks	MW	0.06	0.73	0.58	0.17	0.76
Likes to work alone	MW	0.66	0.18	0.57	0.13	0.24
Likes desk job	MW	0.00[b]	0.53	0.14	0.28	0.04[c]
Tends to procrastinate	MW	0.34	0.23	0.19	0.59	0.19
Works well under pressure	MW	0.32	0.94	0.39	0.72	0.97
Enthusiastic	MW	0.30	0.60	0.21	0.91	0.95
Is a critical thinker	MW	0.48	0.31	0.68	0.92	0.71
Is dependable	MW	0.44	0.27	0.55	0.41	0.21
Is anxious	MW	0.27	0.15	0.37	0.55	0.11
Open to new experiences	MW	0.28	0.33	0.65	0.77	0.23
Is reserved/quiet	MW	0.23	0.48	0.98	0.01[d]	0.05[e]
Is sympathetic/calm	MW	0.32	0.86	0.39	0.60	0.11
Is disorganized	MW	0.09	0.80	0.50	0.28	0.91
Is calm	MW	0.14	0.83	0.34	0.98	0.58

[a] Females are 1.4 times more likely to be in transportation than males

[b] Non-construction alumni are 1.8 times more likely to like a desk job than those in construction

[c] Transportation alumni are 1.3 times more likely to like a desk job than those not in transportation

[d] Structures alumni are 1.6 times more likely to be reserved/quiet than those not in structures

[e] Transportation alumni are 1.2 times more likely to be reserved/quiet than those not in transportation

Respondents were then asked to select up to two characteristics that were important in their career and gave them motivation to pursue it. If a respondent chose two, each was weighted as half a vote within their technical area compared to if they had chosen one, it would be weighted as a full vote. It seems that in general, CEE majors found the ability to grow and gain new knowledge, challenging, making a difference, and high salary/financial gain to be important aspects of their careers, potentially indicating that CEE majors have a competitive nature. However, the ability to grow and gain new knowledge was more important to those in structures and transportation while high salary and financial gain was more important to construction and land development. The dynamics of each technical area's work schedule seemed to be of less importance, such as flexible working hours and whether or not business travel was required.

These results support current literature as well as reiterate the importance of basing decision support on alumni careers and not on student enrollment. A previous study on freshman engineering attrition found that students "having a strong belief that engineers are paid well and that having an engineering degree helps ensure career security had a positive influence on the outcome variable, possibly implying that students who leave in poor standing may be studying engineering primarily for its financial rewards" (*15*). Had students been surveyed, it is hypothesized that job security and salary would have had increased importance when compared the responses of the alumni.

TABLE 4 Important characteristics of career

	Construction	Land Development	Multiple	Structures	Transportation
Ability to grow and gain knowledge	20.0%	28.3%	26.5%	35.3%	30.0%
Ability to travel for business	2.0%	0.9%	3.0%	0.0%	1.4%
Challenging	22.0%	19.1%	13.9%	22.1%	14.5%
Flexible working hours	2.0%	5.7%	6.6%	8.8%	5.5%
Importance/authority/recognition	8.0%	3.0%	4.2%	2.9%	4.1%
Making a difference	20.0%	11.7%	22.3%	20.6%	22.3%
No business travel	2.0%	0.0%	0.6%	0.0%	0.5%
Predictable working hours	0.0%	2.6%	0.6%	1.5%	0.5%
High salary/financial gain	16.0%	17.8%	8.4%	4.4%	10.0%
Stability/job security	8.0%	10.9%	13.9%	4.4%	11.4%
Total	100.0%	100.0%	100.0%	100.0%	100.0%

Note: all greater than or equal to 15% are highlighted.

Role

Similar to technical area, alumni career roles were not well-predicted by immediate family careers at the beginning of their CEE degree, as shown in Table 5. However, gender and personality traits were significant. Also, a high portion of the significant comparisons occurred with respect to those in the practice/design role, indicating that the traits of alumni in that role are especially unique. When comparing Tables 3 and 5, more qualities were found to be significantly different between the roles than between the technical areas. This suggests that using questionnaires to support students in their decisions may provide more guidance when recommending roles rather than technical area. Therefore, it would be beneficial for future research to obtain larger samples of the excluded roles (analytics, research, teaching, other) so that students can gain insight into the common characteristics in those groups.

TABLE 5 Chi-squared P-values and odds ratio statements for role

	Statistical Test	Managing	Multiple	Practice/Design
Gender	Pearson	0.00[a]	0.53	0.01[b]
Father engineer	Pearson	0.64	0.60	0.44
Mother engineer	Pearson	0.11	0.80	0.15
Engineer in family	Pearson	0.51	0.11	0.45
Likes to take risks	MW	0.20	0.01[c]	0.00[d]
Likes to work alone	MW	0.56	0.32	0.09
Likes desk job	MW	0.03[e]	0.87	0.08
Tends to procrastinate	MW	0.51	0.04[f]	0.08
Works well under pressure	MW	0.36	0.40	0.13
Enthusiastic	MW	0.17	0.01[g]	0.03[h]
Is a critical thinker	MW	0.31	0.63	0.10
Is dependable	MW	0.24	0.68	0.75
Is anxious	MW	0.08	0.77	0.01[i]
Open to new experiences	MW	0.18	0.46	0.84
Is reserved/quiet	MW	0.39	0.07	0.03[j]
Is sympathetic/calm	MW	0.24	0.64	0.65
Is disorganized	MW	0.35	0.98	0.65
Is calm	MW	0.64	0.86	0.33

[a] Males are 2.7 times more likely to be in management than females
[b] Females are 1.3 times more likely to be in practice/design than males
[c] Multiple roles alumni are 1.3 times more likely to like to take risks than those not in multiple roles
[d] Non-practice/design alumni are 1.3 times more likely to like to take risks than those in practice/design
[e] Non-managing alumni are 1.7 times more likely to like a desk job than those in managing
[f] Multiple roles alumni are 1.4 times more likely to tend to procrastinate than those not in multiple roles
[g] Multiple roles alumni are 1.1 times more likely to be enthusiastic than those not in multiple roles
[h] Non-practice/design alumni are 1.1 times more likely to be enthusiastic than those in practice/design
[i] Practice/design alumni are 1.4 times more likely to be anxious than those not in practice/design
[j] Practice/design alumni are 1.4 times more likely to be reserved/quiet than those not in practice/design

Table 6 presents the career characteristics important to each of the different job roles. All three roles found the ability to grow and gain knowledge as well as making a difference important in their careers. Those in managing had an increased rate of responding that high salary/financial gain was an important career aspect. This is correlated with findings from Table 4, where the majority of alumni in construction are in management. Therefore, salary is important to both construction and management. Given these associations, it is difficult to create well-defined cause-and-effect relationships because it is unknown what characteristics were important in picking one's technical area and what was important in one's role. For example, an alumnus might pick construction in order to gain knowledge and because it is challenging, then go into management for the increased salary. Due to this multi-stage decision-making, it is recommended that future research includes alumni interviews to get a more in-depth view of the decision process.

TABLE 6 Important characteristics of career

	Managing	Multiple	Practice/Design
Ability to grow and gain knowledge	17.7%	25.8%	31.7%
Ability to travel for business	0.8%	2.5%	1.1%
Challenging	21.0%	20.3%	14.2%
Flexible working hours	3.2%	5.5%	7.1%
Importance/authority/recognition	6.5%	4.7%	3.4%
Making a difference	25.0%	22.5%	16.5%
No business travel	0.0%	0.0%	0.2%
Predictable working hours	0.0%	0.8%	1.8%
High salary/financial gain	15.3%	8.9%	13.1%
Stability/job security	10.5%	8.9%	10.8%
Total	100.0%	100.0%	100.0%

Note: all greater than or equal to 15% are highlighted.

Degree Level

The last predictor analyzed was whether or not an alumni earned a graduate degree in CEE. This includes an M.S. or Ph.D. in CEE as well as a M.E. (Master's in Engineering) with a CEE focus. For this comparison, only samples that started their CEE undergraduate degree between 1995-2010 were included, a total of 291 samples. Had all 567 samples been included, the average age difference between those who did and did not earn a graduate degree was 8 years. The significant differences were then consistent with what was expected when comparing a younger group with an older group and not necessarily due to differences in earning a graduate degree in CEE. After for controlling for age by comparing samples in the 15-year range, the only distinguishable personality trait was that those who earn a graduate degree in CEE are significantly less likely to procrastinate. The likert scale responses to being dependable between the two groups returned a significant p-value, but the lack of diversity in answers resulted in too few observations in each category of the comparison.

TABLE 7 Chi-squared P-values and odds ratio statements for graduate school

	Statistical Test	Received CEE Graduate Degree
Gender	Pearson	0.85
Father engineer	Pearson	0.89
Mother engineer	Pearson	0.96
Engineer in family	Pearson	0.45
Likes to take risks	MW	0.34
Likes to work alone	MW	0.07
Likes desk job	MW	0.33
Tends to procrastinate	MW	0.02[a]
Works well under pressure	MW	0.65
Enthusiastic	MW	0.99
Is a critical thinker	MW	0.85
Is dependable	MW	0.03[b]
Is anxious	MW	0.89
Open to new experiences	MW	0.07

Is reserved/quiet	MW	0.43
Is sympathetic/calm	MW	0.52
Is disorganized	MW	0.67
Is calm	MW	0.97

[a] Alumni who do not have a CEE graduate degree are 1.5 times more likely to procrastinate than those who do have one.
[b] Does not meet the 5 observations minimum requirement for the statistical test.

CONCLUSIONS AND FUTURE RESEARCH

This study provides supportive evidence that personality and gender can impact career decisions, including technical area and role. The family history of having an engineer in the immediate family at the beginning of one's studies was not found to be a significant predictor in alumni careers. While there were significant differences in the types of alumni in each technical area and role, overall the career goals were mostly consistent across the different group segments, suggesting that career goals may help students pick CEE as their major, but not decisions later on in their education. Another possibility is that, consistent with previous literature, students pursuing a CEE degree with salary and job stability in mind are less likely to complete the degree program requirements. Also, the data captured from the survey was not strong at predicting whether someone would earn a graduate degree in CEE. While this study gives guidance to students in terms of which technical area they should consider pursuing, it seems that career role is most easily predicted as the characteristics of alumni in each role are more distinguishable from one another.

Given where significance was found, it is recommended that future studies focus on personality types (e.g. is enthusiastic) and job traits (e.g. desk job) by testing more than 14 of these preferences. Future studies may benefit from already developed tests, such as the Myers-Briggs Type Indicator to test for personality. Also, it is recommended to focus on traits that do not have a negative connotation. For example, very few alumni disagreed or were neutral to being a critical thinker, probably because not being a critical thinker is viewed negatively. Conversely, there was great diversity in responses to if a desk job is preferred as there was not an obvious right or wrong answer. Also, it is recommended for future studies to implement methodologies that account for possible correlations between variables, such as regression or interview-based. Otherwise, any technical area with a high portion of managers may be incorrectly concluded to like a high salary as well. Lastly, while the survey was distributed to many alumni outside of Virginia Tech, about half the responses were from Virginia Tech alumni. Future research would benefit from teaming with other academic institutions or professional organizations to obtain a more representative sample of graduates currently in industry. This would highlight any university- or region-related impacts on the correlations as well as the robustness of the overall study conclusions.

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