MODELING THE EFFECTS OF INVOLVEMENT AND ATTITUDES ON ENERGY INDUSTRY PURSUIT INTENTIONS: A SYSTEMS ANALYSIS OF THE UNIVERSITY-INDUSTRY ENVIRONMENT

by

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ABSTRACT

JORDAN M. GROSS. Modeling the effects of involvement and attitudes on energy industry pursuit intentions: A systems analysis of the university-industry environment. (Under the direction of DR. PATRICIA TOLLEY)

The energy industry's struggle to attract and retain qualified employees continues to threaten the nation's economy, global competitiveness, and national security. Given the nationwide skills and labor shortage in the energy industry, this study was conducted in response to a need to identify causes of person-environment fit and its effects on engineering students' intentions to work in the energy industry after graduation. Structural equation modeling was used to examine the relationships between student inputs, environmental factors, and career-related outcomes. Two models were compared using data collected from 381 undergraduate engineering students from across the country. Results suggest that students who gained knowledge about professions in the energy industry from participating in an internship or co-op at an energy-related company perceived greater fit with the goals and values of the energy industry. In addition, this study found that students who perceive high levels of fit with the energy industry also have high industry attraction, which directly affects their energy industry pursuit intentions. Overall, this research indicates that high quality internships have the potential to increase students' perceived industry fit, which is closely tied to their career intentions. Outcomes of this study are expected to provide stakeholders with new insights to improve practices within the university-industry environment that will educate, promote, and sustain a strong energy workforce for years to come.

DEDICATION

To my friends and family who always believed in me and supported me throughout my journey. I especially want to thank my incredible partner, Kalen, for her unconditional love and encouragement during this process. I also want to thank Jackson and Greta for their endless affection and foolhardiness that helped lift my spirits over the last few years. Thank you all from the bottom of my heart.

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CHAPTER 1: INTRODUCTION

The energy industry is one of the most dynamic, quickly evolving, and fastest growing sectors in the United States' economy (U.S. Department of Commerce, 2015). Energy companies produce oil, natural gas, coal, nuclear power, renewable energy, as well as electricity and other technologies that affect nearly all other sectors of the economy (E^4 Carolinas, 2014). In 2014, the United States remained the world's leading producer of oil and natural gas, exceeding that of Russia and Saudi Arabia, the second- and third-largest producers, respectively (U.S. Energy Information Administration, 2015a) (Figure 1). Advances in new technologies, such as hydraulic fracturing (i.e., hydrofracking) and horizontal drilling, have greatly contributed to the ongoing recovery of the United States economy following the Great Recession (2007-2009). Rapid changes in technology coupled by a growing demand for energy have driven job growth and a shift in the skills that are required for employees to perform more complex tasks than even five years ago (Carnevale et al., 2010; Manpower, 2014). To remain competitive in the energy industry, companies must maintain a robust workforce with a steady flow of new talent and innovation. However, the energy industry is facing a number of workforce issues that could abate the vitality and productivity of the current energy boom.

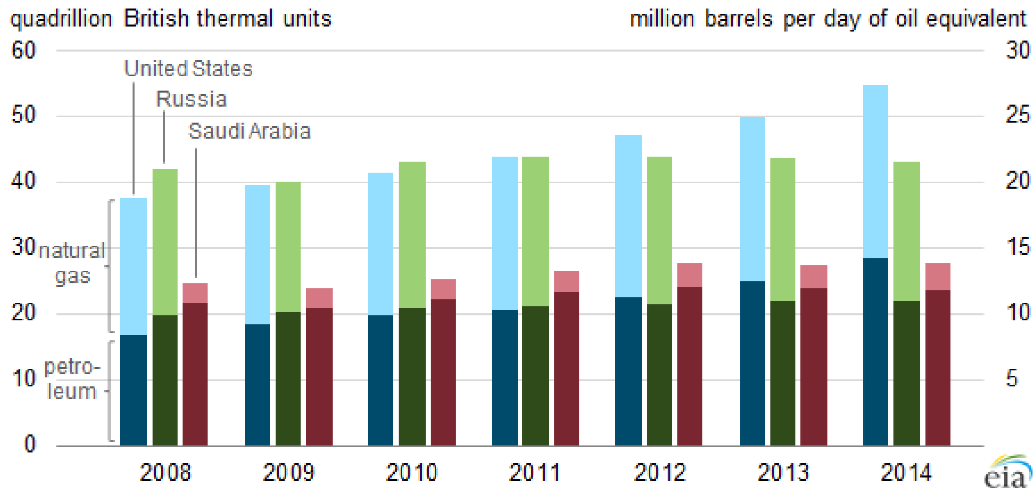

FIGURE 1: Estimated U.S., Russia, and Saudi Arabia petroleum and natural gas production from 2008-2014 (U.S. Energy Information Administration, 2015a). Note: Petroleum production includes crude oil, natural gas liquids, condensates, refinery processing gain, and other liquids, including biofuels. Barrels per day oil equivalent were calculated using a conversion factor of 1 barrel oil equivalent = 5.55 million British thermal units (Btu).

1.1. Energy in the United States

The United States is a leader in the production and supply of energy, and is among the largest energy consumers in the world. Of the 16,000 terawatts of energy that are consumed globally each year, about 20% is accounted for by the United States (U.S. Energy Information Administration, 2015a). Energy is also one of the top industries bringing economic growth back to the United States after the 2008 Great Recession. In general, the energy industry can be defined as all sub-sectors industries (e.g., petroleum, natural gas, coal, nuclear, renewable) involved in energy exploration and production as well as companies involved in energy generation, transmission, and distribution. Companies involved in research and development of energy-related technologies are also considered part of the energy industry.

Energy is needed for most everyday activities, such as driving to work, producing food, heating and cooling homes, lighting office buildings, and running machinery in factories. Energy comes from a combination of sources that fall into two broad categories: renewable (an energy source that can be replenished) and nonrenewable (an energy source that cannot be easily recreated). There are five main renewable energy sources: solar, wind, geothermal, biomass, and hydropower. However, most of the energy produced in the United States comes from nonrenewable energy sources, which include fossil fuels (oil, natural gas, and coal) and radioactive fuels (e.g., uranium) used to produce nuclear power (Figure 2) (U.S. Energy Information Administration, 2015b).

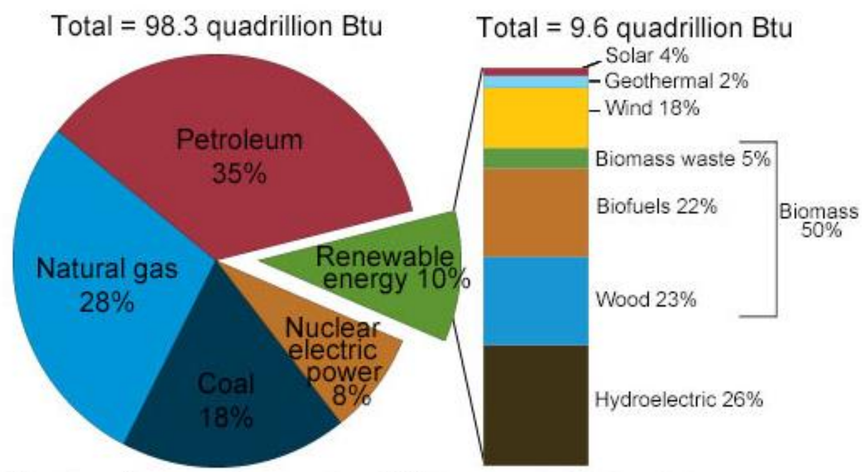

FIGURE 2: United States energy consumption by energy source, 2014 (U.S. Energy Information Administration, 2015b). Note: Sum of components may not equal 100% as a result of independent rounding.

Figure 2 shows a breakdown of the United States energy consumption in 2014 by energy source. Nonrenewable energy sources accounted for 90% of all energy used in the

United States, and the remaining 10% came from renewable sources. The largest renewable energy source was biomass (i.e., wood, biofuels, and biomass waste), which accounted for about half of all renewable energy (U.S. Energy Information Administration, 2015b).

In terms of nonrenewable energy sources, petroleum accounted for 35% of energy consumption, and is used predominately in the transportation sector to fuel cars, trucks, airplanes, and boats. Petroleum is not economically viable to produce electricity since it is more expensive than many other energy sources. About 40% of all energy consumption in the United States is used for electricity (EPA, 2015). Coal is the primary source of electricity in the United States followed by natural gas and nuclear. Only a small fraction of electricity in the United States is produced by renewable resources. Nuclear is the cheapest energy source per kilowatt-hour and produces electricity relatively efficiently. Natural gas is more expensive than nuclear, but it is still more cost effective than petroleum. The most common uses of natural gas are for commercial and residential heating and other industrial purposes.

1.1.1. Supply and Demand

Global energy is a growing market worth about $6 trillion (Manpower, 2014; SelectUSA, n.d.). According to the U.S. Energy Information Administration (EIA), worldwide demand for energy is projected to increase 35% between 2015 and 2035, largely due to the anticipated industrialization in developing countries, such as China and India (Tracy, 2013). While some subsectors, like nuclear energy and coal production, have been stagnant or declining in recent years, growth in the oil and natural gas sectors have reached new heights due to advances in technology that have changed the way the United States produces and consumes energy (Manpower, 2014).

In 2008, approximately 60% of the crude oil produced in the United States came from one of three places: the Gulf of Mexico, Texas, or Alaska (FMI, 2014). During this time, domestic production was on the decline and had been decreasing about two percent annually since 1970, on average. Foreign oil was imported to fill gaps in domestic production (Table 1), which had political and economic repercussions for the nation.

TABLE 1**:** Total U.S. oil supply and net trade from 2007 to 2012 (millions of barrels/day) (Ahn, 2013)

Year	Crude production	NGL production	Refinery gains	Biofuels	Net oil imports	Net crude imports	Net product exports	Total supply
2007	5.077	1.783	0.995	0.460	12.035	10.004	-2.031	8.315
2010	5.479	2.074	1.067	0.867	9.440	9.171	-0.269	9.527
November 2011	6.014	2.373	1.113	0.946	8.059	8.660	0.601	10.576
November 2012	6.893	2.516	1.118	0.840	6.699	8.056	1.358	11.094
2012	6.392	2.398	1.064	0.868	7.542	8.516	0.974	10.827

In the following five years, advances in hydraulic fracturing and horizontal drilling allowed the United States to go from being increasingly dependent on foreign oil to becoming the world's leading producer of oil and natural gas (Doman, 2015) (See Figure 1). Oil imports remain on the decline and strong exports of petroleum and refinery products are creating new opportunities to bring jobs and wealth back to the United States

(Cikanek, 2015). The profits of this energy revolution may only be realized, however, if there is enough human capital to keep up with workforce demands.

While much of the oil and natural gas infrastructure in the United States has traditionally been located along the Gulf Coast, new shale developments have expanded to other states, like Pennsylvania, West Virginia, Ohio, Oklahoma, Colorado, and North Dakota, which have increased oil and gas production at previously unfathomable rates (FMI, 2014). In particular, the Marcellus Shale formation, which underlies a large portion of Pennsylvania, West Virginia, and parts of New York, Ohio, and Maryland (Kargbo, Wilhelm, & Campbell, 2010), has increased natural gas production by six times in just four years (FMI, 2010). The rush to produce natural gas from formations like the Marcellus began to have a dramatic effect on prices in 2012 when the price of natural gas fell to an all-time low of $1.82 per MMBTU, making natural gas one of the cheapest energy resources in the world (FMI, 2010). Meanwhile, in early 2011, increased domestic oil production created surpluses at storage and transportations hubs, causing oil prices in the United States to fall.

As domestic energy production continues to rise, the demand for oil among American consumers has been on the decline. Demographic changes, stricter policies on fuel efficiency, and more sustainable technologies have reduced demand for gasoline in the United States from 9 million barrels per day in 2010 to an estimated 7.4 million barrels per day by 2020 (Jones Lang, LaSalle, 2013). In addition, the number of vehicles per household (i.e., vehicle density) has steadily declined over that last few years as the Baby Boomer generation retires and no longer makes the daily commute to work. The preference of Generation X and Millennials for urban living has also contributed to the reduction in vehicle density (Jones Lang LaSalle, 2013).

In terms of the global energy market, declining oil demand in the United States is not expected to have a significant influence on global oil prices. Global oil demand is projected to increase by 7 million barrels per day by 2020 according to the International Energy Agency. Estimates suggests that steadily rising demand in China, India, and other developing countries will offset lower oil demand in the United States and Europe for the foreseeable future (Jones Lang LaSalle, 2013).

Demand for natural gas, on the other hand, is accelerating at unprecedented rates due to relatively low gas prices, which are expected to continue for years to come (Ahn, 2013). In terms of power generation, many utility companies are making a permanent switch from coal to natural gas since natural gas is cheaper and produces fewer greenhouse gas emissions than coal. For similar reasons, industrial companies are retrofitting or converting older systems to run off natural gas instead of oil or coal. Residential and commercial buildings are also switching from oil or propane to natural gas for heating and cooling. As more vehicles begin to run on compressed natural gas (CNG) and liquefied natural gas (LNG) as a substitute for gasoline, the transportation sector could make a huge impact in the demand for natural gas (Ahn, 2013).

According to a study by Citi Research, the cumulative impact of new energy production, reduced consumption, and associated activity could increase real GDP by 2.0 to 3.3%, or $370-$624 billion (in 2005$), respectively, by 2020 (Ahn, 2013) (Figure 3). The current energy boom is not only creating new jobs directly in the energy industry, but its effects are being realized throughout the broader labor market (Figure 4). One study estimated that 3.6 million new jobs may be created by 2020 including 600,000 jobs in the oil and gas sector and 1.1 million jobs in related industrial and manufacturing activity (Ahn, 2013) (Figure 4). Similarly, a study by IHS Global Insight estimated that the energy boom will directly or indirectly support 3.5 million American jobs by 2035 (IHS, 2013). It is clear that the energy industry significantly impacts nearly all other sectors in the United States economy. However, the inability of energy executives to find enough qualified employees to meet workforce demands could prevent the current energy boom from reaching its full potential.

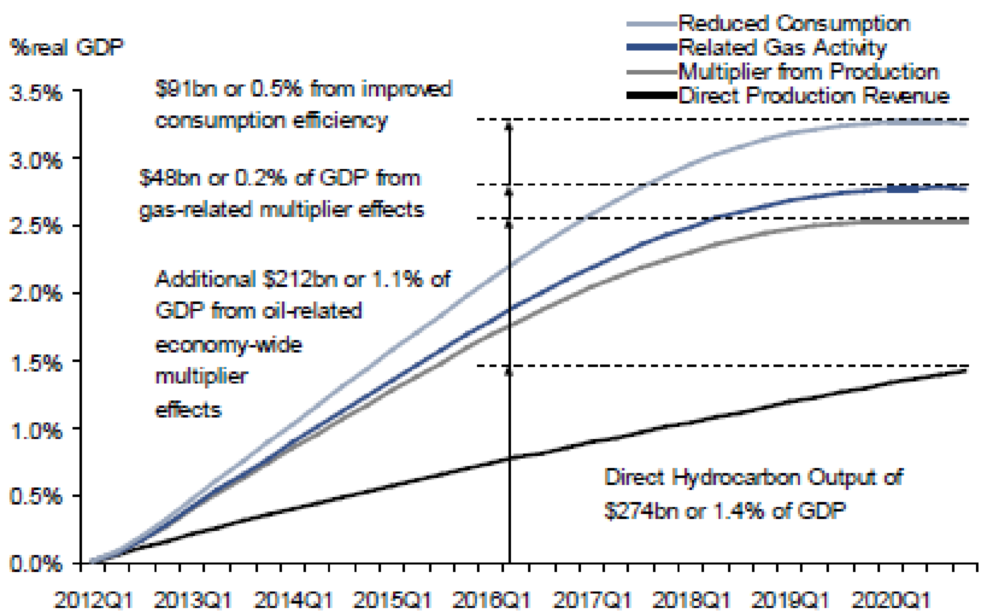

FIGURE 3**:** Cumulative impact on United States real GDP, 2012-2020 (Ahn, 2013).

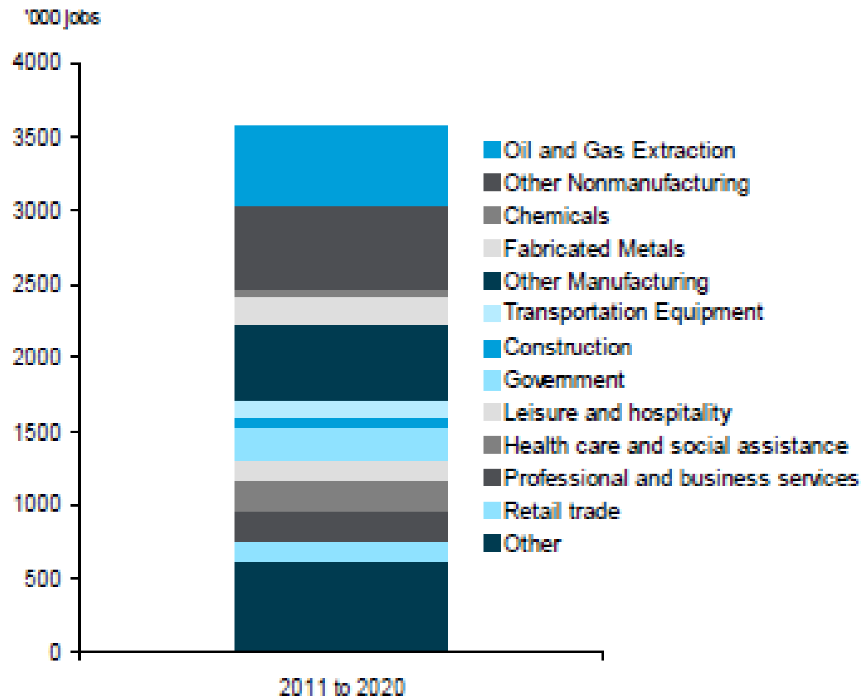

FIGURE 4: Impact of increased domestic energy production on job creation, 2011-2020 (Ahn, 2013).

1.1.2. Workforce Challenges

Competition for talent is a pressure felt by many industries trying to attract skilled workers from domestic and international markets. However, few are facing a human capital deficit of the magnitude and urgency found in the United States energy industry (Manpower, 2014). The number of available jobs in the energy industry is estimated to double by 2020 as a result of an aging workforce and a projected 35% increase in energy demands over the next 20 years (Manpower, 2014). This includes almost half of the engineers and engineering technicians in the energy workforce that are approaching retirement age and will need to be replaced in the next ten years (Center for Energy

Workforce Development, 2013). However, attracting quality candidates for available positions is a major challenge for many energy companies.

During one of the most significant boom periods in recent history, energy executives from across the country are struggling to find the talent needed to fill current workforce demands, and most expect the problem to get worse in the next five years (Manpower, 2014). The most critical challenges faced by many energy companies include an aging skilled workforce, a lack of qualified workers, wage pressure induced by competition for talent, a lack of education/training opportunities, a declining amount of student interest in science, technology, engineering, and math (STEM), and a poor public image of the energy industry (E^4 Carolinas, 2014; Manpower, 2014).

1.1.2.1. Aging Workforce

One of the most critical problems in the energy workforce is that older employees are retiring at greater rates than their positions can be filled by younger workers. Although many organizations in the United States are facing similar challenges, the median age of workers in the energy industry is 3.5 years higher than the median age for workers across all other major industries (Ashworth, 2006). As a result, energy companies are among the first to address this issue, paving the way for others to deal with large waves of retiring Baby Boomers.

1.1.2.2. Skills Gap

The gap between workforce needs and student preparation is another major concern for the energy industry. Several studies have identified gaps between the skills required for new and replacement positions and the qualifications of prospective employees in the energy industry (Center for Energy Workforce Development, 2011;

Sampath & Robinson, 2005). This gap includes skills that are content-based, technical, or related to an applicant's overall employability (Center for Energy Workforce Development, 2011). In 2005, energy companies indicated that the leading skill deficiencies among energy sector job applicants were technical knowledge (56% of applicants), math ability (54%), and communications skills (54%) (Van Horn, 2007). More recent interviews with energy executives revealed skills shortages in leadership, business acumen, organizational preparation, and time management (Manpower, 2014).

The inability to fill replacement positions is exacerbated by the fact that students are not graduating in relevant fields at the same rate and with the same qualifications as they did in the past (National Commission on Energy Policy, 2009). Advances in technology used in the energy industry have driven a shift in the skills that are required for employees to perform more complex tasks than even five years ago (Carnevale et al., 2010; Manpower, 2014). Moreover, the skills that are required for many energy positions are less transferable than those required in other sectors (FMI, 2014). In some energy subsectors, such as utilities, recent graduates who have the skills to work with newer technologies may lack the knowledge associated with older infrastructure that is still in use today. Industry executives are concerned that this growing skills gap will decrease productivity during a time when the industry should be taking advantage of new developments.

A recent survey of energy executives found that 42% of respondents believed that recent graduates are not adequately prepared for available positions without additional training (Manpower, 2014). Fifty-six percent of respondents said that their company was investing more in skills development and training than they were five years ago. In addition, more than a quarter of executives indicated that they do not believe that educational institutions understand the immediate needs of energy employers (Manpower, 2014). This finding may be attributed to the fact that rapid changes in technology make it difficult for educators to anticipate, and employers to forecast, what skills will be needed in the future. Nevertheless, gaps between the skills that energy companies are looking for and the qualifications of prospective employees pose a serious challenge for the energy industry to meet current and future workforce needs (Center for Energy Workforce Development, 2011; Sampath & Robinson, 2005).

On the other hand, some argue that there may not be a classic shortage of talent after all. Critics of the labor shortage have pointed out that with so many candidates available from around the world, employers have little incentive to compromise, and their expectations of who to hire has changed (Brown, 2009). A few decades ago, companies were willing to pay for professional development because they expected their employees to stick around for a long time. Today, however, an increasing number of companies are looking to hire new employees that can make an immediate impact (Brown, 2009). Unlike years before, companies are now more hesitant to spend money on additional training for new employees out of fear that they will leave soon thereafter for another company that offers greater opportunities. In order for energy companies to remain competitive, employers need to focus on recruiting, training, and retaining new talent as well as developing a long-term human resource strategy (FMI, 2014). Without these initiatives, energy companies will risk missing this period of impressive growth and expansion.

1.1.2.3. Industry attraction

Many career opportunities in the energy industry are not attracting students and transitioning workers because of poor industry image and a lack of available educational and career information. The public perception of the energy industry in the United States is often that it causes harm to the environment and that energy jobs are undesirable (National Research Council, 2013). Increasing concerns over pollution, environmental degradation, and health issues are a few reasons why some people are dissuaded from pursuing careers in more traditional energy subsectors, such as oil and gas. In contrast, the emerging renewable energy subsectors (e.g., solar, wind, hydropower, geothermal) are generally seen in a more positive light; however, some negative perceptions still exist around questionable long-term viability and cost-effectiveness. Efforts to inform students, parents, educators, and public policy makers about the importance of the energy industry to society, and the career opportunities that are available, could help to overcome barriers created by the industry's negative image.

Energy companies may also have difficulties hiring engineers especially due to heavy competition for highly capable STEM graduates. Thousands of students graduate from college each year with a STEM degree, but many of them end up choosing other professions, such as medicine, law, and business, which often appear more exciting or profitable than engineering. As competition for limited resources intensifies, labor and talent management are quickly becoming a key differentiator in company performance and overall company value (FML, 2014). Labor shortages are already causing project costs to rise, and some large capital projects are being delayed or cancelled as a result of rising costs and doubts of long-term profitability (FMI, 2014). If the labor shortage continues, potential implications for the energy industry might include higher wage inflation, decreases in future domestic energy production capacity, and a decline in international competitiveness.

Previous research suggests that building strong partnerships between companies and educational institutions is the key to creating solutions to resolve current workforce issues in the energy industry (Manpower, 2014; National Research Council, 2013). One study found that 93% of energy executives agree that partnerships with academic institutions are needed to develop the workforce over the next decade (Manpower, 2014). Other research suggests that university-industry partnerships can help increase the flow of new talent into the energy workforce by addressing the shortfalls in engineering education through innovative approaches to expand workforce preparation (National Research Council, 2013).

1.2. University-Industry Partnerships

University-industry partnerships are a complex system of external (job markets, governments, accrediting agencies), institutional (campus culture, institution type, resources, governance), departmental (discipline, faculty, student characteristics, culture), and individual (background characteristics, educational experiences, and extracurricular involvement) factors that influence educational plans, processes, and outcomes. Each university-industry partnership is unique, in that, each individual or organization involved has their own set of objectives and expected results. In general, corporations want to ensure that there is a steady supply of new talent joining the workforce, and universities want to provide quality education while maximizing future job opportunities for their students. Through a partnership, organizations are able to combine their strengths and develop solutions that otherwise may not have been realized had each worked independently. This creative cooperation, or synergy, is the key to creating a sustainable workforce that will maintain a level of innovation to handle the complex challenges of the 21st century.

Previous studies have shown that university-industry partnerships tend to have positive outcomes when they are founded on mutual need and perceived value (Caro, 2007; Devine, 2008; Walker, 2009; Yong, 2000). Although many university-industry partnerships have similar overarching goals, each partnership has a unique set of objectives and expectations related to specific requirements outlined by the stakeholders involved. Nonetheless, many academic institutions are motivated to partner with corporations to fill financial gaps created by diminishing public funding for higher education.

Universities tend to partner with corporations in hopes to (a) gain new sources of revenue to fund research projects, (b) build new facilities and laboratories, (c) hire more student researchers, and (d) gain recognition that attracts future learners (Caro, 2007; Devine, 2008). In return, corporations hope to gain (a) research and development conducted by talented faculty members, (b) access to research facilities and specialized laboratory equipment, (c) ability to improve curriculum and program design, (d) opportunities to recruit students as new employees, (e) and professional development opportunities for current employees (Caro, 2007). The implementation of new academic programs, networking opportunities, and opportunities to gain real-world experience (e.g., internships, co-ops, and industry-sponsored senior design projects) are other common outcomes of university-industry partnerships that can benefit students, academic institutions, corporations, and the economy.

1.2.1. Partnerships with the Energy Industry

In the energy industry, university-industry partnerships can serve to increase student interest in energy-related fields and minimize the amount of career development and training required for new employees. By uniting university faculty with industry experts, unique curricula can be developed that are more aligned with specialized workforce needs. New academic opportunities and outreach programs (e.g., internships and co-ops) can also promote career awareness and engagement among students that otherwise may not have considered careers in the energy industry before.

Economic development is another reason for building partnerships between energy companies and academic institutions. Financial investments in physical infrastructure (e.g., buildings, laboratories, and equipment) made by industry partners have been shown to support interdisciplinary education, research, technological development, and commercialization (Schott, 2012). Through university-industry partnerships, faculty and industry experts can work together to create environments, both in and out of the classroom, that help students gain the knowledge and experience needed to be successful after graduation.

1.2.2. Engineering Curriculum

The undergraduate engineering curriculum has been a focal point in recent discussions concerning ways to modernize engineering education to meet the needs of the 21st century. The traditional engineering curriculum is often criticized for being too narrowly focused on building technical skills in certain disciplines, and not providing enough opportunities for students to explore other ways of thinking and learning. Many employers agree that a new engineering curriculum is needed to reflect a broad range of concerns, including environmental, political, social, international, as well as legal and ethical ramifications of decision-making (Duderstadt, 2008). Although it is important for scientific and technical courses to be the core of an engineering education, other implications of engineering (e.g., economic, political, social, and environmental) also need to be adequately addressed.

Students must also be able to make connections between what is learned in the classroom and how it can be applied to real-world situations. It is crucial that content knowledge is presented in a relatable manner, so that students can develop a deeper understanding of their discipline in a more meaningful way. Innovative pedagogies, such as active learning, project-based learning, and service learning, offer flexibility to combine technical and professional themes that reinforce the development of a well-rounded engineer. Creative teaching styles and interesting applications of technical material can better connect students to course content, and these strategies often result in higher quality engagement compared to conventional methods of instruction.

With the support of a university-industry partnership, engineering departments can enact changes in the undergraduate experience that help students build "T-shaped" professional skills. Examples of these skills include design, leadership, communication, understanding of historical and contemporary social contexts, lifelong learning, creativity, entrepreneurship, and teamwork (National Science Foundation, 2014). The T-shape refers to having both deep skills in a specific discipline and a broad ability to apply knowledge in different situations. In general, T-shaped individuals are able to constructively participate in interdisciplinary teams because they continually adapt their visions and contributions to new settings (Kucharvy, 2009). Employers look for applicants who are able to go beyond their technical training and apply a more creative approach to problem solving. Therefore, engineering education should promote the development of individuals with a strong understanding of how they can contribute their talents to their workplace and surrounding community after graduation. Advancement in engineering education and improved career persistence in engineering is dependent on the ability of university faculty and industry representatives to create opportunities for students to develop personally and professional through involvement both in and out of the classroom.

1.2.3. Internships

Participating in co-curricular activities supported by university-industry partnerships, such as internship and cooperative education (co-ops) programs, can be life-changing experiences for students during college. Internships and co-ops not only provide real-world opportunities for students to acquire new skills and knowledge, but it allows them to test-drive a professional environment to see if it is a good fit for them. Student involvement in career-oriented activities have been shown to increase students' motivation and self-efficacy, gain specific technical skills, improve their abilities to apply knowledge, solve problems, and communicate professionally (Anderson, Prem, Wirsbinski, & Courter, 2011). These experiences can also improve students' understanding of the work environment, which can lead to greater certainty about their career choices (Anderson et al., 2011).

Companies also benefit from participating in internship programs. Many companies rely on internships as their primary strategy for hiring recent college graduates (E^4 Carolinas, 2013). Internships can serve as a powerful marketing tool for companies by relying on students to share their internship experiences with their peers (E^4 Carolinas, 2013). By providing a valuable experience for their interns, a company can quickly gain a positive reputation and become a company that other students want to work for. Therefore, companies can gain a competitive advantage by developing effective internship programs through university-industry partnerships.

1.3. Problems with the Pipeline

The STEM "pipeline" is a term used to describe students' participation and achievement in science, technology, engineering, and math (STEM) (Lyon, Jafri, & St. Louis, 2012). The STEM pipeline follows a trajectory from childhood through high school, college (possibly including graduate school), and ends with employment in a STEM career (Lyon et al., 2012). However, students' departure from STEM at each of these major transition points is a growing concern commonly referred to as the "leaky pipeline" (Blickenstaff, 2005). In recent years, many studies have investigated potential causes of the leaky pipeline, particularly among women and underrepresented minorities (Atman et al., 2010; Beede et al., 2011; Carnevale, Smith, & Melton, 2011; Gibbs, McGready, Bennett, Griffin, & Launois, 2014; Lyon et al., 2012; Wang, Eccles, & Kenny, 2013).

The pipeline metaphor applies a universal framework for all students, regardless of demographic characteristics, educational background, cognitive abilities, and other formal and informal experiences that may affect students' decisions to leave STEM.

According to Adelman (2006), “There is no linear path to a degree. The default ‘pipeline’ metaphor…is wholly inadequate to describe student behavior [which] moves in starts and stops, sideways, down one path to another and perhaps circling back. Liquids move in pipes; people don’t” (p. 117). Even when students follow similar academic paths, they tend to have different experiences in and out of the classroom that can affect important educational and professional outcomes (Atman et al., 2010). The oversimplification of the pipeline model neglects to address complex interactions that occur between various individual and environmental factors that can impact students’ career development. Therefore, a new model is needed to address these complex interactions in order to develop strategies to sustain the future of a strong STEM workforce.

Labor shortages observed throughout the STEM workforce are partly due to large waves of Baby Boomers retiring, or approaching retirement age, at a greater rate than their positions can be filled by younger, qualified employees (National Research Council, 2013). New STEM jobs are also expected to grow substantially by the end of the decade (Carnevale et al., 2011), especially for positions that require advanced skills and knowledge in STEM. In fact, it is estimated that 90% of new and replacement STEM jobs through 2018 will require at least some post-secondary education and 65% will require a bachelor’s or graduate degree (Carnevale et al., 2011).

Unfortunately, low persistence and graduation rates among college students in STEM disciplines continue to be a national problem. In 2012, it was reported that fewer than 40% of students who enter college intending to major in a STEM discipline successfully complete a STEM degree (President's Council of Advisors on Science and Technology, 2012). Another study found that out of every 100 students who enter college and obtain a bachelor's degree, only 19 will earn a degree in STEM (Carnevale et al., 2011). Out of those 19, only 10 will work in a STEM field after graduation, and 8 of those 10 will still be working in a STEM field after 10 years (Carnevale et al., 2011).

Since projected workforce demands include more well-educated graduates with STEM degrees, it is imperative that efforts be made to increase career persistence in STEM-related fields. Given the current workforce issues troubling the energy industry and the importance of energy in sustaining the nation's economy and global competitiveness, this study seeks to better understand the factors that affect engineering students' intentions to work in the energy industry after graduation.

1.4. Delimitation of the Problem

The success of the energy industry is dependent on having a skilled and sustainable workforce, reliable and affordable energy resources, and continuous innovation (E^4 Carolinas, 2014). STEM skills are at the heart of the technological innovation that drives the nation's economy and high quality of life. Low persistence and graduation rates in STEM, declining student interest in science and engineering careers, the off-shoring of STEM jobs, immigration restrictions, and lack of diversity in the STEM workforce (Duderstadt, 2008) are national challenges that have various stakeholders (i.e., politicians, academics, industry executives, and the public) questioning the ability of the United States to meet 21st century workforce demands. Given the particular importance of energy to the U.S. economy, it is essential that the quantity and quality of new employees entering the energy workforce is improved before substantial economic and environmental costs are imposed that could damage the global economic competitiveness and national security of the United States (National Commission on Energy Policy, 2009).

University-industry partnerships have been endorsed as a means to prepare engineering students to fill available positions in the energy industry. However, little is known about how various aspects of the university-industry partnership system (i.e., external, institutional, and individual factors) influence college students' career intentions. Previous studies in other fields have separately discussed the relationships between student involvement and career decision-making (Foubert & Grainger, 2006; Cooper, Healy, & Simpson, 1994), and between attitudes and career choices (Wan, Wong, & Konh, 2014; Hartung, Porfeli, & Vondracek, 2005; Highhouse, Lievens, & Sinar, 2003), but none have examined the relationship between student involvement, attitudes, and career intentions as they relate to the energy industry. This lack of empirical research makes it difficult to assess the success of university-industry partnerships in improving engineering students' intentions to pursue careers in the energy industry after graduation. This study, therefore, seeks to fill in this gap in knowledge by modeling the relationships between student involvement, attitudes, and energy industry pursuit intentions.

The impact of university-industry partnerships on students and their career decisions is a complex, multifaceted issue that requires an interdisciplinary systems approach. Using a theoretical framework composed of theories from college student development (i.e., Astin's theory of student involvement) and vocational psychology (i.e., person-environment fit theory and the theory of reasoned action), this study aims to investigate the relationships between student involvement within the university-industry environment, attitudes, and intentions to pursue careers in the energy industry. Identifying factors that influence engineering students' career intentions can help identify ways to improve recruitment and career persistence in the energy industry.

1.5. Research Questions

This study was guided by the following research questions:

1) Which of two competing models best measures the direct and indirect relationships between student involvement (i.e., curricular and co-curricular), attitudes (i.e., industry fit and attraction), and energy industry pursuit intentions?
2) What factors within the university-industry environment have the greatest influence on energy industry pursuit intentions?
3) What is the relationship between industry fit, industry attraction, and energy industry pursuit intentions?

1.6. Purpose of the Study

It has been suggested that engineering students' post-graduation plans are influenced by a combination of institutional, programmatic, and individual characteristics. However, much of the research on professional persistence in engineering has used qualitative research methods (e.g., interviews and focus groups) to answer questions about undergraduates' post-graduation plans (e.g., Carrico, Winters, Brunhaver, & Matusovich, 2012; Winters, Matusovich, & Brunhaver, 2012). These and other exploratory approaches (Sheppard et al., 2010) were unable to empirically measure the amount of influence that students' college experiences have on their career intentions.

Although previous studies have expanded our understanding of engineering students' career decision-making in general, researchers have not investigated the development of engineering students' energy industry pursuit intentions. Moreover, there is a lack of quantitative research that examines the ability of university-industry partnerships to improve the quantity and quality of new employees entering the energy industry. This gap in knowledge stifles the improvement and development of interventions designed to increase the number of engineering students planning to join the energy industry, which could have a significant impact on the nation's economy, national security, and global competitiveness.

Therefore, the purpose of this study is to generate a statistical model that can be used to identify factors within the university-industry partnership system that influence engineering students' intentions to pursue a career in the energy industry after graduation. Since students enter college with unique backgrounds and navigate through their college experience along different pathways, more comprehensive methods are needed to account for the complex system that is responsible for shaping the next generation of professional engineers. Developing a tool to assess the relationships between different college experiences, environments, and outcomes within this system will require an interdisciplinary approach in order to meet the requirements and expectations of all stakeholders involved. The models developed for this study were designed based on major theories of college student development and vocational psychology, which will be described in further detail in the next chapter (Figures 9 and 10, p. 72-73).

The primary stakeholders involved in this study include academic institutions (engineering departments, faculty, students, and administrators), energy companies (employers and investors), university-industry partnerships, and other parties (e.g., professional societies, government, and the public) who are concerned about current and future workforce issues in the energy industry. The needs and overarching constraints of the academic institutions and energy companies involved in this study were considered and included in the research design.

1.7. Significance of the Study

1.7.1. Implications for Policy

One of the products of this study is a system model that illustrates relationships between proposed antecedents of engineering students' energy industry pursuit intentions (i.e., students' intentions to pursue a career in the energy industry after graduation). This tool may inform discussions about how university-industry partnerships may be used to cultivate strategies to remedy current workforce issues in the United States' energy industry. Identifying key factors that can lead to career persistence in the energy industry can help develop new innovative programs that use improved practices of recruitment and workforce development based on the findings of this research. Results of this study are intended to suggest student involvement and environmental characteristics that encourage engineering students to pursue careers in the energy industry. This research may also provide support for changes made to the engineering curriculum to provide more flexibility for engineering students to engage in experiences outside of the classroom to help them make more strategic and informed career decisions.

Government and other funding agencies may find the results of this study useful for implementing policies designed to widen pathways into the engineering profession. Future studies may choose to identify how and why certain college environments and experiences promote career persistence in engineering for various sub-populations of students. For example, researchers could investigate the impact of various experiences within the university-industry environment on underrepresented minority students in engineering.

1.7.2. Implications for Practice

Ensuring the persistence of engineering students from degree attainment to the engineering workforce is of interest to educators and practitioners nationwide. In addition to the implications for policy, the results of this study may inform decisions made by university faculty, administration, and industry partners who seek to promote students' interest in pursuing careers in the energy industry. This study will likely have broad implications since it explores the influence of various college experiences on students' post-graduation plans. The practical implications of this study also apply to recruitment for available energy industry positions, which is a complicated process whereby job seekers (i.e., students) are subject to influence from multiple sources. The model developed in this study may also be useful to researchers who are interested in identifying influential factors of career persistence in different industries or among different student populations (e.g., based on ethnicity or major).

1.7.3. Contributions to the Literature

This study will contribute to the vast knowledge of college student development by further developing Astin's input-environment-outcome model (Astin, 1993) by incorporating theories from vocational psychology to capture a more integrated picture of how college experiences affect students' career intentions as an educational outcome. In addition to higher education literature, this research will build on previous engineering education literature, which seeks to identify practices that provide engineering students with a holistic educational experience that will prepare them to become valuable members of society and the workforce after graduation. Lastly, this study will contribute to the vocational psychology literature by expanding the current state of knowledge about relationships between attitudes and intentions at the job, organization, and professional level to include the impacts of these relationships at the industry level.

1.8. Definition of Terms

It is important to note a few distinctions in terminology before continuing this discussion. Literature on secondary education tends to use the term extracurricular to describe activities that take place outside the school day, and co-curricular to describe activities that take place during the school day. Since the school day is less distinct in higher education, the terms extracurricular and co-curricular tend to be used interchangeably (Wilson et al., 2013). In this study, extracurricular and co-curricular activities will be used synonymously. Also, experiences outside of the classroom called "engineering activities" or "career-oriented activities" refer to activities such as engineering student organizations, design competition teams, professional societies, co-ops, internships, and research experiences. Non-engineering activities describe students' involvement in other co-curricular experiences outside of engineering.

The focus of this research is on engineering students' intentions to pursue careers in the energy industry after graduation. The term "energy industry" is used in this study to describe all sub-sectors industries (e.g., petroleum, natural gas, coal, nuclear, renewable) involved in energy exploration and production, organizations involved in energy generation, transmission, and distribution infrastructure, and companies involved in the research and development of energy-related technologies. Energy industry pursuit intentions is a construct that was developed for this study to represent the likelihood that engineering students will pursue a career in the energy industry after graduation. Energy industry pursuit intentions is used as the outcome variable in the hypothesized models developed for this study.

1.9. Summary

Energy executives from across the country are concerned about the growing skills gap and aging workforce, which are causing companies to struggle to find enough qualified employees to fill available positions. The lack of empirical knowledge about the processes by which engineering students' develop their career intentions is currently preventing academic institutions and industry partners from developing strategies to meet growing energy workforce demands. In order to find lasting solutions to these workforce issues, energy companies must gain a better understanding of what drives new employees to join the energy industry. Therefore, the purpose of this study is to generate a statistical model that can be used to identify factors within the university-industry partnership system that influence engineering students' intentions to pursue careers in the energy industry after graduation (i.e., energy industry pursuit intentions).

CHAPTER 2: LITERATURE REVIEW

Educational institutions, government agencies, and industry representatives have voiced concerns about the disparity between the preparation of engineering graduates and current workforce needs. The engineering profession has evolved over time due to rapid changes in technology, shifts in population demographics, and economic globalization; however, changes in engineering education have been slow to catch on. Despite numerous efforts to develop strategies for improvement, the engineering profession continues to struggle with recruiting and retaining enough students (National Science Board, 2007; Ohland et al., 2008) and practicing engineers to satisfy current workforce demands (Frehill, Di Fabio, Hill, Traeger, & Buono, 2008).

Finding ways to increase persistence in the engineering profession has become a priority in engineering education research. Previous studies have investigated individual (e.g., Eris et al., 2010), programmatic (e.g., Lichtenstein, McCormick, Sheppard, & Puma, 2010), and contextual factors (e.g., Winters et al., 2012) as they relate to engineering students' post-graduation career plans. The National Science Foundation (NSF) has also launched initiatives over the past several decades to address the challenges in engineering education. Substantial investments have been made at all levels including curriculum development, undergraduate research experiences, graduate fellowships, and training for K-12 teachers and college faculty. Although many of these programs have generated positive results, they have mostly led to local improvements rather than systemic transformation in the perceptions, education, and practice of engineering (Duderstadt, 2008).

The inability to attract the best and brightest into the engineering profession is a complicated issue. Part of the problem is the way engineering is perceived by prospective students, teachers, parents, guidance counselors, and society at large (National Science Board, 2007). Survey data show that, in general, the public associates engineers with economic growth and national defense, but many people fail to recognize the role that engineering plays in improving health, the environment, and quality of life (National Science Board, 2007).

In addition, many students matriculate into engineering programs with limited knowledge and exposure to the engineering profession (Atman et al., 2010). A study by Atman et al. (2010) found that only about 20% of first-year engineering students had significant exposure to engineering activities before entering college (e.g., engineering coursework or internships during high school). Students' lack of familiarity with different engineering careers has also been shown to contribute to their departure from engineering before and after earning an undergraduate degree (Carrico et al., 2012). These perceptions are largely a result of several factors, including narrowly focused engineering curricula, general acceptance of restrictively technical roles in many engineering careers, and the inconsistent messages sent by different interest groups to promote the engineering profession (Duderstadt, 2008). In light of these shortcomings, it is not surprising that today's best students often choose careers in other fields, such as medicine, law, and business, that appear to have more influence, reward, and stability than engineering.

Previous research on professional persistence in engineering has largely focused on students' decision to pursue engineering versus non-engineering careers. One study found that only about 30% of engineering students planned to continue in engineering exclusively after graduation (i.e., work and/or graduate school) (Atman et al., 2010). In contrast, most other students considered a combination of engineering and non-engineering options. Similarly, Lichtenstein et al. (2009) found that 42% of senior engineering students definitely intended to pursue a career in engineering after graduation while 14% of students did not. The remaining 44% were still unsure, which suggests that many college students are not proactively planning for life after graduation. This lack of forward thinking has been shown to result in rushed and spontaneous career decision-making (Perry, 1970). In general, little is known about the process by which students commit to their career choices during college. This gap in knowledge stifles the development of interventions designed to increase students' intentions to pursue careers in certain fields, such as engineering, after graduation.

2.1. Student Involvement

Since students are exposed to myriad environments during college, it is critical that educators and employers understand how different types of involvement affect students' personal and professional development. Many researchers have used person-environment theories to examine student development (e.g., Banning & Kaiser, 1974; Holland, 1966; Tinto, 1987/1993) and identify relationships between individual outcomes (e.g., behaviors, decisions, identity, and learning) with different environmental contexts. For example, Urie Bronfenbrenner (1917-2005) introduced his ecological systems theory (Bronfenbrenner, 1979) to explain growth and development in early childhood, and asserted that development is a function of the interaction between a person and their environment. Bronfenbrenner's developmental ecology model is a nested series of contextual environments that surround the individual (i.e., student) located at the center of the system (Figure 5).

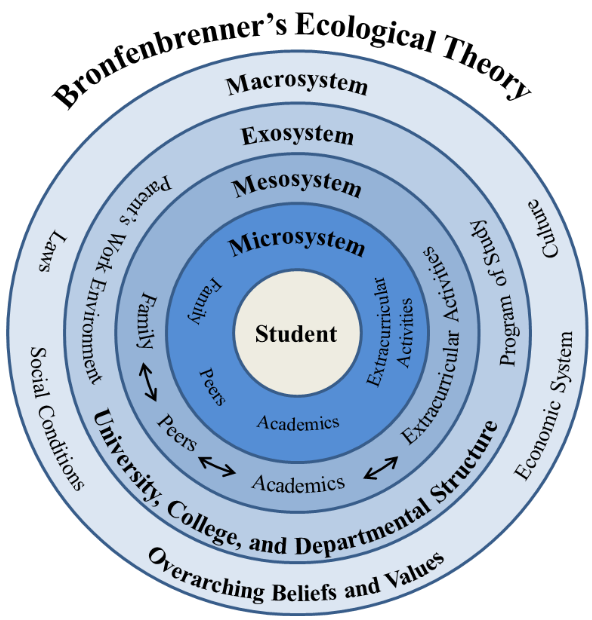

FIGURE 5: Bronfenbrenner's developmental ecology model (Bronfenbrenner, 1993).

Bronfenbrenner's model (1993) includes four levels of context (i.e., the microsystem, mesosystem, exosystem, and macrosystem) that represent the systems where development occurs as an individual interacts with different environments. In a higher education setting, the subsystems can be seen as spheres of influence that impact students' growth and decision-making during college. Complex interactions between these subsystems raise questions about the impact of student involvement on developmental outcomes in different college environments (e.g., curricular and co-curricular activities). In terms of engineering education, there is a growing body of literature dedicated to understanding the impacts of undergraduate engineering experiences on students' educational and professional outcomes.

2.1.1. The Engineering College Experience

Comparing student involvement across majors can uncover valuable insights about programmatic features that are unique to the engineering experience (Lichtenstein et al., 2010). Lichtenstein et al. (2010) used data from the National Survey of Student Engagement (NSSE) to examine student engagement indicators (e.g., student-faculty interaction, time on task, and enriching educational experiences) and their outcomes for engineering students and students in other majors. The study found that engineering students are similar to non-engineering majors in their 1) interaction and research with faculty, 2) participation in co-curricular activities, 3) participation in learning communities, 4) volunteer/community participation, 5) self-reported GPA, 6) support for student success, and 7) overall satisfaction. However, there were various differences between engineering students and other majors in terms of 1) time-on-task, 2) enriching educational activities, and 3) engagement outcomes (Lichtenstein et al., 2010).

Although engineering students responded similarly to other students on several of the time-on-task variables (e.g., hours spent participating in co-curricular activities, social activities, commuting), engineering students spent significantly more time preparing for class and less time working for pay off campus (Lichtenstein et al., 2010). More considerable differences were observed in terms of students' enriching educational experiences. Senior engineering students reported the greatest involvement in culminating senior experiences (94.8%), which is not surprising since most accredited engineering programs are mandated to provide a senior year design course. Engineering seniors also had among the highest participation in a practicum, co-op, field experience, or internship (85.6%), on average. Yet, senior engineering students reported the lowest involvement in foreign language courses (33.5%) and study abroad (22.0%), and nearly the least involvement in independent/self-study (22.6%) (Lichtenstein et al., 2010).

Disparities between engineering students' experiences and those of students in other majors suggest possible programmatic differences. The robust nature of the engineering curriculum reduces the number of electives that engineering students can take and the amount of time they can spend off campus. These curricular demands likely attribute to the reasons why engineering students are less apt to take foreign language courses or study abroad (Lichtenstein et al., 2010). Differences in curriculum could also influence disparities seen in engagement outcomes between engineering students and those in other majors. For example, although engineering students reported significantly higher gains in practical competence, they had amongst the lowest scores for reflective learning, integrative learning, general education gains, and gains in personal and social development (Lichtenstein et al., 2010). Overall, the results of the study indicate that curricular demand has the largest programmatic influence on engineering students' level of engagement during college.

2.1.1.1. Engineering Student Involvement

Among the studies that have focused specifically on engineering undergraduates, Wilson, Plett, VanAntwerp, and Bruxvort (2011) found a link between social connections made through co-curricular activities and women's persistence in engineering. Research from the Center for the Advancement of Engineering Education (CAEE) (e.g., Stevens, Amos, Garrison, & Jocuns, 2007) also identified the importance of participation in co-curricular activities to promote academic success. Other studies reported that co-curricular involvement (Choudhary, 2012) and social integration (Massi et al., 2012) can lead to higher GPAs among engineering students. However, Wilson et al. (2013) points out that 1) the availability of co-curricular activities, 2) students' availability to participate in these activities, and 3) associated benefits of co-curricular activities may vary by institution and campus culture.

Another study called the Academic Pathways Study (APS) investigated connections between students' involvement in engineering and non-engineering activities and their perceived confidence and gain in a variety of skills (Atman et al., 2010). The study found that non-engineering activities largely contributed to engineering students' confidence in professional and interpersonal skills; however, these skills were only weakly predicted by involvement in engineering co-curricular activities or performing research with a faculty member (Atman et al., 2010). No predictive relationship was found between exposure to engineering through co-op, internship, or work experience and students' confidence in professional and interpersonal skills. One explanation that the authors suggest is that more socially confident students may be drawn to non-engineering activities more than less socially confident students. Nevertheless, these results suggest that engineering activities do not have the same effect on engineering students' professional and interpersonal confidence as non-engineering activities (Atman et al., 2010).

Most participants in the APS acknowledged the importance of professional and interpersonal skills; yet, students tended to rate these kinds of skills secondary to math and science skills (Atman et al., 2010). Researchers found that 1) participation in engineering co-curricular activities, 2) involvement in research, 3) frequency of interaction with faculty, and 4) exposure to engineering through co-ops, internships, and work experience had no predictive power related to students' confidence in math and science skills (Atman et al., 2010). These findings suggest that improvements should be made to increase the professional and social skill development for engineering students as a result of their involvement in engineering-focused co-curricular activities. Since many engineering students tend to participate in more engineering than non-engineering co-curricular activities, it is important that engineering activities provide similar opportunities for students to gain a broad set of skills (i.e., technical and social skills) that will increase their chances for success after graduation.

2.1.1.2. Engineering College Experiences by Class Standing

To gain a clearer picture of engineering students' college experiences, the Academic Pathways Study (APS) conducted several analyses to compare groups of students based on class standing, gender, and socioeconomic status (Atman et al., 2010). In terms of class standing, senior engineering students had more co-op, internship, and research experiences than first-year engineering students, as well as greater involvement in other engineering co-curricular activities. However, participation in non-engineering activities was comparable between the two groups.

Further results revealed that seniors were less academically involved in both their engineering and liberal arts courses (i.e., being absent or late for class, turning in assignments that did not reflect their best work) compared to first-year students. It is plausible that the decline in academic involvement among senior engineering students may be associated with the increase in their participation in engineering activities and research (Atman et al., 2010). This may reveal that senior engineering students have a desire to expand their ways of learning, and may not be as concerned with their curricular performance as they were in their earlier college years.

Senior male students also reported a greater sense of curricular overload and more difficulty balancing their personal and academic lives than first-year male students. This difference was not present among female students whose sense of curricular overload and difficulty with balance exceeded those of male students at both the first-year and senior levels. Reasons for this discrepancy will be revealed in the following discussion about gender effects on the engineering college experience.

2.1.1.3. Engineering College Experiences by Gender

In general, female and male students majoring in engineering have many similar college experiences according to results of the Academic Pathways Study (APS). Men and women reported similar 1) GPAs, 2) levels of interaction and satisfaction with their instructors, 3) levels of academic involvement, and 4) exposure to engineering through co-ops, internships, and research (Atman et al., 2010). In contrast, female students reported more frequent involvement in engineering and non-engineering co-curricular activities than did their male counterparts at both the first-year and senior levels. In addition, when asked about the importance of co-curricular experiences, female students attributed more importance to non-engineering activities than male students. From these results, it appears that undergraduate women in engineering place greater value in activities outside of the classroom than do their male counterparts (Chachra, Chen, Kilgore, & Sheppard, 2009).

Another noteworthy difference between male and female engineering students was observed in relation to their sense of curricular overload. In the APS, women reported a greater sense of curricular overload than men at both first-year and senior level ($p < 0.05$). Female students also reported greater pressure to balance their social and academic lives than male students ($p < 0.05$). Interestingly, the authors noted that no correlation was found between curricular overload and participation in co-curricular activities (Atman et al., 2010).

2.1.1.4. Engineering College Experiences by Socioeconomic Status

Differences in the engineering college experience based on socioeconomic status (SES) were examined using survey data from a smaller targeted study within the Academic Pathways Study (APS) (i.e., Broader Core Sample, n = 842) (Atman et al., 2010). Results from the study showed that students in the highest and lowest SES quartiles reported similar 1) frequency of interaction with instructors, 2) academic involvement in engineering and non-engineering classes, 3) motivation to study engineering for social good and mentor reasons, and 4) strength of intention to complete their engineering degree. In contrast, students in the lowest quartile expressed a greater sense of curriculum overload, were less satisfied with college instructors, were less involved in non-engineering co-curricular activities, and were less confident in technical skill sets.

Furthermore, students in the lowest quartile who were motivated to study engineering for financial and family reasons, were 1) more involved in engineering co-curricular activities, 2) reported more importance to professional and interpersonal skills in the practice of engineering, and 3) expressed greater intention to continue in engineering after graduation (Donaldson, Lichtenstein, & Sheppard, 2008). Collectively, the findings from the Academic Pathways Study (APS) show that differences in student characteristics play a significant role in defining how engineering students construct and experience activities both in and out of the classroom throughout their college years.

2.1.2. Curricular and Co-Curricular Involvement

Involvement in curricular and co-curricular activities varies from student to student. Some students desire significant levels of involvement during their college years, while others are either more selective in their choices of engagement, or prefer to be uninvolved in activities outside of the classroom (Atman et al., 2010). The way that students choose to allocate their time is a product of many factors that are unique to each student and their respective environment.

One study by Thompson, Clark, Walker, and Whyatt (2013) explored students' value of co-curricular activities using a sample of students from the United Kingdom. Their results showed that personal interest was the greatest motivator for students to engage in certain co-curricular activities. Students were also motivated by a desire to meet people and make friends, as well as for career development and financial gains (Thompson et al., 2013). Most students (80%) recognized that their co-curricular activities could have career-related benefits, but the skills they listed were very general (e.g. communication skills or team work).

For most students in the study, enjoyment and the social elements of co-curricular activities were essential aspects of their experiences (Thompson et al., 2013). Several students noted that they used co-curricular activities as an escape to cope with stress, while others indicated that the social elements of co-curricular activities provided an important support mechanism for them. Students also expressed that the enjoyment of co-curricular activities came from doing something meaningful for the community, even if it was challenging and impinged on time they could spend on academic work (Thompson et al., 2013).

Although the study by Thompson et al. (2013) was not specifically focused on engineering students, uncovering reasons why undergraduate students choose to engage in various co-curricular activities can help to better understand the college experience in general. Overall, many students choose co-curricular experiences that are strongly aligned with their personal identity. Co-curricular activities are pursued primarily for interest and enjoyment, and students' experiences are enhanced by a sense of social support. The study showed that students are aware of the value of co-curricular activities for employability, developing confidence, character, social skills, planning, and organization. However, it seems that it may be difficult for some students to tailor their pattern of co-curricular activities with specific jobs or occupational fields (Thompson et al., 2013).

There are many factors that may influence students' choices in curricular and co-curricular involvement. Previous studies have shown that engineering students' experiences can differ based on gender (Chachra et al., 2009), underrepresented racial/ethnic minority status, underlying motivation, and confidence factors (Atman et al., 2010). A study by Wilson et al. (2013) found that institutional culture had a stronger influence on STEM students' involvement in co-curricular activities than student characteristics alone. Another study found that students' undergraduate experiences are largely shaped by programmatic structure and may differ by major (Lichtenstein et al., 2010). Although these studies point to different factors that may be important in determining the type of experience that engineering students have during college, there are still gaps in knowledge related to what engineering students desire from their college experiences and how their involvement is related to developmental outcomes.

To fill this gap in knowledge, Finelli et al. (2012) surveyed nearly 4,000 undergraduate engineering students from 18 American institutions to identify differences in student involvement in curricular versus co-curricular activities. Overall, the results indicated that engineering students are highly involved in a variety of activities during college. Of the 15 co-curricular activities listed on the survey, five were related to engineering (e.g., engineering student organizations focused on women, color, major, discipline, or professional interest) and the other ten were non-engineering activities (e.g., student government, varsity athletic team, social fraternity or sorority, on-campus religious organization). Their findings showed that 68% of respondents participated in at least one non-engineering activity, while 76% reported participating in at least one engineering activity (Finelli et al., 2012).

The study also found that the most common co-curricular activity was participation in an engineering student organization based on major, discipline, or professional interest (70%) (Finelli et al., 2012). The next most common activities were involvement in an engineering design competition team (30%), on-campus religious organization (29%), engineering student organization focused on women (23%), social fraternity or sorority (22%), and leadership program or academy (20%) (Finelli et al., 2012). These results suggest that engineering students tend to prefer participating in engineering activities over non-engineering activities. However, the descriptive nature of the data presented by Finelli et al. (2012) limits the ability to distinguish between engineering students who are more likely to participate in co-curricular activities in general, and those who may prefer to only participate in engineering activities. Nonetheless, the percentage gap between students' participation in engineering activities (76%) and non-engineering activities (68%) provides evidence that a trend toward engineering activities exists to some degree.

2.1.3. Benefits of Student Involvement

Higher education research has demonstrated links between involvement in co-curricular activities and various educational and developmental outcomes. In general, research on the value of co-curricular activities has shown that student engagement is related to a number of workplace skills, such as improved critical thinking, leadership, and social skills (Thompson et al., 2013; Tieu et al., 2010). Activities outside of the classroom, such as internships, cooperative education (co-ops), disciplinary and professional societies, and research with faculty members, have also been shown to have significant impacts on students' persistence in engineering (Astin, 1984; Kolb, Boyatzis, & Mainemelis, 2001; Pascarella & Terenzini, 2005).

Since many traditional engineering programs do not require a professional development core as part of the curriculum, experiential learning opportunities outside the classroom can supplement academic programs by promoting specialized learning and skill development. In general, career-oriented experiences provide students with opportunities to develop new interests, get acquainted with the engineering community, and increase self-confidence. Experiential learning focuses on problem solving, reflection, and application, which allows students to not only gain content knowledge, but also provides an opportunity for self-evaluation and the establishment of a personal belief system (Kolb et al., 2001). This greater sense of self can be used to guide students in making more purposeful decisions about their futures. In order to improve the academic and professional persistence of engineering students, academic institutions must work with industry partners to create more inclusive environments that resonate with this generation of students and their values.

2.1.3.1. Internships and Co-ops

Internships and cooperative education programs (co-ops) are career-oriented activities that provide opportunities for undergraduates to explore, reflect, and learn in a formal work environment. Previous studies have found that these types of experiential learning programs can increase students' motivation and self-efficacy, gain specific technical skills, improve their abilities to apply knowledge, solve problems, and communicate professionally (e.g., Anderson et al., 2011). In addition, internships and co-ops have been shown to improve students' understanding of the work environment, which can lead to greater certainty about their career choices (Anderson et al., 2011). Another study by Reisberg et al. (2012) found that participation in a well-placed co-op can improve students' work self-efficacy, which measures students' belief in their command of various social requirements necessary for success in the workplace (e.g., exhibiting teamwork, expressing sensitivity, managing politics, handling pressure). Through its enhancement of self-efficacy, cooperative education has also shown to sustain students' academic performance (Davie & Russell, 1974; Reisberg et al., 2012) and their persistence to graduation (Somers, 1986).

2.1.4. Shortcomings of the Engineering College Experience

The Academic Pathways Study (APS) showed that while most engineering students reported considerable intellectual growth during their undergraduate years, some students felt that majoring in engineering restricted their ability to take advantage of other aspects of the college experience (Atman et al., 2010). For example, engineering students reported lower gains in personal growth and fewer opportunities to study abroad than students in other majors (Atman et al., 2010). The complexity and heterogeneity of experiences among individual college students makes it difficult to draw conclusions about the impact of certain activities on developmental outcomes, in general. Even when students participate in the same curricular and co-curricular activities, they may internalize their experiences in different ways. In addition, students come to college from diverse backgrounds, which can also impact the outcomes of their experiences (Atman et al., 2010).

Although most engineering students are highly active in engineering and non-engineering co-curricular activities, research shows that students are not always strategic in their choices of involvement on and off campus (Thompson et al., 2013). This also holds true for many engineering students who wait too long to make plans for after graduation, such as choosing a career or going to graduate school (Lichtenstein et al., 2009). Few studies have explored the relationship between involvement in co-curricular activities and students' perceived value of their experiences, especially among engineering students. This leaves many questions unanswered about the value of an engineering education and the overall college experience.

A study by Stevens et al. (2007) was conducted to find out about the sacrifices that engineering students make to successfully become engineers after graduation. In their interviews, students frequently justified the difficulty of the engineering curriculum compared to other majors because they anticipated a comfortable lifestyle as an engineer in the future. This is referred to as a meritocracy of difficulty, which is used to explain how engineering students spend their time and justifies why they make extreme sacrifices during their formative college years.

In the study, students often reported sacrificing time for social activities, such as relaxation, going to parties, and spending time with friends in order to focus on their academic responsibilities. Many students also reported giving up other pursuits, like playing music, which were important to them prior to becoming an engineering student. In addition, students commonly explained that giving up a portion of a good night's sleep on a regular basis was considered a necessary part of being in engineering (Stevens et al., 2007).

Stevens et al. (2007) points out that one of the most significant implications of the meritocracy of difficulty is the way it leads engineering students to distinguish themselves from students in other majors. In their narratives, engineering students had a tendency to view their discipline as superior to other majors (Stevens et al., 2007). Engineering students described the dramatic differences in the difficulty of their work and the amount of time they had to commit to their schoolwork compared to their non-engineering peers. To some students, it seemed like engineering students are generally more attached to their major, while non-engineering students tend to spend more time exploring and trying new things. Other engineering students reported not being able to relate to students in other majors, and even talked about feelings of resentment towards students in other majors because they believed that they had easier work and better lives (Stevens et al., 2007).

This phenomenon of isolation could further explain why engineering students have a tendency to be more involved in engineering rather than non-engineering activities. In addition to their desire to gain practical competencies for future employment, engineering students' strong identity with their discipline may sway them to participate in co-curricular activities where they interact mostly with other engineering students. Therefore, students who find comfort in their sense of community in engineering may be less inclined to participate in non-engineering activities. However, it is important to note that not all engineering students are equally committed to their major or plan to join the engineering workforce after graduation.

2.1.4.1. Career Decision-Making

Students' post-graduation plans may also play a role in how engineering students choose to allocate their time. Results from the Academic Pathways Study (APS) showed that about 30% of engineering students had post-graduation plans focused exclusively on engineering (i.e., work and/or graduate school) (Atman et al., 2010). These students were strongly motivated to study engineering for intrinsic reasons and were likely to participate in co-op and/or internship experiences. In general, these students were less confident in their professional and interpersonal skills than students with exclusively non-engineering post-graduation plans. This lack of confidence in social skills may be another reason why some engineering students avoid participating in non-engineering activities. A key finding in this study, however, was that most other students were considering a combination of engineering and non-engineering post-graduation options. This shows that even late into their senior year, some students were still uncertain as to whether an engineering or non-engineering career path would be the best fit for them (Lichtenstein et al., 2009).

The lack of strategic career planning among engineering students reiterates the need to reform engineering education to emphasize the development of various professional and social skills as well as technical expertise. Complex challenges of the 21st century require that engineering graduates have both deep skills in a specific discipline and a broad ability to apply their knowledge in different situations. More research in engineering education is still needed to guide the future direction of the engineering experience to improve the number of talented students that enter and persist in engineering after graduation.

2.2. Theoretical Framework

Given the interdisciplinary nature of this study, several theories from different disciplines are used to guide the research approach in this investigation. The theoretical framework is composed of theories from the fields of college student development and vocational psychology. This section describes how Astin's theory of student involvement, person-environment fit theory, and the theory of reasoned action are used in this study to better understand the effects of involvement and attitudes on engineering students' career intentions.

2.2.1. Astin's Theory of Student Involvement

Alexander Astin (1984) developed the theory of student involvement to explain how environmental influences can impact student development during college. Astin defines student involvement as “the amount of physical and psychological energy that the student devotes to the academic experience” (Astin, 1984, p. 518). Unlike other theories that examine development primarily through a psychological lens (e.g., Chickering, 1969; Kohlberg, 1971; Perry, 1970), Astin’s theory is more oriented around the behavioral mechanisms and processes that facilitate student development (Astin, 1984). That is, Astin’s theory of student involvement focuses on *how* students develop during college, not on development itself (Astin, 1984).

Early research on the impact of higher education mainly focused on identifying the significance of the overall college experience. These studies typically used characteristics of the entire institution (e.g., size, selectivity, location) to compare outcomes of those who went to college with those who did not. With the vast expansion and diversification of individuals attending college over the past few decades, researchers have become increasingly interested in comparing the impact of different college experiences on student outcomes (Astin, 1970b). Rather than using between-college environmental variables as seen in early college impact studies, more recent research uses various within-college environmental variables (e.g., academic involvement, student-faculty interaction, peer association, involvement in co-curricular activities) to assess individual impacts on student outcomes (Astin, 1970b).

2.2.1.1. The Input-Environment-Outcome Model

Several decades ago, Astin developed the input-environment-outcome (I-E-O) model as a conceptual and methodological guide to study the impact of college experiences on students' personal, social, academic, and vocational development (Astin, 1970a, 1970b). “The I-E-O model is very simple, yet it provides a powerful framework for the design of assessment activities and for dealing with even the most complex and sophisticated issues in assessment and evaluation" (Astin, 1991, p. 16). The model was founded on the premise that any educational assessment is incomplete unless it includes data on student inputs, outcomes, and the educational environment to which students are exposed.

The I-E-O model is comprised of three conceptually distinct components: student inputs, student outcomes, and the educational environment (Figure 6). Inputs refer to personal qualities and experiences that students bring initially to college (Astin, 1993). These may include variables such as demographic characteristics or the initial level of talent at the time of entry (Astin, 1991). Outcomes refer to aspects of students' development (e.g., knowledge, skills, attitudes, aspirations, beliefs, and behaviors) that programs are trying to enhance (Astin, 1970a). The environment refers to students' actual experiences during college (Astin, 1991). Examples of environmental variables include administrative policies, curriculum, teaching practices, peer associations, and other characteristics of the college environment (Astin, 1970a).

Outcome variables may also be referred to as dependent variables, criterion variables, outputs, or endogenous variables (Astin, 1991). Environmental and input variables are both types of independent variables, antecedent variables, or exogenous variables. Inputs can also be treated as control variables. In some studies, environmental variables are referred to as educational experiences, practices, programs, or interventions. (Astin, 1991).

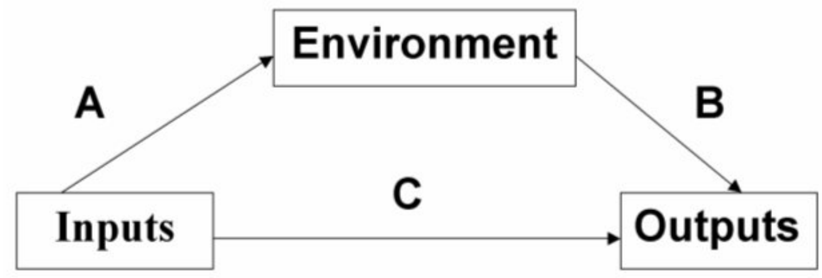

FIGURE 6: Astin's input-environment-outcome (I-E-O) model (Astin, 1991).

The three arrows in the I-E-O model (A, B, and C) represent the relationships among the three types of variables (Figure 6) (Astin, 1991). Educational assessment and evaluation are mainly concerned with relationship B, which are the effects of environmental variables on student outcomes. However, according to Astin's theory, the relationship between environmental variables and student outcomes cannot be wholly understood without taking student inputs into account. As seen in the model, student inputs can be directly related to both the environment (relationship A) and student outcomes (relationship C). In theory, relationship C exists because differences among students tend to be relatively consistent over time. Relationship A is included in the model since different types of students often choose different types of environments during college. Therefore, the model suggests that since inputs are related to both environments and outcomes, inputs can affect the observed relationship between environments and outcomes (Astin, 1991). The present study is particularly interested in learning about environmental variables that can be changed or controlled since these experiences offer the possibility of improving student outcomes.

In general, Astin's research involves determining if and how students are affected by their college experiences, which is a question of "inferring causation" (Astin, 1970a,

p. 224). The I-E-O model serves as a tool to assess how students grow or change due to various environmental conditions during college (Astin, 1993). The methodological challenges for researchers, however, are 1) identifying specific inputs, outcomes, and environmental variables that are to be assessed, 2) devising appropriate means for measuring them, and 3) determining which students have been exposed to each environmental variable (Astin, 1970b).

The primary objective of this study is to identify which environmental factors have the greatest influence on engineering students' intentions to pursue a career in the energy industry after graduation (i.e., energy industry pursuit intentions). Astin's I-E-O model provides the foundational framework for which relationships between student outcomes (i.e., energy industry pursuit intentions) and various environmental variables are evaluated. In addition, this study seeks to expand the I-E-O model by incorporating a second level of environmental variables to test the impact of students' perceptions and attitudes toward careers in the energy industry on their career intentions. This part of the model is guided by person-environment fit theory and the theory of reasoned action, which are described in the following section.

2.2.2. Person-Environment Fit Theory

In order to increase students' intentions to join the energy workforce after graduation, efforts should be made to create inclusive environments in both academic and professional settings where students feel equally welcome and valued. The feeling of inclusion is related to a person's perception of how well they fit within a particular job or organization. The concept of fit comes from vocational theories related to person-environment fit, which can generally be defined as "the congruence, match, similarity, or correspondence between the person and the environment” (Edwards & Shipp, 2007, p. 211).

Person-environment fit is a multifaceted construct with multiple conceptual and methodological approaches. Research on this subject has examined various dimensions of person-environment fit. For example, needs-supplies fit examines the fit between a person’s needs and the supplies available to them to meet their needs in a particular environment. Another example is demands-abilities fit, which looks at the fit between a person’s abilities and the demands of their environment (Edwards & Shipp, 2007). Person-environment fit can also be conceptualized based on the type, or level, of environment (Kristof, 1996). Some studies may be interested in examining the relationship between an individual’s characteristics and those of a particular job (i.e., person-job fit), while others are interested in measuring the compatibility between the values of an individual and those of an organization and its members (i.e., person-organization fit) (Kristof-Brown, Zimmerman, & Johnson, 2005).

Empirical research has supported the importance of person-environment fit across several contexts. A meta-analysis conducted by Kristof-Brown et al. (2005) found that recently hired employees who identified with the culture of their organization (i.e., person-organization fit) had an increased level of attraction, commitment, and intentions to remain with the organization. Subsequent studies have applied this theory to analyze the importance of fit between individuals and the culture of an entire profession. For example, Lai et al. (2008) compared groups of nursing students based on their intentions to stay in the nursing profession one year after graduation, and found a significant difference in the degree to which students identified with the values of the profession.

Their findings emphasized the importance of student identification with the culture of the nursing profession, and its relationship to employee commitment and turnover (Lai et al., 2008).

A more recent study by Harrison (2010) investigated the antecedents of nursing students' person-environment fit and their impact on career-related outcomes for the nursing profession. Harrison (2010) developed a construct called professional fit to measure the extent to which an individual perceives a match with the values and goals of a particular profession. Results from the study indicated that changes in nursing students' professional fit, as a result of participation in a work integrated learning program, predicted higher levels of job and organizational attraction and career choice intentions.

Previous measures of person-environment fit are not appropriate to use in the current study since its focus is on an entire industry rather than a particular job, organization, or profession. This study, therefore, proposes a new dimension of person-environment fit called industry fit, which describes the congruence between an individual's professional goals and values and those of a particular industry.

2.2.3. Theory of Reasoned Action

Interactions between students and their environment can affect the attitudes that students develop during college. Understanding students' attitudes toward the energy industry may help educators and employers develop new practices to increase students' intentions to work in the energy industry after graduation. In this study, the theory of reasoned action provides a framework to examine the relationship between students' attitudes toward careers in the energy industry and their energy industry pursuit intentions.

The theory of reasoned action suggests that human behavior is determined by an individual's intention to engage in a behavior, and that the intention is a function of the individual's attitude toward the behavior and subjective norms (Fishbein & Ajzen, 1975) (Figure 7). Intention represents a person's readiness to perform a given behavior, and it is considered to be the immediate antecedent of behavior. The notion that intentions predict behavior better than attitudes has been well supported by empirical research (e.g., Kim & Hunter, 1993).

The theory of reasoned action makes a clear distinction between attitudes and intentions. An attitude is passive in nature and does not necessarily imply that a behavior will occur (Highhouse et al., 2003). In contrast, intentions refer to thoughts about the behavior that do imply further action. For instance, a person's intention to apply for a job is a better predictor of their action to actually pursue that position rather than their attitudes toward the job itself.

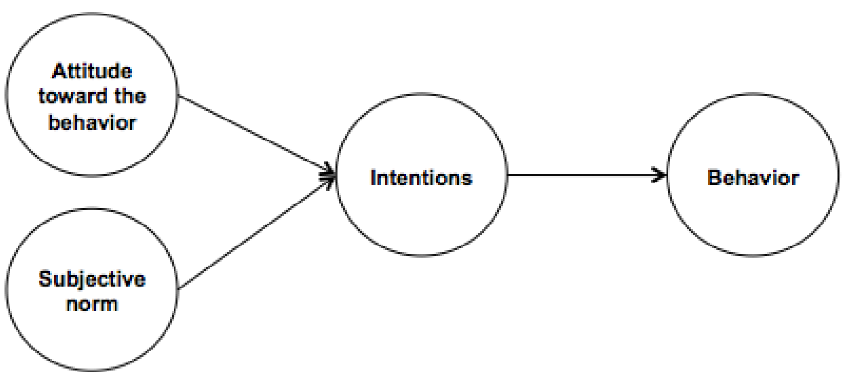

FIGURE 7: Theory of reasoned action (Fishbein & Ajzen, 1975).

Studies in industrial and organizational psychology frequently use attraction and intentions as predictors of job and organizational choice (e.g., Highhouse et al., 2003). In general, it is thought that individuals who have positive attitudes towards a particular job (i.e., job attraction) will be more inclined to engage in behaviors associated with obtaining that position (Harrison, 2010). It can, therefore, be presumed that those who have positive attitudes towards a particular industry (i.e., industry attraction) will be more inclined to engage in behaviors associated with getting a job in that industry.

Since behavior is dependent on intentions, the theory of reasoned action suggests that the energy industry's recruitment and retention of the nation's most talented students depends on students' intentions to pursue energy-related jobs. Furthermore, the theory suggests that students' intentions to work in the energy industry are a function of their attitudes (i.e., industry attraction) toward the industry itself and subjective norms. Since industry attraction may not be the only factor to influence students' energy industry pursuit intentions, it may also be important to consider the effects of other environmental variables, such as peer influence and institutional emphasis (i.e., subjective norms), on students' industry fit and intentions.

The attraction-selection-attrition (ASA) model introduced by Schneider (1987) suggests that a person's attraction to an environment is a function of their level of congruence. For example, if someone experiences a high level of fit with the culture of a particular organization, they will also find it to be an attractive place to work. Therefore, it seems possible that students' attraction to the energy industry could be a function of their perceived industry fit.

Person-environment fit theory and the theory of reasoned action provide a basis for describing the relationship between industry fit, industry attraction, and energy industry pursuit intentions. Combined with Astin's input-environment-outcome (I-E-O) model, the theoretical framework for this study suggests that those who experience high levels of fit are more attracted to the environment (i.e., energy industry), which influences intentions to enter that environment. Empirical research has supported these theoretical relationships. For example, Carless (2005) found that attraction mediated the relationship between person-job fit and applicants' intentions to accept a job offer from a telecommunications company. In order to remedy current workforce issues in the energy industry, academic institutions and industry partners must gain a better understanding of how different environments can provide additional means to attract engineering students to jobs in the energy industry after graduation.

2.3. Summary

Rapid changes in technology, demographics, and globalization are currently driving a movement to revolutionize engineering education in order to effectively prepare a new generation of engineers to meet 21st century challenges. As demand for energy continues to rise, the United States energy industry is facing several workforce issues as large waves of Baby Boomers begin to retire, and replacement positions require workers with higher levels of education and different skills than their predecessors. Unfortunately, the existing pipeline is inadequate to provide the needed STEM-capable workers to fill all current and projected positions in the energy industry.

Due to the nature and extent of these workforce issues, developing a talented energy workforce will require strong partnerships between academic institutions and industry corporations. However, little is known about the effects of university-industry environments on engineering students' intentions to pursue careers in the energy industry after graduation. Therefore, this study seeks to better understand how student characteristics and various environmental factors influence engineering students' energy industry pursuit intentions. This research will expand upon Astin's input-environment-outcome model by incorporating concepts and theories from vocational psychology to facilitate a holistic examination of environmental variables within the university-industry partnership system.

CHAPTER 3: METHODS

3.1. Research Setting

This study was conducted at a large public urban research university in the southeastern United States. Enrollment at the university exceeds 28,000 students, including approximately 5,200 graduate students. The university has seven academic colleges, including the College of Engineering, which has around 3,600 students and the closest relationship with the university-industry partnership due to its focus on energy engineering.

The Energy Production and Infrastructure Center (EPIC) is a university-industry partnership at the site university. EPIC is a collaborative, multidisciplinary effort that unites the academic and research expertise of the university with a vast wealth of knowledge from over 240 energy corporations in the area. This initiative was formed to meet the growing demand for highly trained power and energy professionals, and to help develop innovative solutions that promote an affordable and sustainable energy supply for the future (EPIC, 2013). This university-industry partnership has been working on expanding energy engineering experiences both in and out of the classroom through the implementation of new course offerings, energy concentrations, internships, senior design projects, scholarships, and more. These interventions are made possible by bringing together the strengths of industry partners and the resources available at the university.

In recent years, energy companies in the region have joined forces with educational institutions to provide meaningful internship experiences for college students that will bring awareness to the many opportunities that are available for employment in the energy industry. In the summer of 2013, approximately 600 students participated in internships and co-op assignments at local energy companies (E^4 Carolinas, 2014). Internships ranged across different areas of the energy industry, such as smart grid, nuclear, gas, solar, and manufacturing. Students who participated in internships also represented various majors, including engineering, IT, human resources, communications, finance, legal, and accounting (E^4 Carolinas, 2014).

EPIC has worked hard to create new ways for students to engage with the energy industry; however, there is currently no system in place to empirically measure the success of these efforts. Since one of the goals of EPIC is to prepare engineering students to fill available positions in the energy industry, a measure of success would be to determine the amount of influence these interventions have on engineering students' intentions to pursue careers in the energy industry after graduation. Thus, this study seeks to fulfill EPIC's need for measuring its success by evaluating the impact that students' involvement with the university-industry environment has on their career intentions.

3.2. Research Design

Quantitative, causal comparative research methods are used to examine the effects of student involvement, attitudes, and university-industry environmental factors on students' energy industry pursuit intentions. A convenience sample of undergraduate engineering students from the site university as well as students participating in internships and co-ops at eight energy-related companies was used. Data was collected using an online survey instrument called the Career Assessment for Students in Energy (CASE) survey, which was developed for this study. The online survey was active from June 22, 2015 to August 21, 2015. Descriptive statistics are used to illustrate characteristics of the survey data, and structural equation modeling (SEM) is used to examine hypothesized relationships for two competing models. Approval from the site university's Institutional Review Board (IRB) was granted prior to the start of data collection.

3.3. Sample Selection

The sample (n = 381) was selected from two sources: 1) College of Engineering students from the site university and 2) engineering students from 58 different institutions participating in internships or co-ops at one of eight energy-related companies that partner with the site university. In order for a student to be included in the sample, participants must have either 1) been enrolled as an undergraduate student in the College of Engineering at the site university during Spring 2015 semester, and at least 18 years old, or 2) participated in an internship or co-op at one of the target energy-related companies during Summer 2015, been an undergraduate student enrolled in a college or university, and at least 18 years old.

Students' email addresses were gathered directly either from the energy-related companies or the College of Engineering at the site university. Email addresses were used to send unique links to the online survey to ensure that participants only took the survey once. One energy-related company who would not disclose its employees' e-mail addresses was sent an e-mail with a generic link to the survey, which was forwarded to intern and co-op students at the company. Reminder e-mails were sent bi-weekly to those who had not yet responded to the survey.

Links to the online survey were sent to 2,429 e-mail addresses including those for 438 intern and co-op students and 1,991 students in the College of Engineering at the site university. In total, 499 subjects responded to the online survey resulting in a 21% response rate. However, not all of the respondents were eligible to be included in the sample. Respondents were excluded from the sample if they 1) did not agree to the consent form at the beginning of the survey, 2) previously responded to the survey using a different e-mail address, 3) were a graduate student, 4) were not an engineering major, or 5) did not respond to any survey questions (Table 2).

TABLE 2: Frequencies of respondents that were excluded from the sample

Reason for Exclusion from Sample	Count	Percent (%)
Did not consent to survey	1	0.2
Previously responded to survey	4	0.8
Graduate student	18	3.6
Non-engineering major	30	6.0
Did not answer any survey questions	65	13.0
Total	118	23.6

After removing 118 ineligible subjects from the sample of respondents, the final sample size was 381. To determine the overall response rate, the 118 ineligible subjects were removed from the total sample pool (n = 2,376), resulting in a 16% response rate. Although this seems rather low, it is likely that the proportion of ineligible subjects (24%) would have been similar for the overall subject pool, causing the response rate to be underestimated. In addition, engineering students from the site university who participated in an internship or co-op at an energy-related company could have only used one of their e-mail addresses to take the survey (i.e., university e-mail address or company e-mail address). Therefore, numerous survey invitations could not be used, which also contributed to the underestimated response rate.

This method of sample selection yielded an acceptable sample size (n = 381) consisting of participants from 58 universities across the country with the largest percentage from universities in North Carolina (63%) (Figure 8). Capturing a diverse sample generates variability in the data and increases the generalizability of the study's results.

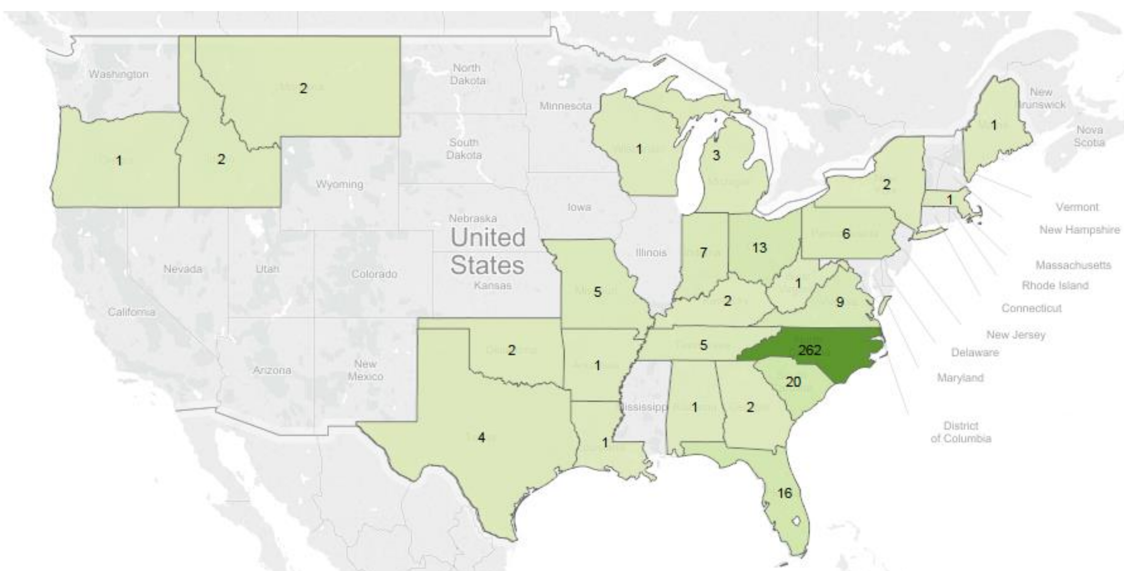

FIGURE 8: Geographic distribution of the sample (n = 370) by participants' academic institution at the state level. Participants that did not indicate their college or university and those from foreign institutions are not included in this figure. States that are more heavily shaded have more participants than states with lighter shading.

Table 3 shows a breakdown of the sample by gender, age, ethnicity, and academic class. In terms of gender, males accounted for 74.0% of the sample and females accounted for 14.4%. The representation of females in the sample is close to the 2012 national average of 19.2% women earning bachelor's degrees in engineering (National Science Foundation, 2015). As for age, a vast majority of the sample consisted of students between the ages of 18 and 24 (71%). In terms of ethnicity, almost 70% percent of the sample identified as White/Caucasian, following by 6% Hispanic/Latino, 5% Asian/Asian American, and 4% as Black/African American. This distribution is similar to the percentage of engineering degrees earned by underrepresented minorities in 2012 (12.9%) (National Science Foundation, 2015). As for academic class, juniors made up almost 40% of the sample, followed by sophomores (21.5%), seniors (21.3%), and freshmen (6.8%).

3.4. Instrumentation

The Career Assessment for Students in Energy (CASE) survey is the instrument developed to collect data for this study (see Appendix A). There are a total of 76 items on the survey, which include items to measure observed and latent variables in the models, demographic questions, and other items that were not analyzed in this study. Most items were selected and/or modified from pre-existing survey instruments, and new items were created when previous measures were not available. This section describes each of the variables included in the hypothesized models tested in this study.

TABLE 3: Demographics of study sample

Factor	Characteristic		*n*	%
Gender				
	Female		55	14.4
	Male		282	74.0
	Other gender identification		1	0.3
	Prefer not to answer		2	0.5
	Did not respond		41	10.8
		Total	381	100.0
Age				
	18-24		271	71.1
	25-34		53	13.9
	35-44		13	3.4
	45 or older		3	0.8
	Did not respond		41	10.8
		Total	381	100.0
Ethnicity				
	White/Caucasian		266	69.8
	Hispanic/Latino		24	6.3
	Black/African American		16	4.2
	Native American/American Indian		3	0.8
	Asian/Asian American		18	4.7
	Multiple		6	1.6
	Other		7	1.8
	Did not respond		41	10.8
		Total	381	100.0
Class				
	Freshman		26	6.8
	Sophomore		82	21.5
	Junior		151	39.6
	Senior		81	21.3
	Did not respond		41	10.8
		Total	381	100.0

3.4.1. Variables

3.4.1.1. Pre-College Knowledge of the Energy Industry (*precoll*)

Precoll is a measure of students' prior knowledge about careers in the energy industry before college. Four items from the APPLES survey (Sheppard et al., 2010) used to measure "Knowledge of the Engineering Profession" were modified to measure the level of knowledge that students had about jobs in the energy industry prior to enrolling in college. The survey items used to measure *precoll* are listed below (Table 4). Response options included: none, very little, some, quite a bit, or a great deal.

TABLE 4: Survey items used to measure *precoll*

Survey Question	Description
	Prior to enrolling in college, please indicate your level of knowledge in the following areas:
Q5	How much knowledge did you have about jobs in the energy industry?
Q6	How much knowledge did you have about corporations in the energy industry?
Q7	How much knowledge did you have about employment opportunities in the energy industry?
Q8	How much knowledge did you have about how to get a job in the energy industry?

3.4.1.2. Curricular Involvement (*curr*)

Curr is an observed variable that measures the extent to which students have participated in energy-related technical electives. In the two hypothesized models, *curr* is a count variable measuring how many energy-related technical electives participants have taken. In the survey, students were asked, “How many energy-related technical elective courses have you taken so far in college?” Response options included: none, 1, 2, 3, 4, or more than 5. Due to the ambiguity of the last response option, all responses for “more than 5” were treated as missing data.

3.4.1.3. Internship/Co-op (*cocurr*)

Cocurr is a dichotomous, observed variable that measures whether or not a student gained knowledge about professions in the energy industry by participating in an internship or co-op at an energy-related company. This variable was created based on responses to Q19 of the CASE survey, which asked, “How did you gain your knowledge about professions in the energy industry? (check all that apply).” Possible response options included: from being a visitor at an energy company, from being a co-op student or intern at an energy company, from being an employee at an energy company (not an internship or co-op), from a family member, from a close friend, from school-related experiences (i.e., a professor or class), or other (open-ended response). The response option “from being a co-op student or intern at an energy company” was re-coded into a new variable (i.e. *cocurr*) where a 1 signifies respondents that gained knowledge about professions in the energy industry by participating in an internship or co-op, and a 0 represents those who did not.

3.4.1.4. Institutional Emphasis (*instemp*)

Instemp is the extent to which an institution (i.e., college or university) emphasizes topics related to the energy industry. This variable is measured using four items that were modified from the National Survey of Student Engagement (NSSE).

Participants were asked to respond to the questions listed in Table 5. The response options for these questions were: none, very little, some, quite a bit, or very much.

TABLE 5: Survey items used to measure *instemp*

Survey Question	Description
	How much does your college or university emphasize the following?
Q23	The importance of the energy industry to society
Q24	Employment opportunities in the energy industry
Q25	Current workforce demands within the energy industry
Q26	Current technological needs in the energy industry

3.4.1.5. Peer Influence (*peers*)

Three items were created to measure peer influence (Table 6). Response options for all three survey questions were: none, some, most, or all.

TABLE 6: Survey items used to measure *peers*

Survey Question	Description
Q28	How many of your peers/friends are interested in studying energy?
Q29	How many of your peers/friends take energy-related technical elective courses in college?
Q30	How many of your peers/friends want to work in the energy industry after graduation?

3.4.1.6. Industry Fit (*fit*)

Fit refers to students' perception of congruence between their own goals and values and those of the energy industry. Four items from Harrison (2010) used to measure Professional Fit were modified to measure *fit*. In the CASE survey, participants were asked to respond to the items below (Table 7). Response options were: strongly disagree, disagree, neutral, agree, or strongly agree.

TABLE 7: Survey items used to measure *fit*

Survey Question	Description
	Rate the following items related to the energy industry:
Q56	I feel that the energy industry is a good fit for me professionally.
Q57	I identify with the values of the energy industry.
Q58	My professional goals fit with the goals of the energy industry.
Q59	I feel that the energy industry represents my own personal values.

3.4.1.7. Industry Attraction (*attract*)

Attract is students' attraction to careers in the energy industry. Four items from Hunjra, Ahmad, Rehman, & Safwan (2011) used to measure Professional Attraction were modified to measure *attract*. In the CASE survey, participants were asked to rate their agreement with the statements below (Table 8). Response options included: strongly disagree, disagree, neutral, agree, or strongly agree.

TABLE 8: Survey items used to measure *attract*

Survey Question	Description
	Rate your agreement with the following statements about your attraction to the energy industry:
Q60	A career in the energy industry is attractive to me.
Q61	If I had the opportunity and resources, I would work in the energy industry.
Q62	Among various options, I would rather work in the energy industry.
Q63	Working in the energy industry implies more advantages than disadvantages to me.

3.4.1.8. Energy industry pursuit intentions (*intent*)

Intent is a measure of students' intentions to pursue a career in the energy industry after graduation. Three items from the APPLES survey (Sheppard et al., 2010) were modified to measure participants' energy industry pursuit intentions (Table 9). Response options for all three survey items were: definitely not, probably not, not sure, probably yes, or definitely yes.

TABLE 9: Survey items used to measure *intent*

Survey Question	Description
	Indicate your intentions to work in the energy industry:
Q64	Do you intend to work in the energy industry for at least 3 years after graduation?
Q65	Is it likely that you will work in the energy industry after graduation?
Q66	Are you more likely to look for a job in the energy industry than any other occupational sector?

3.5. Hypothesized Models

Two competing models were developed in this study to answer the following research questions:

Research Question #1: Which of two competing models best measures the direct and indirect relationships between student involvement (i.e., curricular and co-curricular), attitudes (i.e., industry fit and attraction), and energy industry pursuit intentions?

Research Question #2: What factors within the university-industry environment have the greatest influence on energy industry pursuit intentions?

Research Question #3: What is the relationship between industry fit, industry attraction, and energy industry pursuit intentions?

Each model includes student input, environment, and outcome variables in congruence with Astin's input-environment-outcome (I-E-O) model. The merit of these models resides in the presence of environmental variables that capture characteristics of both student involvement and attitudes toward the energy industry. These models expand Astin's I-E-O model by incorporating constructs from vocational psychology (i.e., fit, attraction, and intentions) that link environmental variables from the university setting (e.g., student involvement, institutional emphasis, peer influence) to students' energy industry pursuit intentions. Both models were specified a priori based on the study's theoretical framework. This type of confirmatory approach is traditionally recommended when using structural equation modeling (SEM).

The models consist of exogenous and endogenous variables. Exogenous variables are predictor or independent variables, and are considered to be the starting points of the model. Dependent variables, on the other hand, are referred to as endogenous variables. Unlike exogenous variables, the presumed causes of endogenous variables are represented in the model (Kline, 2011). These terms can be used with respect to both latent and observed variables.

A conceptual diagram of the first model tested in this study is shown in Figure 9. Hypothesized relationships included in the model are based on Astin's I-E-O model, person-environment fit theory, and the theory of reasoned action:

H_1: Pre-college knowledge of the energy industry (*precoll*) is directly related to curricular involvement (*curr*).

H_2: Curricular involvement (*curr*), internship/co-op (*cocurr*), institutional emphasis (*instemp*), and peer influence (*peers*) are all directly related to industry fit (*fit*).

H_3: Industry fit (*fit*) is directly related to industry attraction (*attract*).

H_4: Industry attraction (*attract*) is directly related to energy industry pursuit intentions (*intent*).

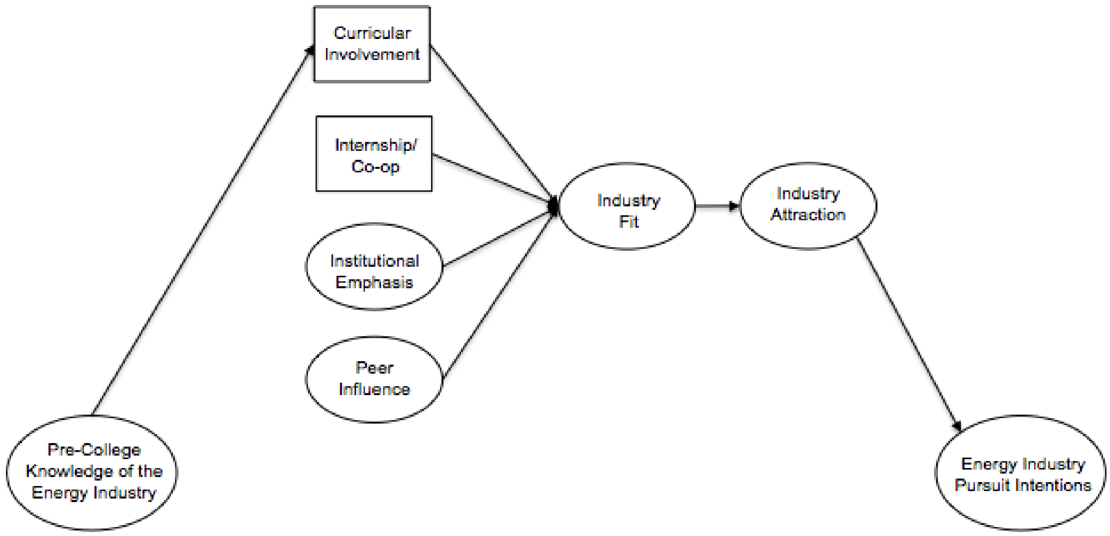

FIGURE 9: Conceptual diagram of model #1 with hypothesized relationships. Ovals represent latent variables, and rectangles represent observed variables. Single-headed arrows are used to define direct relationships between variables.

A conceptual diagram of the second model tested in this study is shown in Figure 10. The following hypothesized relationships are included in the model:

H_1: Pre-college knowledge of the energy industry (*precoll*) is directly related to curricular involvement (*curr*).

H_2: Curricular involvement (*curr*) and internship/co-op (*cocurr*) are directly related to industry fit (*fit*).

H_3: Industry fit (*fit*) is directly related to industry attraction (*attract*).

H_4: Institutional emphasis (*instemp*), peer influence (*peers*), and industry attraction (*attract*) are all directly related to energy industry pursuit intentions (*intent*).

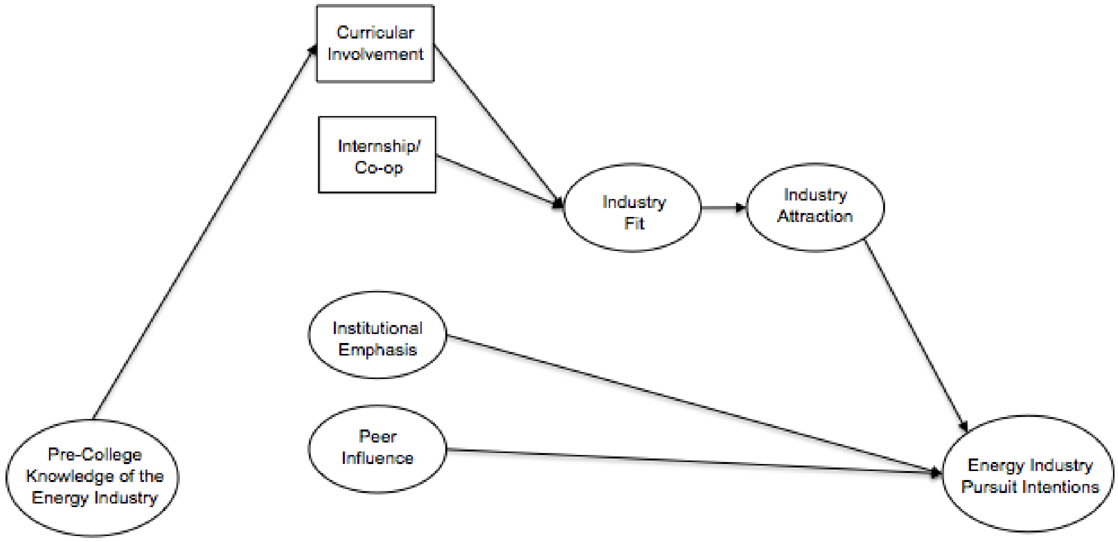

FIGURE 10: Conceptual diagram of model #2 with hypothesized relationships. Ovals represent latent variables, and rectangles represent observed variables. Single-headed arrows are used to define direct relationships between variables.

The difference between the two models resides in the hypothesized relationships involving institutional emphasis and peer influence. In the first model, it is hypothesized that curricular involvement (*curr*), internship/co-op (*cocurr*), institutional emphasis (*instemp*), and peer influence (*peers*) are all directly related to industry fit (*fit*). This hypothesis was made based on Astin's I-E-O model and person-environment fit theory in that a student’s interaction with different environmental characteristics would influence their perceived fit with the energy industry. The second model offers another way to look at the relationships between these variables.

In the second model, it is hypothesized that institutional emphasis and peer influence are directly related to energy industry pursuit intentions rather than industry fit. The rationale behind this hypothesis is based on fundamental differences between the four environmental variables included the models. Curricular involvement and internship/co-op are variables that involve decisions made by the student to gain knowledge and exposure to the energy industry. In contrast, institutional emphasis and peer influence reflect environmental characteristics that are out of the student's control. Since industry fit is a factor that deals with students' perception of their own fit with the energy industry, it is hypothesized that direct relationships exist from curricular involvement and internship/co-op to industry fit, but not for institutional emphasis and peer influence. Instead, the second model hypothesizes that institutional emphasis and peer influence are directly related to energy industry pursuit intentions. This hypothesis tests an alternate path of influence that bypasses the need to establish perceived fit and attraction before developing career intentions. Given the boundless number of models that could potentially fit the data, testing multiple models is recommended when using structural equation modeling (SEM) (Kline, 2011).

3.6. Data Analysis

SPSS and Mplus were the two main statistical programs used to analyze data in this study. SPSS was primarily used for descriptive analyses and data preparation for structural equation modeling (SEM) in Mplus. Mplus was selected among various modeling programs because 1) it offers a wide range of models, estimators, and algorithms that can handle missing data, 2) it has an easy-to-use interface and graphical displays of data and analysis results, and 3) it can analyze models with both continuous and categorical latent variables.

3.6.1. Structural Equation Modeling

Structural equation modeling (SEM) is used to test the models in this study. SEM is a robust methodology that takes a confirmatory (i.e., hypothesis-testing) approach to test a structural theory, which is represented by hypothesized "causal" relationships between multiple variables (Byrne, 2010; Bentler, 1988). The term structural equation modeling conveys two important aspects of the method: 1) that the causal processes of interest are represented by a series of structural (i.e., regression) equations, and 2) that these structural relations can be modeled graphically to more clearly represent the theory being examined (Byrne, 2012).

One of the strength of SEM is that it allows researchers to statistically test a hypothesized model in a simultaneous analysis of the entire system of variables to determine the extent to which it is consistent with the sample data (Byrne, 2012). If the data support the hypothesized model, then more complex theoretical models can be developed. However, if the data does not support the model, the original model can either be modified and re-tested, or other hypothesized models need to be developed and tested (Schumacker & Lomax, 2004).

3.6.1.1. Advantages of SEM

There are several advantages of using SEM over other multivariate techniques (DeShon, 1998). First, SEM takes a confirmatory approach to analyze data unlike other multivariate methods that are exploratory and more descriptive by nature. SEM demands that the pattern of hypothesized relationships are specified a priori, which allows the data to be analyzed for descriptive as well as inferential purposes (Byrne, 2012).

Second, SEM can estimate and correct for measurement error, which is not possible in most other multivariate procedures (Byrne, 2012). Most other methods assume that independent, or explanatory, variables have no error, which may lead to serious inaccuracies, especially when the errors are large (Byrne, 2012). Third, whereas other methods of data analysis are based solely on observed measurements, SEM can analyze both observed and unobserved (i.e., latent) variables (Byrne, 2012). Forth, SEM takes into account the interactions among independent variables, correlations among error terms, and influences by unknown external factors, which cannot be accomplished with alternative methods.

Lastly, unlike standard multivariate regression analysis, SEM can run significance tests among direct, indirect, and total effect estimates. Other relevant strengths of SEM include the use of confirmatory factor analysis (CFA) to reduce measurement error, and the ability to evaluate the direction of causal relationships (Sabatini, 2006). For these reasons, it is not surprising that SEM has become increasingly popular among researchers across many disciplines (Kline, 2011).

3.6.1.1.1. Steps of SEM

There are five steps in structural equation modeling: 1) model specification, 2) model identification, 3) model estimation, 4) model testing, and 5) model modification.

3.6.1.1.2. Model Specification

Model specification is the representation of hypotheses in the form of a set of equations or as a path diagram that defines a structural equation model. It is customary to start a SEM analysis by drawing a path diagram, like those illustrated in Figures 9 and 10. Path diagrams show what is to be tested and what relationships are hypothesized to exist between variables. Standard notation for path diagrams uses rectangle to represent observed variables and circles to represent latent constructs. Single-headed arrows, or paths, are used to define causal relationships in the model, and double-headed arrows indicate covariances or correlations. Statistically, the single-headed arrows represent regression coefficients, and the double-headed arrows represent covariances (Hox & Bechger, 1998).

3.6.1.1.3. Model Identification

Model identification is the second step that determines if a unique set of parameter estimates can be found based on the sample data contained in the sample covariance matrix and the theoretical model (Schumacker & Lomax, 2004). Each potential parameter in a model must be specified as either a free, fixed, or constrained parameter. A free parameter is one that is unknown and, therefore, needs to be estimated. A fixed parameter is one that is fixed to a specified value, typically either zero or one. A constrained parameter is one that is unknown, but is constrained to equal one or more other parameters.

There are three levels of model identification that reflect the amount of information in the sample variance-covariance matrix (S) necessary for uniquely estimating the model parameters. A model is under-identified if one or more parameters cannot be uniquely solved because there is not enough information in the matrix S (more unknown parameters than equations). A model is just-identified if there is just enough information in the matrix S for all of the parameters to be uniquely solved (equal number of equations as unknown parameters). Lastly, a model is over-identified if there is more than one way to estimate the unknown parameters due to adequate information in the matrix S (more equations than unknowns) (Kline, 2011).

The counting rule can be used to determine the level of model identification by comparing the number of observed variables to the number of free parameters to be estimated (Kline, 2011). The number of observed variables is the number of distinct values in the matrix S, which is equal to p(p+1)/2 , where p is the number of observed variables.

3.6.1.1.4. Model Estimation

Model estimation is the process of estimating parameters in a structural equation model. The goal of this step is to obtain estimates for each parameter, such that the difference between parameter estimates and the sample variance-covariance matrix (S) is as small as possible (Schumacker & Lomax, 2004). The estimation process involves the use of a fitting function to minimize the difference between the estimated population matrix ∑ and the sample matrix S. There are several fitting functions, or estimation procedures, provided by different statistical software programs. Full information maximum likelihood (ML) estimation was selected as the estimation procedure in this study due to its ability to 1) optimize differences between parameter estimates and sample data, 2) handle missing data without deletion or imputation, and 3) produce statistical measures of explained variance and overall goodness-of-fit.

3.6.1.1.5. Model Testing

Once the parameter estimates are obtained, the model can be tested to determine how well the data fit with the model (Schumacker & Lomax, 2004). Unlike many statistical procedures that are based on a single fit index (e.g., F test in ANOVA), there are an increasing number of fit indices in SEM. Many of the fit indices are derived from the chi-square value, which represents the difference between the estimated population matrix ∑ and the sample matrix S. Mplus provides several global goodness-of-fit indices, including the overall chi-square (χ^2), RMSEA (Root Mean Square Error of Approximation), CFI (Comparative Fit Index), and TLI (Tucker Lewis Index). Fit indices are used to inform whether the overall model is acceptable or not. However, acceptable fit indices do not imply that specified relationships in the model are strong or significant.

3.6.1.1.6. Model Modification

Model modification is an optional last step that typically occurs if the researcher is not satisfied with the model fit. There are two main strategies to re-specify a model: theoretically and empirically. In the first strategy, a researcher can either add hypothesized relationships (i.e., model building) or remove paths (i.e., model trimming) from the existing model based on theory. The other strategy is to use empirical tests, such as modification indices, to re-specify the model. Although empirical tests may help the researcher detect specification errors that are most likely to properly specify alternate models (Schumacker & Lomax, 2004), it is important that all model modifications be grounded in theory, and ideally specified a priori.

3.6.2. Confirmatory Factor Analysis

Structural equation modeling (SEM) can be divided into two parts: 1) the measurement model that relates observed indicator variables to latent constructs, and 2) the structural model that specifies hypothesized relationships among latent constructs. Confirmatory factor analysis (CFA) is a statistical technique used to verify the structure of the measurement model (Suhr, 2006) by testing the multidimensionality of a theoretical construct (i.e., latent variable). In this study, CFAs were conducted to test the multidimensionality of each latent variable in the hypothesized models. This technique tests how well each set of observed variables (i.e., survey items) measures their underlying latent construct. CFAs must be tested and produce an acceptable fit before the structural models can be tested.

3.6.3. Assumptions

There are several assumptions that were addressed in SPSS before proceeding with the subsequent SEM analyses in Mplus.

3.6.3.1. Multicollinearity

The first assumption is multicollinearity, which exists when two or more predictor variables are so highly correlated that they are essentially measuring the same thing. Multicollinearity can be assessed several ways. Variance inflation factors (VIF) are commonly used to measure the degree of multicollinearity among latent variables (Kline, 2011); however, Mplus does not provide this option. In this case, another method to test for multicollinearity is to examine a zero-order correlation matrix among explanatory variables. Bivariate correlations exceeding ±.80 generally indicate high multicollinearity between two variables (Asher, 1983; Berry & Feldman, 1985; Pedhazur, 1982). In this study, several zero-order correlations among explanatory variables exceeded .80 (see Appendix F). However, multicollinearity is not thought to be a major concern since CFAs for each measurement model supported convergent and discriminant validity.

3.6.3.2. Normality

Estimation in SEM with Maximum Likelihood (ML) assumes multivariate normality of continuous outcome variables (Kline, 2011). Multivariate normality means that: 1) all individual univariate distributions are normal, 2) each variable is normally distributed for each value of every other variable (i.e., bivariate normal), and 3) all bivariate scatterplots are linear, and the distribution of residuals is homoscedastic. Since it is difficult to adequately assess all aspects of multivariate normality, it is helpful to first inspect univariate distributions, which are often indicative of multivariate non-normality (Kline, 2011).

Univariate normality can be assessed by examining the skew and kurtosis for each distribution. Skewness refers to the symmetry of the distribution about the mean, and kurtosis is a measure of how peaked or flat the distribution is relative to normal. Fortunately, statistical software programs, like SPSS, can produce precise measures of skew and kurtosis. The skew index (SI) and kurtosis index (KI) are standardized measures that permit comparisons of different distributions to the normal curve. It is suggested that variables with absolute values of SI > 3.0 are considered extremely skewed, absolute values of KI > 10.0 are considered problematic, and absolute values of KI > 20.0 indicate a more serious problem (Kline, 2011). Plotting histograms is also a simple way to identify extreme skewness. In this study, all variables were normally distributed, except for curricular involvement (*curr*), which was slightly positively skewed (SI = 1.59). No data transformations were made to handle non-normality. Frequency distributions for all variables are presented in the next chapter.

3.6.3.3. Linearity and Homoscedasticity

Linearity and homoscedasticity (uniform distribution) among residuals are assumptions related to multivariate normality. The presence of bivariate curvilinear relations can be detected by looking at scatterplots. Heteroscedasticity (non-uniform distributions) among residuals can be caused by non-normality in X or Y, the presence of more random error at some level of X or Y than at others, or outliers. Since most of the data in this study is normally distributed and there are no significant outliers, it is presumed that this assumption is met.

3.6.3.4. Relative Variances

Covariance matrices are considered ill-scaled if the ratio of the largest to the smallest variance is greater than 10.0 (Kline, 2011). Analyzing ill-scaled covariance matrices in SEM can be problematic. Most estimation methods in SEM, including Maximum Likelihood (ML), are iterative. This means that the computer derives initial estimation values and then modifies them through subsequent cycles of calculation. The goal of this iterative process is to compute better estimates at each stage that optimize the overall fit of the model to the data. The process stops when improvements become small and the solution is stable. The process could fail, however, if the estimates do not converge to stable values.

When the computer adjusts the estimates from one step to the next in an iterative process for an ill-scaled matrix, the sizes of these changes may be different for variables with small variances than for those with large variances (Kline, 2011). Consequently, the iterative process may produce estimates with worse, rather than better, fit. All model estimations conducted in this study terminated normally, suggesting that the covariance matrices were not ill-scaled.

3.7. Missing Data

Researchers have examined various methods of handling missing data. Most methods assume that the pattern of missing observations is ignorable (Kline, 2011). There are two types of ignorable patterns, missing at random (MAR) and missing completely at random (MCAR). The data loss pattern is considered MAR if the missing observations on variable X differ from the observed scores on that variable only by chance. If, in addition, the presence versus absence of data for variable X is unrelated to any other variable in the data set, then the data loss pattern is MCAR. MCAR holds stricter assumptions about the randomness of data loss than MAR. Yet, the existence of MCAR in real data sets still remains questionable (Kline, 2011).

There is no single, definitive test that can determine whether missing data is truly MAR or MCAR. Typically, researchers examine various features of their data set for signs of systematic data loss (Kline, 2011). One approach that is commonly used is a multivariate statistical test developed by Little that informs whether data is missing randomly in a given data set (Little & Rubin, 2002). Using Little's MCAR Test, it was determined that the data set in this study is missing at random (MAR) (p = .077).

Kline (2011) describes four categories of methods used to deal with missing observations: 1) available case methods, 2) single-imputation methods, 3) model-based imputation methods, and 4) special form of maximum likelihood (FIML) estimation for incomplete data. The first category is available case methods, which removes incomplete cases from the data set either through listwise and pairwise deletion. In listwise deletion, any variable in the data set with a missing value would cause a subject to be deleted. In contrast, pairwise deletion only excludes data when they are missing on the variables selected for analysis (Schumacker & Lomax, 2004). These techniques are not recommended because of the loss of information in the data set through the deletion of cases, which can also cause a substantial reduction in the sample size.

The second category is single-imputation methods that replace each missing score with a single calculated score (Kline, 2011). The most basic technique in this category is mean substitution, which involves replacing a missing score with the overall sample mean. Although this method is simple, it can alter the distribution of the data by reducing variability (Kline, 2011). Regression-based substitution is a more sophisticated single-imputation technique that involves replacing each missing score with a predicted score using multiple regression based on non-missing scores for other variables in the data set. Although this technique is generally preferred over mean substitution, all single-imputation methods tend to underestimate error variance, especially when the proportion of missing data is relatively high (Vriens & Melton, 2002). Therefore, single-imputation methods were not recommended for this study.

The next category is model-based imputation methods that can generate one or more estimated scores for each missing observation (i.e., multiple imputation). The expectation-maximization (EM) algorithm is one example of this method that some researchers suggest produces the most accurate estimate of missing observations (Enders & Bandalos, 2001). Unlike mean substitution, the multiple imputation method preserves the original variability in the data set, and also accounts for uncertainty caused by data estimation. Despite these advantages, there are researchers that contest the use of imputed data in an effort to generate unbiased results (Hancock & Mueller, 2008b).

The last category of methods to handle missing data is the use of a special form of full-information maximum likelihood (FIML) estimation that does not delete cases or impute missing observations. Instead, this method uses a raw data file to separate cases into subsets that have the same pattern of missing observations. Statistical information (e.g., means and variances) is extracted from each subset, which allows all cases to be retained in the analysis. Studies have also found that special ML-based methods for incomplete data generally outperformed classical methods (Arbuckle, 1996; Enders & Bandalos, 2001; and Peters & Enders, 2002). For these reasons, the original dataset with missing values was retained and analyzed in this study using the special form of full-information maximum likelihood (FIML) estimation in Mplus.

In summary, this study contributes a theoretical and methodological analysis of relationships between engineering student inputs, environmental factors, and career-related outcomes. This research undertakes a methodology to rigorously assess two hypothesized models grounded by Astin's theory of student involvement, person-environment fit theory, and the theory of reasoned action. Structural equation modeling is used to advance the current state of knowledge by analyzing hypothesized causal relationships among proposed determinants of energy industry pursuit intentions. Assumptions of the data analyses were explicitly described to provide more precise and accurate results.

CHAPTER 4: RESULTS

This chapter is divided into three sections. In the first section, descriptive statistics are presented for all variables in the two hypothesized models. The second section displays results from the confirmatory factory analyses (CFAs) conducted to test the measurement models. In the third section, results from the structural equation modeling (SEM) analyses are presented for the two competing models.

4.1. Descriptive Statistics

4.1.1. Model Variables

The first step of the data analysis involved examining scores for the observed variables and the survey items that comprise the latent variables in the models. The following sub-sections present descriptive statistics, including means and standard deviations, for all survey items used to measure observed and latent variables in the hypothesized models. Frequency distributions and inter-item correlations are also displayed for all latent variables. Inter-item correlations are used to reflect the strength of the relationship between two variables. In this study, correlation coefficients of .5 or larger are considered strong, values between 0.5 and 0.3 are moderate, values between 0.3 and 0.1 are small, and anything less than 0.1 is negligible (Cohen, 1988). Cronbach's alpha (α) based on standardized items are also reported as a measure of reliability and internal consistency for all multi-item variables.

4.1.1.1. Pre-College Knowledge of the Energy Industry (*precoll*)

Four survey items were used to measure students' prior knowledge related to careers in the energy industry. Participants were asked to report how much knowledge they had before coming to college about 1) jobs in the energy industry, 2) corporations in the energy industry, 3) employment opportunities in the energy industry, and 4) how to get a job in the energy industry. These items were measured on a 5-point scale ranging from none (1) to a great deal (5). Cronbach's alpha for this scale was acceptable (α = .884).

Mean scores for the four *precoll* indicator variables ranged from 2.21 to 2.48 (Table 10). These values fall between the response options very little and some. The frequency distributions shown in Table 11 indicate that most students had little prior knowledge about careers in the energy industry before college. For example, about 54% of participants reported having none or very little knowledge about jobs in the energy industry before enrolling in college. Moreover, 65% of respondents indicated that they had none or very little knowledge about how to get a job in the energy industry before going to college.

Table 12 displays the inter-item correlations among the pre-college knowledge variables. All correlation coefficients were greater than .5 and statistically significant at the 0.01 level. This indicates that there are strong, positive associations between the four indicators used to measure the *precoll* variable.

TABLE 10: Descriptive statistics for survey items used to measure *precoll*

Survey Question	*n*	Mean	Std. Deviation
Prior to enrolling in college, please indicate your level of knowledge in the following areas:			
Q5. How much knowledge did you have about jobs in the energy industry?	381	2.46	.875
Q6. How much knowledge did you have about corporations in the energy industry?	381	2.48	.899
Q7. How much knowledge did you have about employment opportunities in the energy industry?	381	2.46	.919
Q8. How much knowledge did you have about how to get a job in the energy industry?	381	2.21	.950

TABLE 11: Frequency distributions for survey items used to measure *precoll*

Prior to enrolling in college, please indicate your level of knowledge in the following areas:

Jobs in the energy industry	*n*	%
None	47	12.3
Very little	157	41.2
Some	138	36.2
Quite a bit	33	8.7
A great deal	6	1.6
Total	381	100.0
Corporations in the energy industry		
None	49	12.9
Very little	151	39.6
Some	138	36.2
Quite a bit	36	9.4
A great deal	7	1.8
Total	381	100.0
Employment opportunities in the energy industry		
None	52	13.6
Very little	155	40.7
Some	129	33.9
Quite a bit	37	9.7
A great deal	8	2.1
Total	381	100.0
How to get a job in the energy industry		
None	93	24.4
Very little	156	40.9
Some	99	26.0
Quite a bit	26	6.8
A great deal	7	1.8
Total	381	100.0

TABLE 12: Inter-item correlations among indicators of *precoll*

	Q5	Q6	Q7	Q8
Q5	1.000	.714**	.657**	.585**
Q6	.714**	1.000	.645**	.577**
Q7	.657**	.645**	1.000	.750**
Q8	.585**	.577**	.750**	1.000

**Correlation is significant at the 0.01 level (2-tailed)

4.1.1.2. Curricular Involvement (*curr*)

Curricular involvement is a count variable measuring how many energy-related technical electives participants have taken so far in college. These include courses such as energy systems, power systems analysis, electrical machinery, sustainable energy production, etc. Scores for this variable ranged from zero to four, and those who answered "more than 5" were recoded as missing data (see Chapter 3).

Table 13 shows that students in the sample have taken few energy-related technical electives (mean = 1.58). Over 64% of the sample did not take any energy-related technical elective courses, and nearly 20% reported taking one energy-related elective (Table 14). Less than 5% of the sample took three energy-related electives, and only four participants reported taking four energy-related electives.

TABLE 13: Descriptive statistics for survey items used to measure *curr*

Survey Question	*n*	Mean	Std. Deviation
Q14. How many energy-related technical elective courses have you taken so far in college?	359	1.58	.926

TABLE 14: Frequency distributions for survey item used to measure *curr*

How many energy-related technical elective courses have you taken so far in college?	*n*	%
0	231	64.3
1	70	19.5
2	38	10.6
3	16	4.5
4	4	1.1
Total	359	100.0

4.1.1.3. Internship/Co-op (*cocurr*)

Cocurr is a dichotomous, observed variable that measures whether or not a student gained knowledge about professions in the energy industry by participating in an internship or co-op at an energy-related company. A score of one indicates that a respondent gained knowledge about professions in the energy industry, and a score of zero denotes those who did not. In the sample, 46% of respondents (*n* = 176) reported gaining knowledge about professions in the energy industry by participating in an internship or co-op at an energy-related company (Table 15).

TABLE 15: Descriptive statistics for survey item used to measure *cocurr*

Survey Question	*n*	Mean	Std. Deviation
How did you gain your knowledge about professions in the energy industry?			
Q19. From being a co-op student or intern at an energy company	381	0.46	.499

4.1.1.4. Institutional Emphasis (*instemp*)

Instemp is a multi-item variable that measures the extent to which a student's college or university emphasizes topics related to the energy industry. This variable consists of four survey items that were measured on a 5-point scale ranging from none (1) to very much (5). The Cronbach's alpha for this scale was acceptable at $\alpha = .899$.

Mean scores for the four institutional emphasis indicators ranged from 2.95 to 3.30 (Table 16) with a score of 3 indicating some institutional emphasis. Frequency distributions for the four survey items were similar with some degree of variability between them (Table 17). In the sample, 42% of participants reported that their college or university emphasizes the importance of the energy industry to society either quite a bit or very much. Likewise, 42% of participants indicated quite a bit or very much institutional emphasis in terms of employment opportunities in the energy industry. However, while only 6% of the sample reported very much institutional emphasis on current workforce demands in the energy industry, more than double that amount (13%) indicated very much institutional emphasis related to the importance of the energy industry to society.

Table 18 shows the inter-item correlations among the indicators of institutional emphasis. The correlation coefficients ranged from .643 to .759 and were all statistically significant at the 0.01 level. Since all of the correlation coefficients were greater than .5, it can be interpreted that the items used to measure *instemp* are strongly related.

TABLE 16: Descriptive statistics for survey items used to measure *instemp*

Survey Question	*n*	Mean	Std. Deviation
How much does your college or university emphasize the following?			
Q23. The importance of the energy industry to society	371	3.30	1.031
Q24. Employment opportunities in the energy industry	371	3.28	1.017
Q25. Current workforce demands within the energy industry	371	2.95	1.003
Q26. Current technological needs in the energy industry	371	3.06	1.028

TABLE 17: Frequency distributions for survey items used to measure *instemp*

How much does your college or university emphasize the following?		
The importance of the energy industry to society	*n*	%
None	16	4.3
Very little	62	16.7
Some	137	36.9
Quite a bit	108	29.1
Very much	48	12.9
Total	371	100.0
Employment opportunities in the energy industry		
None	18	4.9
Very little	57	15.4
Some	142	38.3
Quite a bit	111	29.9
Very much	43	11.6
Total	371	100.0
Current workforce demands within the energy industry		
None	26	7.0
Very little	95	25.6
Some	145	39.1
Quite a bit	82	22.1
Very much	23	6.2
Total	371	100.0
Current technological needs in the energy industry		
None	28	7.5
Very little	72	19.4
Some	150	40.4
Quite a bit	92	24.8
Very much	29	7.8
Total	371	100.0

TABLE 18: Inter-item correlations among indicators of *instemp*

	Q23	Q24	Q25	Q26
Q23	1.000	.696**	.676**	.647**
Q24	.696**	1.000	.759**	.643**
Q25	.676**	.759**	1.000	.719**
Q26	.647**	.643**	.719**	1.000

**Correlation is significant at the 0.01 level (2-tailed)

4.1.1.5. Peer Influence (*peers*)

Three items were used to measure peer influence. Response options for the three survey items were none (1), some (2), or most (3). Cronbach's alpha for this scale was acceptable (α = .819). Mean scores for the three peer influence indicators were all slightly under two (Table 19). This suggests that, on average, participants have some peers/friends that are interested in studying energy, have taken energy-related technical electives, and want to work in the energy industry after graduation.

TABLE 19: Descriptive statistics for survey items used to measure *peers*

Survey Question	*n*	Mean	Std. Deviation
Q28. How many of your peers/friends are interested in studying energy?	355	1.97	.443
Q29. How many of your peers/friends take energy-related technical elective courses in college?	355	1.88	.499
Q30. How many of your peers/friends want to work in the energy industry after graduation?	355	1.92	.450

Table 20 shows that the vast majority of participants have some peers/friends that are interested in studying energy (80%), some peers/friends that take energy-related technical elective courses (74%), and some peers/friends that want to work in the energy industry after graduation (79%). This data also shows that there are more participants that have no peers/friends interested in energy than participants who indicated that most of their peers/friends are interested in energy. However, there is still a fair amount of students who reported that most of their peers/friends are interested in studying energy (8%), take energy-related electives (7%), and want to work in the energy industry (7%).

TABLE 20: Frequency distributions for survey items used to measure *peers*

		n	%
How many of your peers/friends are interested in studying energy?			
	None	41	11.5
	Some	285	80.3
	Most	29	8.2
	Total	355	100.0
How many of your peers/friends take energy-related technical elective courses in college?			
	None	67	18.9
	Some	262	73.8
	Most	26	7.3
	Total	355	100.0
How many of your peers/friends want to work in the energy industry after graduation?			
	None	51	14.4
	Some	281	79.2
	Most	23	6.5
	Total	355	100.0

Inter-item correlations among the indicators of *peers* are shown in Table 21. The correlation coefficients were all positive and statistically significant at the .01 level. Since the values of the inter-item correlations ranged from .582 to .623, it can be interpreted that these items are strongly related.

TABLE 21: Inter-item correlations among indicators of *peers*

	Q28	Q29	Q30
Q28	1.000	.582**	.623**
Q29	.582**	1.000	.600**
Q30	.623**	.600**	1.000

**Correlation is significant at the 0.01 level (2-tailed)

4.1.1.6. Industry Fit (*fit*)

Industry fit is a 4-item variable that measures a student's perception of congruence with the goals and values of the energy industry. These items were scored on a 5-point scale ranging from strong disagree (1) to strongly agree (5). Cronbach's alpha for this scale was acceptable at α = .915. Mean scores for the four industry fit indicators ranged from 3.53 to 3.82 (Table 22). These values suggest that participants fell between neutral (3) and agree (4) in terms of their perceived fit with the energy industry, on average.

TABLE 22: Descriptive statistics for survey items used to measure *fit*

Survey Question	*n*	Mean	Std. Deviation
Rate the following items related to the energy industry:			
Q56. I feel that the energy industry is a good fit for me professionally.	341	3.61	1.019
Q57. I identify with the values of the energy industry.	341	3.82	.818
Q58. My professional goals fit with the goals of the energy industry.	341	3.68	.959
Q59. I feel that the energy industry represents my own personal values.	341	3.53	.922

The frequency distributions shown in Table 23 indicate that most students tend to perceive a positive fit with the energy industry. In particular, 59% of participants agreed or strongly agreed with the statement, “I feel that the energy industry is a good fit for me professionally.” Similarly, 58% of the sample agreed or strongly agreed that their professional goals fit with the goals of the energy industry, and 49% agreed or strongly agreed that the energy industry represents their own personal values. Yet, the highest combined percentage for agree and strongly agreed was 67% for those who identified with the values of the energy industry.

TABLE 23: Frequency distributions for survey items used to measure *fit*

I feel that the energy industry is a good fit for me professionally.	*n*	%
Strongly disagree	8	2.3
Disagree	44	12.9
Neutral	89	26.1
Agree	132	38.7
Strongly agree	68	19.9
Total	341	100.0
I identify with the values of the energy industry.		
Strongly disagree	2	0.6
Disagree	13	3.8
Neutral	98	28.7
Agree	158	46.3
Strongly agree	70	20.5
Total	341	100.0
My professional goals fit with the goals of the energy industry.		
Strongly disagree	5	1.5
Disagree	31	9.1
Neutral	106	31.1
Agree	126	37.0
Strongly agree	73	21.4
Total	341	100.0
I feel that the energy industry represents my own personal values.		
Strongly disagree	6	1.8
Disagree	29	8.5
Neutral	140	41.1
Agree	111	32.6
Strongly agree	55	16.1
Total	341	100.0

Table 24 shows the inter-item correlations among the indicators of industry fit. The correlation coefficients ranged from .676 to .819 and were all statistically significant at the 0.01 level. Since all of the correlation coefficients were greater than .5, it can be interpreted that the items used to measure *fit* are strongly related. However, the associations between items are not too strong that they are measuring the same variable.

TABLE 24: Inter-item correlations among indicators of *fit*

	Q56	Q57	Q58	Q59
Q56	1.000	.676**	.819**	.696**
Q57	.676**	1.000	.700**	.732**
Q58	.819**	.700**	1.000	.759**
Q59	.696**	.732**	.759**	1.000

**Correlation is significant at the 0.01 level (2-tailed)

4.1.1.7. Industry Attraction (*attract*)

Industry attraction is a 4-item variable that measures students' attraction to careers in the energy industry. The four survey items were scored on a 5-point scale ranging from strong disagree (1) to strongly agree (5). Cronbach's alpha for this scale was acceptable (α = .933).

Mean scores for the four industry attraction indicators ranged from 3.39 to 3.83 (Table 25), and frequency distributions in Table 26 show that most of the sample is attracted to careers in the energy industry. However, the mean score for one of the industry attraction indicators (mean = 3.39) was lower than the other three (means = 3.81, 3.83, and 3.81). Specifically, 70% of participants agreed or strongly agreed that a career in the energy industry is attractive to them. Likewise, 69% of the sample agreed or strongly agreed that, given the opportunity and resources, they would work in the energy industry. However, only 46% of participants agreed or strongly agreed that, among various options, they would rather work in the energy industry. Still, 63% of the sample agreed or strongly agreed that working in the energy industry implies more advantages than disadvantages.

TABLE 25: Descriptive statistics for survey items used to measure *attract*

Survey Question	*n*	Mean	Std. Deviation
Rate your agreement with the following statements about your attraction to the energy industry:			
Q60. A career in the energy industry is attractive to me.	341	3.81	1.019
Q61. If I had the opportunity and resources, I would work in the energy industry.	341	3.83	.973
Q62. Among various options, I would rather work in the energy industry.	341	3.39	1.083
Q63. Working in the energy industry implies more advantages than disadvantages to me.	341	3.81	.887

TABLE 26: Frequency distributions for survey items used to measure *attract*

	n	%
A career in the energy industry is attractive to me.		
Strongly disagree	8	2.3
Disagree	36	10.6
Neutral	60	17.6
Agree	147	43.1
Strongly agree	90	26.4
Total	341	100.0
If I had the opportunity and resources, I would work in the energy industry.		
Strongly disagree	7	2.1
Disagree	27	7.9
Neutral	72	21.1
Agree	146	42.8
Strongly agree	89	26.1
Total	341	100.0
Among various options, I would rather work in the energy industry.		
Strongly disagree	13	3.8
Disagree	59	17.3
Neutral	113	33.1
Agree	95	27.9
Strongly agree	61	17.9
Total	341	100.0
Working in the energy industry implies more advantages than disadvantages to me.		
Strongly disagree	2	0.6
Disagree	19	5.6
Neutral	104	30.5
Agree	134	39.3
Strongly agree	82	24.0
Total	341	100.0

Table 27 shows the inter-item correlations among the indicators of industry attraction. All correlation coefficients were statistically significant and ranged from .739

to .823. Since all of the correlation coefficients were greater than .5, it can be interpreted that the items used to measure *attract* are strongly related.

TABLE 27: Inter-item correlations among indicators of *attract*

	Q60	Q61	Q62	Q63
Q60	1.000	.823**	.803**	.766**
Q61	.823**	1.000	.760**	.739**
Q62	.803**	.760**	1.000	.764**
Q63	.766**	.739**	.764**	1.000

**Correlation is significant at the 0.01 level (2-tailed)

4.1.1.8. Energy Industry Pursuit Intentions (*intent*)

Energy industry pursuit intentions is the outcome variable used in the two hypothesized models. This variable consists of three items that measure students' intentions to pursue a career in the energy industry after graduation. These items are scored on a 5-point scale ranging from definitely not (1) to definitely yes (5). Cronbach's alpha for this scale was acceptable at $\alpha = .948$.

Mean scores for the three indicators ranged from 3.34 to 3.47 (Table 28) with a score of 3 indicating not sure and 4 corresponding to probably yes. For the first item, 52% of the sample responded probably yes or definitely yes to the question, "Do you intend to work in the energy industry for at least 3 years after graduation?" (Table 29). Likewise, 53% of participants responded probably yes or definitely yes to the second question that asked, "Is it likely that you will work in the energy industry after graduation?" For the third question, 50% of the participants responded probably yes or definitely yes when asked, "Are you more likely to look for a job in the energy industry than any other occupational sector?"

TABLE 28: Descriptive statistics for survey items used to measure *intent*

Survey Question	*n*	Mean	Std. Deviation
Indicate your intentions to work in the energy industry:			
Q64. Do you intend to work in the energy industry for at least 3 years after graduation?	341	3.47	1.123
Q65. Is it likely that you will work in the energy industry after graduation?	341	3.47	1.083
Q66. Are you more likely to look for a job in the energy industry than any other occupational sector?	341	3.34	1.271

Although responses were similar for all three survey items on average, frequency distributions differed between the first two items and the third. The first two items both had 4% of the sample respond definitely not, while 18% and 20% responded definitely yes, respectively. In contrast, 9% of the sample responded definitely not to the third item, and 23% responded definitely yes. This shows that while the first two items about working in the energy industry in general had similar frequency distributions, the third item that compared the energy industry to all other occupational sectors had higher frequencies at both extremes.

TABLE 29: Frequency distributions for survey items used to measure *intent*

Do you intend to work in the energy industry for at least 3 years after graduation?	*n*	%
Definitely not	15	4.4
Probably not	58	17.0
Not sure	90	26.4
Probably yes	109	32.0
Definitely yes	69	20.2
Total	341	100.0
Is it likely that you will work in the energy industry after graduation?		
Definitely not	12	3.5
Probably not	58	17.0
Not sure	91	26.7
Probably yes	117	34.3
Definitely yes	63	18.5
Total	341	100.0
Are you more likely to look for a job in the energy industry than any other occupational sector?		
Definitely not	30	8.8
Probably not	69	20.2
Not sure	73	21.4
Probably yes	92	27.0
Definitely yes	77	22.6
Total	341	100.0

Table 30 shows the inter-item correlations among the indicators of *intent*. The correlation coefficients ranged from .841 to .877 and were all statistically significant at the .01 level. Since all of the correlation coefficients were greater than .5, it can be interpreted that the items are strongly related. However, these associations are not too strong that they are measuring the same variable.

TABLE 30: Inter-item correlations among indicators of *intent*

	Q64	Q65	Q66
Q64	1.000	.877**	.860**
Q65	.877**	1.000	.841**
Q66	.860**	.841**	1.000

**Correlation is significant at the 0.01 level (2-tailed)

4.2. Confirmatory Factor Analyses (CFAs)

Confirmatory factor analyses (CFAs) were performed in Mplus to test the measurement portion of the hypothesized models. While there is no golden rule for evaluating CFA model fit, reporting a variety of goodness-of-fit indices is recommended (Hooper, Coughlan, & Mullen, 2008). Mplus provides several global fit indices including the overall chi-square (χ^2), RMSEA (Root Mean Square Error of Approximation), CFI (Comparative Fit Index), and TLI (Tucker Lewis Index). In this study, acceptable goodness-of-fit is based on the following recommended values: chi-square with *p*-value greater than .05, RMSEA less than .07, CFI greater than .95, and TLI greater than .95 (Hu & Bentler, 1999; Marsh, Hau, & Wen, 2004; Yu, 2002).

4.2.1. Single Factor CFAs

Single factor CFAs were conducted for each of the six latent constructs to test for convergent validity. In some cases, two or three measurement models were tested at the same time in order to obtain estimates for the entire sample (n = 381) in the presence of missing data. In most cases, data was missing due to incomplete cases where participants did not complete all survey questions (see Chapter 3). Full information maximum likelihood (ML) estimation was selected to estimate free parameters in the models due to its ability to handle missing data without the use of imputation or deletion.

To test for a single-factor solution, all of the indicator variables were forced to load on the hypothesized latent construct. The following subsections describe the results of the single factor CFAs for each of the six latent constructs in the hypothesized models. In these analyses, generic labels were used for the indicator variables as shown in Table 31.

TABLE 31: Indicator variable labels used in Mplus

Latent Variable	Mplus Variable Label	Survey Question
precoll	V1	Q5
	V2	Q6
	V3	Q7
	V4	Q8
instemp	V7	Q23
	V8	Q24
	V9	Q25
	V10	Q26
peers	V11	Q28
	V12	Q29
	V13	Q30
fit	V14	Q56
	V15	Q57
	V16	Q58
	V17	Q59
attract	V18	Q60
	V19	Q61
	V20	Q62
	V21	Q63
intent	V22	Q64
	V23	Q65
	V24	Q66

4.2.1.1. Pre-College Knowledge of the Energy Industry (*precoll*)

Four indicator variables were hypothesized to measure the latent construct *precoll*: V1, V2, V3, and V4. All factor loadings in the model were statistically significant ranging from .704 to .917 (Figure 11). Standardized residual variances for all indicators were satisfactory as well, ranging from 0.159 to 0.504. The overall model fit was acceptable (χ^2 = 0.012, *df* = 1, *p* = .9143; RMSEA = .000, RMSEA [90%CI] = .000, .053; CFI = 1.000; TLI = 1.007), suggesting that the model is consistent with the data.

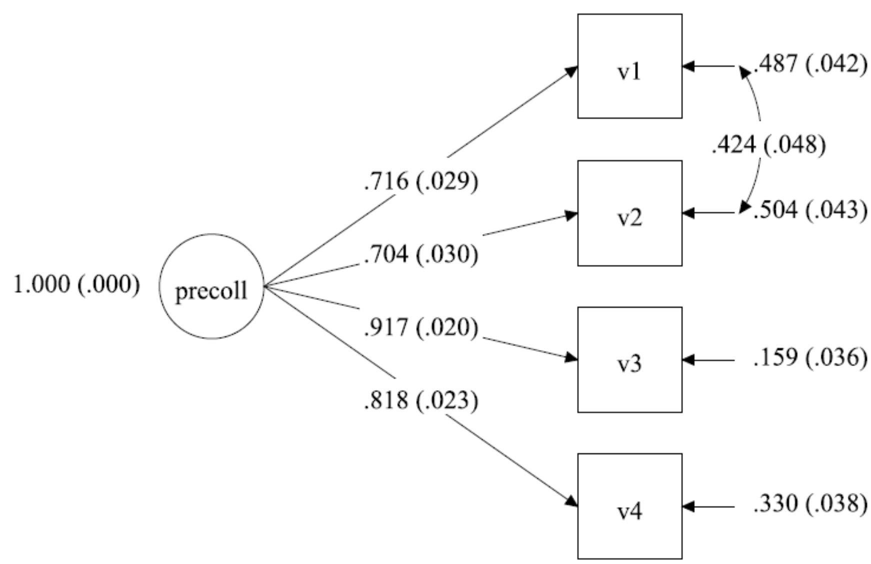

FIGURE 11: Measurement model showing the structure of pre-college knowledge of the energy industry (*precoll*) with standardized parameter estimates and standard errors displayed in parentheses.

The modification indices showed that to improve model fit, an error covariance should be added between V1 and V2. These items measure how much knowledge students had about jobs (V1) and corporations (V2) in the energy industry before enrolling in college. Since these items share the same stem phrase and both relate to employers in the energy industry, the error covariance was set as a free parameter (.424).

4.2.1.2. Institutional Emphasis (*instemp*)

Four indicator variables were hypothesized to measure institutional emphasis (*instemp*): V7, V8, V9, and V10 (Figure 12). In order to use data for the entire sample, the measurement models for *instemp* and *precoll* were tested simultaneously. The covariance between *instemp* and *precoll* was very low (.120), which suggests that these two variables are not strongly related.

All factor loadings for the *instemp* indicator variables were statistically significant ranging from .778 to .922. Standardized residual variances for these indicators were also satisfactory ranging from 0.150 to 0.395. The overall model fit was acceptable (χ^2 = 15.686, df = 7, p = .5462; RMSEA = .000, RMSEA [90%CI] = .000, .043; CFI = 1.000; TLI = 1.001).

For the two-factor model, the modification indices showed that adding an error covariance between V7 and V9 would improve model fit. These items measure how much a student's college or university emphasizes "the importance of the energy industry to society" and "current workforce demands within the energy industry," respectively. These items were both prefaced by the same question, which asked students "How much does your college or university emphasize the following?" Due to the similarity in the content between these items, the error covariance was set as a free parameter (-.445).

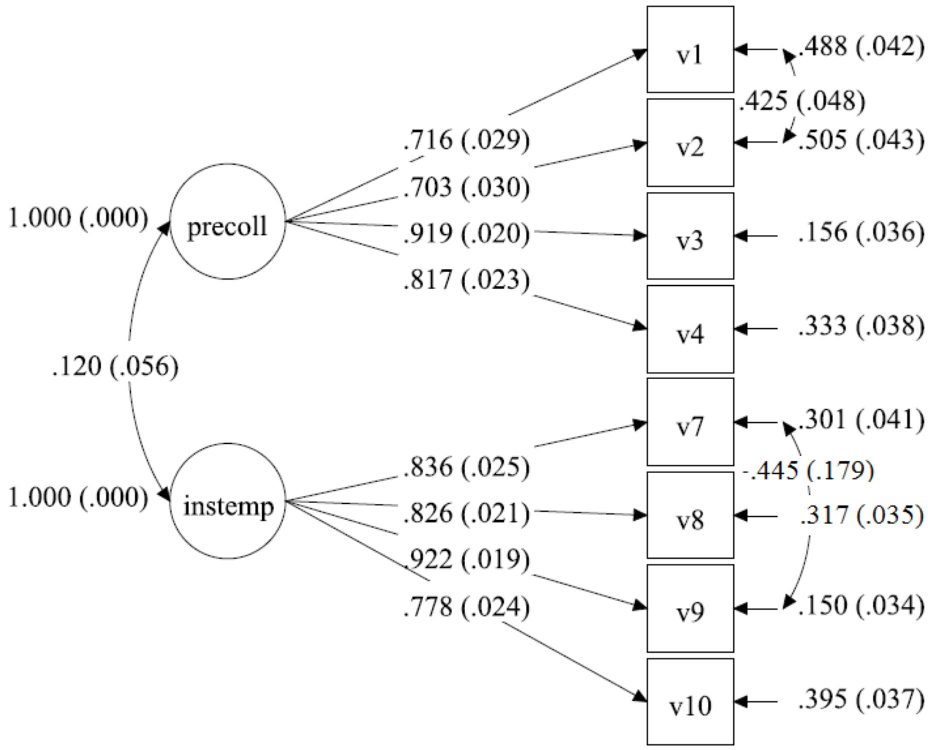

FIGURE 12: Measurement model showing the structure of institutional emphasis (*instemp*) with standardized parameter estimates and standard errors displayed in parentheses.

4.2.1.3. Peer Influence (*peers*)

Three indicator variables were hypothesized to measure peer influence (*peers*): V11, V12, and V13. The measurement models for *peers*, *instemp*, and *precoll* were tested simultaneously in order for the model to be identified and produce parameter estimates based on the entire sample. Covariances between *instemp* and *precoll*, *peers* and *precoll*, and *peers* and *instemp* were .120, .252, and .259, respectively. This suggests that *peers* is weakly related to *instemp* and *precoll*, and the relationship between *instemp* and *precoll* is negligible.

All factor loadings for the *peers* indicator variables were statistically significant ranging from .747 to .811 (Figure 13). Standardized residual variances for these indicators were satisfactory ranging from 0.343 to 0.442. The overall model fit was acceptable since the *p*-value was greater than .05 and the other fit indices were satisfactory (χ^2 = 50.544, *df* = 39, *p* = .1020; RMSEA = .028, RMSEA [90%CI] = .000, .048; CFI = .995; TLI = .993). No modifications were made when testing this model.

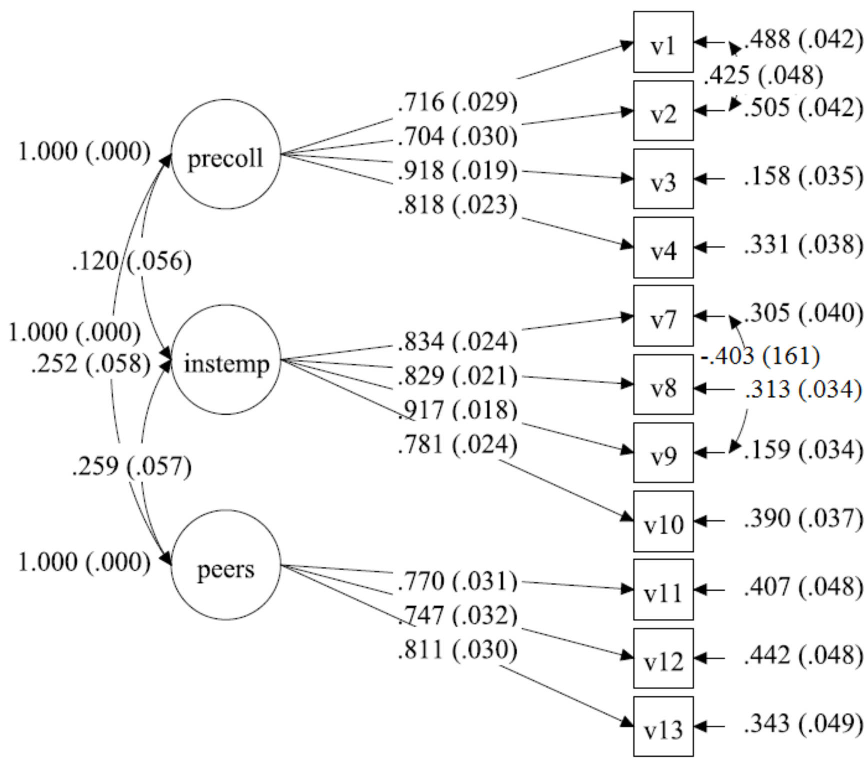

FIGURE 13: Measurement model showing the structure of peer influence (*peers*) with standardized parameter estimates and standard errors displayed in parentheses.

4.2.1.4. Industry Fit (*fit*)

Industry fit was measured by four indicator variables: V14, V15, V16, and V17. The measurement models for *fit* and *precoll* were tested simultaneously in order to produce estimates based on data for the entire sample. The covariance between *fit* and *precoll* was very low (.174), which suggests that these two variables are not strongly related.

Results of the CFA showed that the factor loadings for all four indicators of *fit* were statistically significant ranging from .757 to .935 (Figure 14). Standardized residual variances for these indicators were also satisfactory ranging from 0.126 to 0.427. The overall model fit was acceptable (χ^2 = 15.194, *df* = 17, *p* = .5815; RMSEA = .000, RMSEA [90%CI] = .000, .042; CFI = 1.000; TLI = 1.002).

The modification indices recommended adding an error covariance between V15 and V17 to improve model fit. These items measure the extent to which students agreed that they “identify with the values of the energy industry” and “feel that the energy industry represents my own personal values,” respectively. Since these items are considered to be related through their reference to values, the error covariance was set as a free parameter with an estimated value of .315.

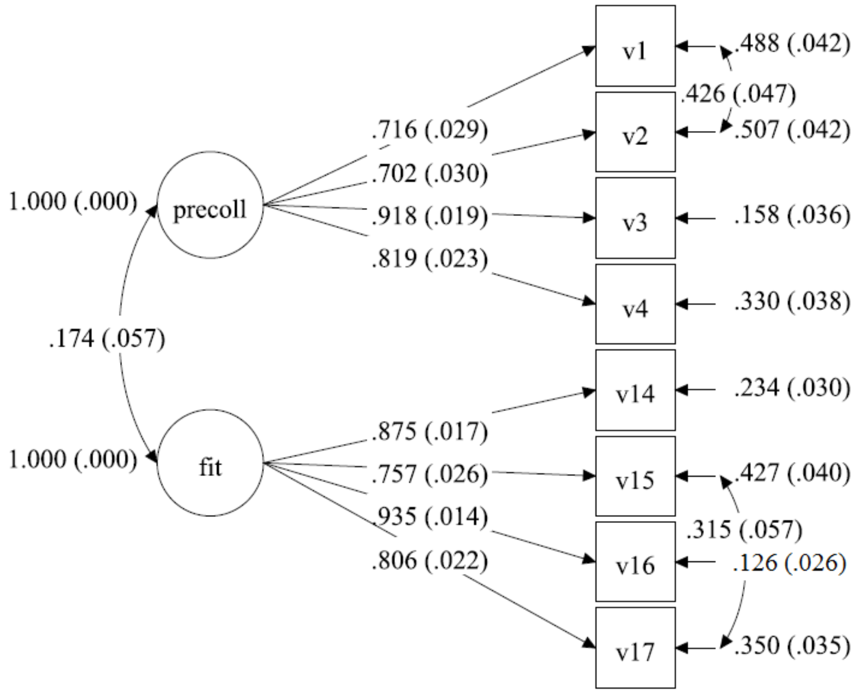

FIGURE 14: Measurement model showing the structure of industry fit (*fit*) with standardized parameter estimates and standard errors displayed in parentheses.

4.2.1.5. Industry Attraction (*attract*)

Four indicator variables are used to measure industry attraction: V14, V15, V16, and V17. Measurement models for *attract* and *precoll* were tested simultaneously in order to produce parameter estimates based on the entire sample. The covariance between *attract* and *precoll* was very low (.102) indicating that the relationship between these two variables is negligible.

All factor loadings were relatively high and statistically significant (Figure 15). The lowest factor loading was estimated between V19 and *attract* (.856). Standardized residual variances were low, which reflects little measurement error for these indicators. The highest standardized residual was estimated for V19 (0.268). The overall model fit was acceptable according to the chi-square and other model fit indices (χ^2 = 13.832, *df* = 17, *p* = .6790; RMSEA = .000, RMSEA [90%CI] = .000, .037; CFI = 1.000; TLI = 1.003).

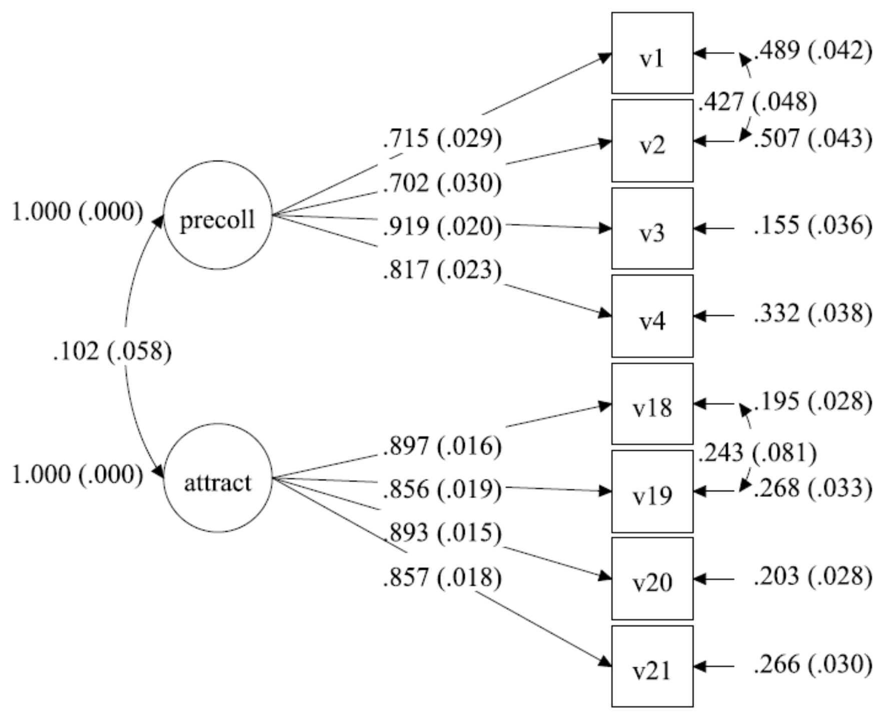

FIGURE 15: Measurement model showing the structure of industry attraction (*attract*) with standardized parameter estimates and standard errors displayed in parentheses.

The modification indices recommended adding an error covariance between V18 and V19 to improve the model. These items measure the extent to which students agreed that “a career in the energy industry is attractive to me” and “if I had the opportunity and resources, I would work in the energy industry,” respectively. The relationship between these items could potentially be influenced by a common factor outside of the model associated with students' attitudes toward the energy industry. Therefore, the error covariance in the model was freed (.243).

4.2.1.6. Energy Industry Pursuit Intentions (*intent*)

Three indicator variables were hypothesized to measure energy industry pursuit intentions (*intent*): V22, V23, and V24. The measurement models for *intent* and *precoll* were tested simultaneously in order to produce parameter estimates based on the entire sample. The covariance between *intent* and *precoll* was very low (.148), which suggests that these two variables are not strongly related.

All factor loadings for the indicator variables were statistically significant and very high (Figure 16). The lowest factor loading was estimated between *intent* and V24 (.908). Standardized residual variances for these indicators were also satisfactory low ranging from 0.102 to 0.175. The overall model fit was acceptable since the p-value for the chi-square test was greater than .05 and the other fit indices met the recommended values (χ^2 = 13.464, df = 12, p = .3363; RMSEA = .018, RMSEA [90%CI] = .000, .057; CFI = .999; TLI = .999). No modifications were made to this model.

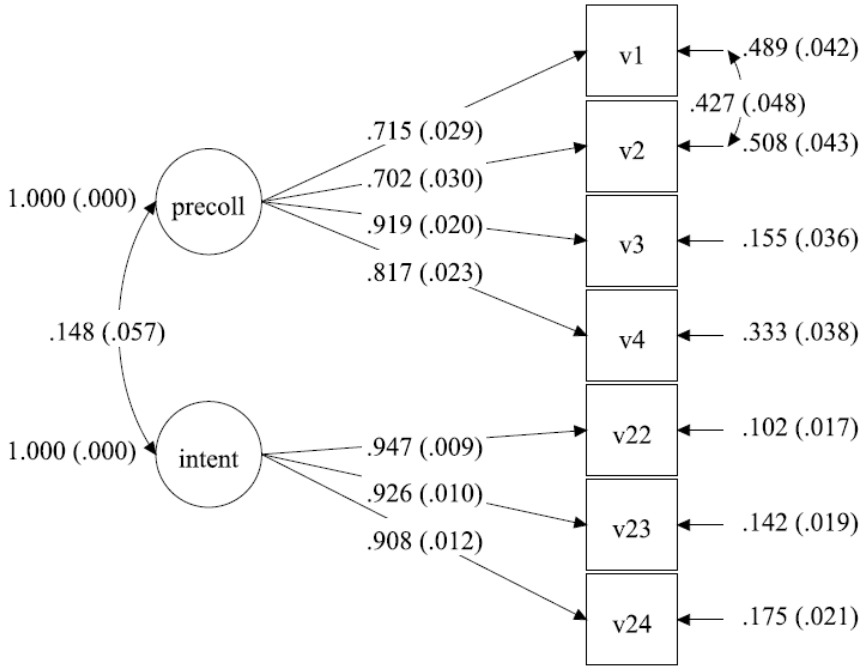

FIGURE 16: Measurement model showing the structure of energy industry pursuit intentions (*intent*) with standardized parameter estimates and standard errors displayed in parentheses.

4.2.2. Multifactor CFA

A multifactor CFA was conducted to test a six-factor solution representing the multidimensionality of pre-college knowledge about the energy industry (*precoll*), institutional emphasis (*instemp*), peer influence (*peers*), industry fit (*fit*), industry attraction (*attract*), and energy industry pursuit intentions (*intent*). Figure 17 shows a path diagram with standardized parameter estimates for the model. Error covariances were included in the model specification to account for similarities in the stem-phrases and content for each pair of items as discussed previously.

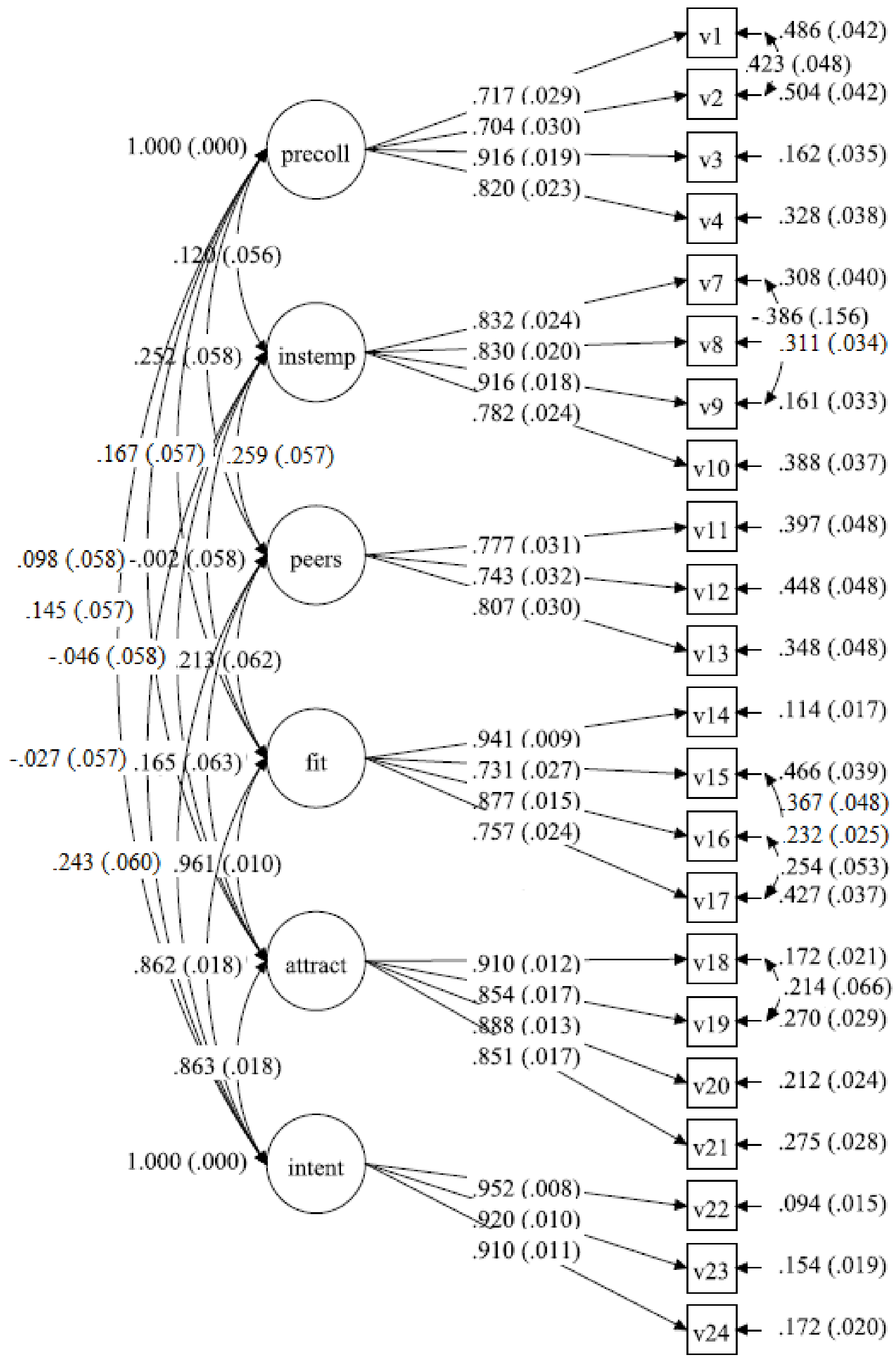

FIGURE 17: Path diagram with standardized parameter estimates.

Results of the analysis determined that all factor loadings were statistically significant and highly satisfactory for each of the six latent constructs. The lowest factor loading was estimated between V2 and *precoll* (0.704) and the highest factor loading was between V22 and *intent* (0.952). The residual variances for all indicators were satisfactory as well, ranging from 0.094 to 0.504. The overall model fit had a significant chi-square (χ^2 = 245.887, *df* = 189, *p* = .0034; RMSEA = .028, RMSEA [90%CI] = .017, .038; CFI = .991; TLI = .989), which suggests that the model is not consistent with the data. However, the model seems to be a good fit according to the other fit indices. Given the statistical significance of the factor loadings and the satisfactory values for most of the fit indices, it was determined that the model adequately fits the data for the purposes of this study.

Discrepancies observed between the different fit indices are likely a function of the hypotheses that are tested for each fit index. The model chi-square (χ^2) tests the exact-fit hypothesis, which presumes that there are no differences between the population covariances and those predicted by the model (Kline, 2011). Some authors argue that the exact-fit hypothesis may be farfetched in many SEM applications (Mile & Shevlin, 2007; Steiger, 2007) since perfection is not usually the standard for testing statistical models (Kline, 2011). The value of χ^2 can also be affected by multivariate normality, correlation size, unique variance, and sample size. Furthermore, the model chi-square does not compensate for model complexity, and the value of χ^2 can easily be reduced by adding free parameters (Kline, 2011).

In contrast, the other fit indices reported in this study (i.e., RMSEA, CFI, and TLI) are approximate fit indices. The Comparative Fit Index (CFI) and the Tucker-Lewis Index (TLI) are both incremental fit indices, which indicate the relative improvement in fit of the hypothesized model compared with a statistical baseline model (Kline, 2011).

The baseline model is typically the independence (null) model, which assumes zero population covariances among the observed variables. The CFI is non-centrality-based and normed with a range from zero to one (Hu & Bentler, 1999). The TLI, on the other hand, compensates for the effect of model complexity and is non-normed, which allows its values to fall outside the range from zero to one (Hu & Bentler, 1999). The RMSEA is an absolute fit index that is scaled as a badness-of-fit index where a value of zero indicates the best fit. It is also a parsimony-adjusted index that does not approximate a central chi-square distribution (Kline, 2011). Since all fit indices have their strengths and limitations, it is important to consider multiple indices when assessing model fit.

Mplus suggested several modification indices to improve the model. An error covariance was added between V16 and V17, which measure the extent to which students agreed with the statements “My professional goals fit with the goals of the energy industry” and “I feel that the energy industry represents my own personal values,” respectively. The relationship between these items could be influenced by the use of the word “my” in the phasing of both items. More specifically, these items both ask participants to rate the congruence between their own goals and values with those of the energy industry. Under this rationale, the error covariance was set as a free parameter. All other recommendations were not consistent with the theoretical framework used to specify the model. Therefore, no further modifications were included in the analysis.

In structural equation modeling (SEM), exogenous variables are typically assumed to covary although the causes of these associations are not analyzed in the model (Kline, 2011). In general, the covariances between latent variables were very weak or negligible, except for the covariances between *fit*, *attract*, and *intent*, which were very high. The covariance between *fit* and *attract* was .961; the covariance between *fit* and *intent* was .862; and the covariance between *attract* and *intent* was .863. These values suggest a strong relationship between *fit*, *attract*, and *intent*, yet the cause of these relationships is not accounted for in the CFA model since they are all exogenous variables. The next section presents results that will further describe these relationships as well as those between the other variables included in the hypothesized models.

4.3. Structural Equation Modeling (SEM)

As described in Chapter 3, two models were specified a priori and tested using structural equation modeling (SEM) in Mplus. The two models differ in the hypothesized relationships involving institutional emphasis (*instemp*) and peer influence (*peers*). In the first model, it is hypothesized that *instemp* and *peers* are indirectly related to energy industry pursuit intentions (*intent*) through industry fit (*fit*) and industry attraction (*attract*). In contrast, the second model hypothesized that *instemp* and *peers* are directly related to the outcome variable (*intent*).

Results for each model and its hypotheses are presented below. Rectangles are used in the path diagrams to represent observed variables and ovals represent latent constructs. Single-headed arrows, or paths, are used to define causal relationships, which are measured by regression coefficients (Hox & Bechger, 1998).

4.3.1. Model #1

The analysis for the first model converged normally and generated admissible solutions in Mplus. The path diagram with standardized parameter estimates is displayed in Figure 18, and both standardized and unstandardized path coefficients are presented in

Table 32. Table 32 also shows disturbance variances, which are error terms (residuals) that represent unexplained variance for each latent endogenous variable.

In terms of overall fit, the model fails the chi-square test (χ^2 = 443.742, *df* = 240, *p* < .001), indicating that the discrepancy between the observed and model-implied covariances is statistically significant. However, the model had acceptable goodness-of-fit statistics across the range of all other indices examined. The RMSEA with its 90% confidence interval is .047 (.040 – .054), the CFI is .969, and the TLI is .964. Although the failed chi-square test suggests the presence of some misspecification in the model, the other fit indices provide evidence to suggest that the model adequately fits the data and relationships between variables should be further examined.

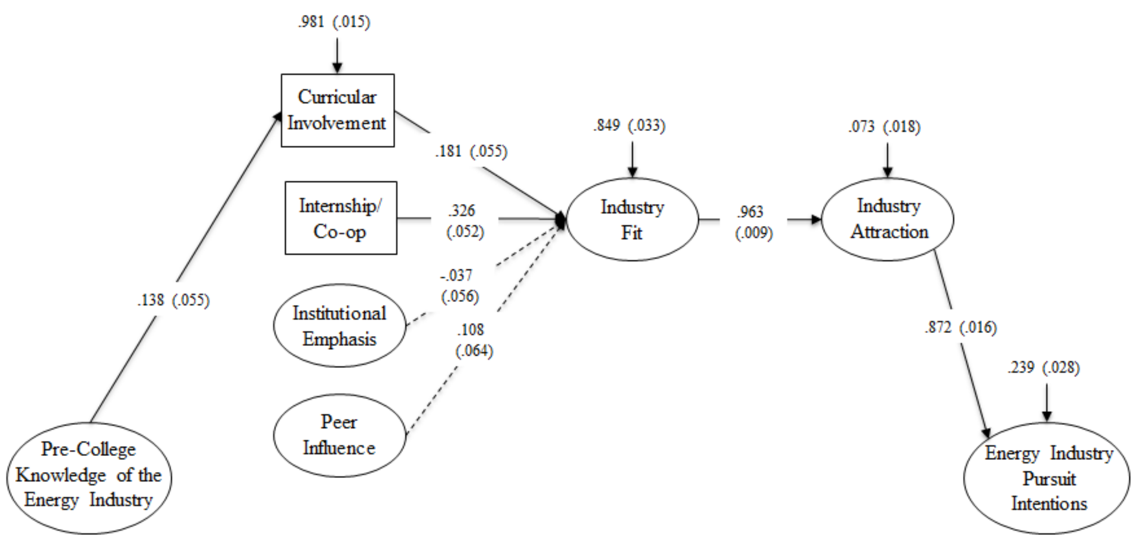

FIGURE 18: Path diagram of model #1 with standardized parameter estimates. Standardized errors are shown in parentheses. Solid lines represent statistically significant path coefficients, and dashed lines denote paths that are not statistically significant (p >.05).

TABLE 32: Maximum likelihood estimates for model #1

Parameter	Unstandardized	SE	Standardized
	Direct effects		
precoll → *curr*	.204*	.082	.138*
curr → *fit*	.182**	.055	.181**
cocurr → *fit*	.609**	.101	.326**
instemp → *fit*	-.040	.061	-.037
peers → *fit*	.295	.173	.108
fit → *attract*	.931**	.035	.963**
attract → *intent*	1.016**	.046	.872**
	Disturbance variances		
curr	.839**	.063	.981**
fit	.742**	.066	.848**
attract	.061**	.015	.075**
intent	.254**	.029	.235**

*p < .05; **p < .01

H_1: Pre-college knowledge of the energy industry (*precoll*) is directly related to curricular involvement (*curr*). The path from *precoll* to *curr* was statistically significant at the .05 level (p = .013) suggesting that there is sufficient evidence to reject the null hypothesis and conclude that there is a direct relationship between students' pre-college knowledge of the energy industry and their curricular involvement. The unstandardized direct effect from *precoll* to *curr* was .204, which means that a 1-point increase on the *precoll* variable predicts a .204-point increase on the *curr* variable. The standardized path coefficient from *precoll* to *curr* was .138. This can be interpreted as a one standard deviation increase in *precoll* results in an increase of .138 standard deviations in *curr*.

The disturbance variance for *curr* was .839, which was the highest residual among the latent endogenous variables in the model. Since *curr* is a self-report of how many energy-related technical elective courses students have taken in college, it is not likely that the high disturbance is due to measurement error. Rather, the non-normal distribution of this variable may have caused a discrepancy between the actual values and those estimated in Mplus. Therefore, this disturbance is not believed to be a major concern.

H_2: Curricular involvement (*curr*), internship/co-op (*cocurr*), institutional emphasis (*instemp*) and peer influence (*peers*) are all directly related to industry fit (*fit*). This hypothesis had mixed results. The paths from *curr* to *fit*, and from *cocurr* to *fit*, were both statistically significant (p = .001 and p < .001, respectively). However, the direct effects of *instemp* and *peers* on *fit* were not statistically significant (p = .512 and p = .089, respectively). Although the direct effects of *curr* on *fit*, and of *cocurr* on *fit*, were statistically significant, their standardized path coefficients were relatively weak (.181 and .326, respectively). Together, these variables only explained 15% of the variance in industry fit (R^2 = .151). These results suggest that curricular involvement and knowledge gained through internships and/or co-ops have a greater impact on industry fit than institutional emphasis and peer influence. However, there are likely other factors that influence students' perception of industry fit that were not included in the model.

H_3: Industry fit (*fit*) is directly related to industry attraction (*attract*). The unstandardized path coefficient for the direct effect of industry fit on industry attraction (.931) is statistically significant, and the corresponding standardized path coefficient (.963) is appreciable in magnitude. It is not surprising, then, that industry fit explains almost 93% of the variance in industry attraction (R^2 = .927). These results support the hypothesis that students' attraction to the energy industry is directly influenced by their perception of fit with the goals and values of the energy industry.

H_4: Industry attraction (*attract*) is directly related to energy industry pursuit intentions (*intent*). The path from *attract* to *intent* was statistically significant (p<.001) suggesting that there is sufficient evidence to reject the null hypothesis and conclude that there is a direct relationship between students' attraction to the energy industry and their energy industry pursuit intentions. The unstandardized direct effect from *attract* to *intent* was 1.016, which means that a 1-point increase on the *attract* variable predicts a 1.016-point increase on the *intent* variable. The standardized path coefficient from *attract* to *intent* was .872, which means that a one standard deviation increase in *attract* results in an increase of .872 standard deviations in *intent*. Also, the results of this analysis indicated that *attract* explains 76% of the variance in *intent* (R^2 = .761). This evidence supports the hypothesis that industry attraction is an immediate antecedent of energy industry pursuit intentions.

4.3.1.1. Indirect Effects

Reported in Table 33 are total standardized indirect effects for the first model. Indirect effects are estimated statistically as the product of direct effects for constituent paths (Kline, 2011). For example, the standardized indirect effect of *curr* on *intent* is estimated as the product of standardized coefficients from *curr* to *fit* (.181), from *fit* to *attract* (.963), and from *attract* to *intent* (.872). The result (.152) indicates that a .152 standard deviation increase in *intent* is expected for every one standard deviation increase in *curr* via its prior effect on *fit* and *attract*. Although the indirect effect of *curr* on *intent* is statistically significant (p = .001), the relationship is relatively weak.

The indirect effect of *cocurr* on *intent* (.274) was also statistically significant, and the highest among those tested for this model. The indirect effect of *precoll* on *intent*

(.021) was just barely statistically significant at the .05 level (p = .047) even though the strength of this effect is almost negligible. The indirect effects from *instemp* to *intent*, and from *peers* to *intent*, were not statistically significant.

TABLE 33: Total standardized indirect effects for model #1

	Estimate	SE	p-value
curr → *intent*	.152**	.046	.001
cocurr → *intent*	.274**	.044	.000
precoll → *intent*	.021*	.011	.047
instemp → *intent*	-.031	.047	.511
peers → *intent*	.091	.054	.089

*p < .05; **p < .01

4.3.2. Model #2

The SEM analysis for the second model converged normally and produced estimates in Mplus as requested. Figure 19 shows a path diagram for the model with standardized parameter estimates. Reported in Table 34 are standardized and unstandardized estimates of path coefficients and disturbances for the model. Results of the goodness-of-fit tests were very similar to those observed for the first model. Although this model had a slightly lower chi-square and the same degrees of freedom as the first model, it still failed the chi-square test (χ^2 = 439.006, df = 240, p < .001). The other fit indices, however, all had acceptable values (RMSEA = .047, RMSEA [90%CI] = .040, .053; CFI = .969; TLI = .965) suggesting that the model adequately fits the data.

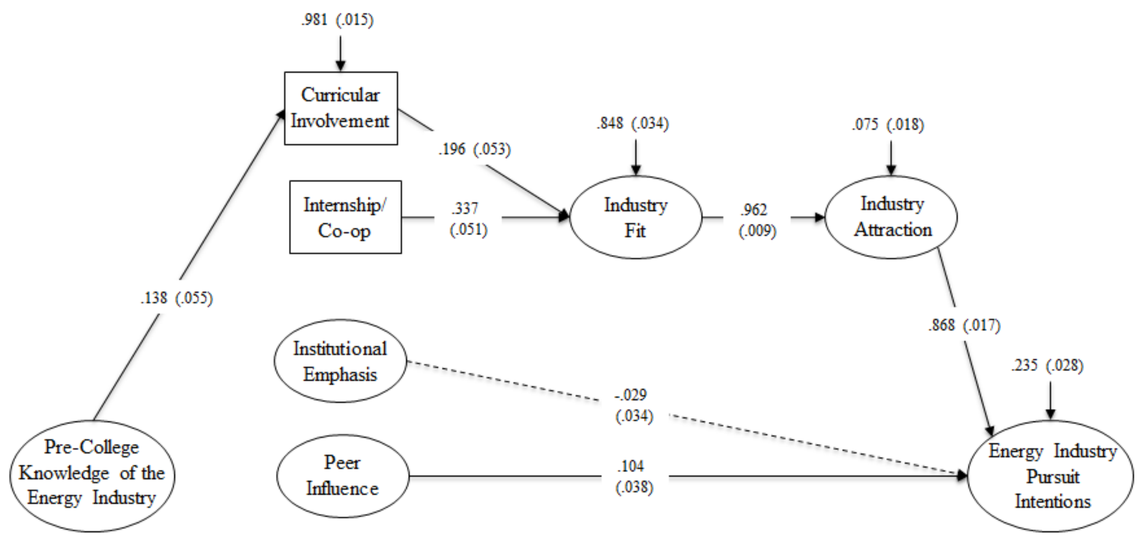

FIGURE 19: Path diagrams of model #2 with standardized parameter estimates.

TABLE 34: Maximum likelihood estimates for model #2

Parameter	Unstandardized	SE	Standardized
	<u>Direct effects</u>		
precoll → *curr*	.205*	.082	.138*
curr → *fit*	.199**	.054	.196**
cocurr → *fit*	.633**	.101	.337**
fit → *attract*	.931**	.035	.962**
instemp → *intent*	-.035	.041	-.029
peers → *intent*	.317**	.115	.104**
attract → *intent*	.998**	.046	.868**
	<u>Disturbance variances</u>		
curr	.839**	.063	.981**
fit	.742**	.066	.848**
attract	.061**	.015	.075**
intent	.254**	.029	.235**

*p < .05; **p < .01

H$_1$: Pre-college knowledge of the energy industry (*precoll*) is directly related to curricular involvement (*curr*). Results for the first hypothesis, which is the same as previously described for model #1, suggests that there is a significant direct effect (*p* =

.013) from *precoll* to *curr*. The relationship between *precoll* and *curr* was also relatively weak in both models. In the second model, the unstandardized direct effect between *precoll* and *curr* was consistent with that observed in the first model (.205 and .204, respectively).

H_2: Curricular involvement (*curr*) and internship/co-op (*cocurr*) are directly related to industry fit (*fit*). The paths from *curr* to *fit*, and from *cocurr* to *fit*, were both statistically significant (p<.001). Unlike the first model, direct effects from *instemp* to *fit*, and *peers* to *fit*, were not hypothesized in this model. The absence of these paths resulted in slightly higher standardized path coefficients between *curr* and *fit* (.196), and from *cocurr* to *fit* (.337). Still, these direct effects on *fit* are relatively weak and the two variables only account for 15% of the variance in industry fit (R^2 = .152).

H_3: Industry fit (*fit*) is directly related to industry attraction (*attract*). Results for this hypothesis were the same as reported for the first model. In both models, the direct effect from *fit* to *attract* was statistically significant (p<.001), and the standardized path coefficients were consistent between the first and second model (.963 and .962, respectively). Results from testing this model also showed that industry fit explains almost 93% of the variance in industry attraction (R^2 = .925), which is consistent with the results from the first model.

H_4: Institutional emphasis (*instemp*), peer influence (*peers*), and industry attraction (*attract*) are all directly related to energy industry pursuit intentions (*intent*). Similar to the first model, results for the second model revealed a significant relationship between *attract* to *intent* (p < .001). The path between *peers* and *intent* was also found to be statistically significant (p = .006), although the standardized path coefficient was too weak to be practically meaningful (.104). The path from *instemp* to *intent* was not statistically significant (p = .386). Overall, the model was able to account for 77% of the explained variance for *intent* (R^2 = .765).

4.3.2.1. Indirect Effects

Table 35 displays the total standardized indirect effects for the second model. All three indirect effects tested for this model were statistically significant and greater than those estimated for the first model. The indirect effect from *precoll* to *intent* (.023) was negligible, and the indirect effect of *curr* on *intent* (.164) was weak. Although the indirect effect from *cocurr* to *intent* (.282) was the strongest among those tested, its effect is still relatively weak. Possible explanations for these results are discussed in the next chapter.

TABLE 35: Total standardized indirect effects for model #2

	Estimate	SE	*p*-value
curr → *intent*	$.164^{**}$	.045	.000
cocurr → *intent*	$.282^{**}$	.044	.000
precoll → *intent*	$.023^{*}$	.011	.039

$^{*}p < .05$; $^{**}p < .01$

4.4. Summary

Reliability and internal consistency for all multi-item variables were supported by acceptable values of Cronbach's alpha. The frequency distributions for *precoll* indicated that most students had little prior knowledge about careers in the energy industry before coming to college. Over 64% of the sample reported that they have not taken any energy-related technical elective courses in college. Almost half (46%) of respondents reported gaining knowledge about professions in the energy industry by participating in an internship or co-op at an energy-related company.

In general, the vast majority of participants indicated that they have some peers/friends that are interested in studying energy (80%), some peers/friends that take energy-related technical elective courses (74%), and some peers/friends that want to work in the energy industry after graduation (79%). The frequency distributions for *fit* indicated that most students tend to perceive a positive fit with the energy industry. In addition, most of the sample (70%) agreed that they are attracted to careers in the energy industry. However, only 46% of participants agreed that, among various options, they would rather work in the energy industry. As for the outcome variable, over half (53%) of the sample indicated that they intend to pursue a career in the energy industry after graduation, yet many of them (29%) may be considering employment options in other occupational sectors as well.

Convergent validity for all six latent constructs was supported by acceptable fit determined through single factor confirmatory factor analyses (CFA), and a multifactor CFA successfully tested for discriminant validity between constructs. Results from the SEM analysis indicated that *instemp* does not significantly affect *fit* or *intent*, and *cocurr* has the strongest direct effect on *fit* as well as the strongest indirect effect on *intent*. The analysis also revealed very strong relationships between *fit*, *attract*, and *intent*. Overall, the second model is preferred over the first model since it had more significant relationships than the first model, and was able to account for slightly more explained variance for the outcome variable (77% versus 76%, respectively).

CHAPTER 5: DISCUSSION

The purpose of this study has been to examine aspects of the university-industry environment that influence engineering students' intentions to work in the energy industry after graduation. This chapter presents responses to the study's three research questions using evidence described in the previous chapter. Limitations of the study are also discussed in this chapter, as well as recommendations for future research.

5.1. Research Question #1

Which of two competing models best measures the direct and indirect relationships between student involvement (i.e., curricular and co-curricular), attitudes (i.e., industry fit and attraction), and energy industry pursuit intentions? When comparing the two models, the second model is preferred over the first model for several reasons. Empirically, the chi-square tests for both models were inconclusive relative to data fit. Although the second model had a slightly lower chi-square value than the first model (χ_D^2 = 4.736), a chi-square difference test could not be conducted to measure the significance of model invariance since the degrees of freedom are the same for both models. Therefore, other aspects of the models must be examined to determine which model is preferred.

The most distinguishing characteristic between the two models is the number of hypothesized relationships that were statistically significant. There were seven hypothesized relationships tested in each model. Yet, the second model supported more of its hypothesized relationships compared to the first. Specifically, the first model hypothesized that institutional emphasis and peer influence were directly related to industry fit. However, both of these paths were not found to be statistically significant. In contrast, the second model hypothesized that institutional emphasis and peer influence were directly related to energy industry pursuit intentions. The results of the second model revealed a significant relationship between peer influence and energy industry pursuit intentions, but not for institutional emphasis.

It is important to note that although the relationship between peer influence and energy industry pursuit intentions was relatively weak (standardized direct effect = .104), including this relationship in the second model helped account for slightly more explained variance for the outcome variable than the first model (77% and 76%, respectively). Therefore, it can be concluded that the second model better explains the effects of the university-industry environment on energy industry pursuit intentions than the first model.

This finding may be of interest to stakeholders whose objective is to improve recruitment efforts in order to fill available positions in the energy industry. Job seekers are often subject to influences from multiple sources, and these results suggest that students' peers/friends may serve as an untapped source of influence to increase students' intentions to work in the energy industry. This may also hold true for universities that are trying to increase the number of students interested in taking energy-related courses. Since students are likely to share their academic experiences with their peers, energy-related courses that have a positive reputation can quickly become courses that other students want to take.

5.2. Research Question #2

What factors within the university-industry environment have the greatest influence on energy industry pursuit intentions? This question aims to compare the relative impacts of curricular involvement in energy-related coursework, knowledge gained about the energy industry through participation in an internship or co-op, institutional emphasis on energy-related topics, and peer influence on students' intentions to pursue careers in the energy industry. A comparison of standardized path coefficients and indirect effects shows that knowledge gained through participation in an internship or co-op has the strongest influence on energy industry pursuit intentions. However, it is important to consider the reasons why this might be and provide suggestions for how stakeholders can use these findings to better leverage students' intentions to work in the energy industry after graduation.

In this study, institutional emphasis was not significantly related to either industry fit or energy industry pursuit intentions. This variable measured how much students' college or university emphasized the importance of the energy industry to society, employment opportunities in the energy industry, current workforce demands, and technological needs in the energy industry. The lack of relationship between institutional emphasis and industry fit may be due to institutions' failure to connect these concepts with students' own goals and values.

For instance, a university's College of Engineering may offer a series of seminars on energy-related topics where professionals from the energy industry are invited to talk with students about their jobs and the work they do to benefit society. Students may see posters scattered around campus or receive emails advertising the seminar series, which increases the students' perception of institutional emphasis on energy-related topics. However, it is ultimately up to the student to decide whether or not they want to attend the seminar. For the students that do attend the seminar, they may learn something new and interesting about the energy industry, yet this passive intervention may not have a profound effect on their attitudes toward the energy industry (i.e., industry fit).

Results from this study suggest that creating an environment that emphasizes energy-related topics is not enough to drive students to pursue careers in the energy industry. Instead, the influential power seems to lie in providing students with the right information for them to determine whether or not their goals and values fit with those of the energy industry. Developing recruitment strategies that target students' values and motivations for studying engineering or energy-related coursework are needed in order to increase students' energy industry pursuit intentions.

Peer influence is another aspect of the university-industry environment that can potentially affect students' career intentions. When testing the second model, this study found that peer influence was directly related to energy industry pursuit intentions, albeit a weak effect. These findings suggest that students' intentions to pursue careers in the energy industry may be influenced by the interests and activities of their peers/friends.

In contrast, results from testing the first model indicated that peer influence was not significantly related to students' perception of industry fit. This may be explained by examining the different levels of context that exist in the university-industry environment. Peer influence is an external stimulus that may affect students' development and decision-making differently than curricular and co-curricular involvement, which are environmental factors that are intentionally chosen by students.

Since industry fit is a factor that measures perception on a personal level, it seems justifiable that more proximal antecedents, such as curricular and co-curricular involvement, would have a more significant effect on industry fit than more distal factors, like peer influence and institutional emphasis.

In fact, results from this study show that curricular involvement and knowledge gained from internships/co-ops had greater direct effects on industry fit than the other two environmental variables tested in this study (i.e., peer influence and institutional emphasis). It is worth noting, however, that these relationships were relatively weak and only accounted for 15% of the variance in industry fit. This suggests that there are other factors that influence industry fit that were not included in the models. To better understand the antecedents of industry fit, future studies should investigate the relationships between industry fit and other types of student involvement within the university-industry environment, such as project-based learning, mentorship, research experience, and student-faculty interaction. Future studies may also want to examine relationships between industry fit and other student attitudes related to the nature of work, career prospects, and perceived social status of jobs in the energy industry.

Nevertheless, results of both models showed that the direct effect from knowledge gained through an internship or co-op to industry fit was almost twice as strong as the direct effect from curricular involvement to industry fit. This suggests that knowledge gained about the energy industry through internships or co-ops has a greater effect on students' perception of industry fit than the number of energy-related technical electives that students take in college. Similar results were observed in terms of indirect effects of curricular involvement and knowledge gained through an internship or co-op on energy industry pursuit intentions. Therefore, it can be concluded that among the environmental variables tested in this study, knowledge gained about the energy industry through internships and co-ops has the greatest indirect effect on students' energy industry pursuit intentions.

Internship and co-op experiences during college can provide valuable opportunities for students to explore professional environments, learn about the culture of an organization, and develop competencies that are required for certain positions. Findings from this study are consistent with previous research that shows that participating in internships and co-ops can improve students' understanding of a particular work environment, which can influence the degree of fit that students perceive as well as their career intentions (e.g., Anderson et al., 2011; Harrison, 2010). However, this study also found evidence to suggest that the quality of these experiences can vary from student to student.

In this study, 90% of the sample that participated in an internship or co-op at an energy-related company at the time of the study reported that they gained knowledge about professions in the energy industry from being a co-op student or intern at an energy company. In contrast, the other 10% (n = 18) did not indicate that they gained knowledge about professions in the energy industry from their intern or co-op experience. It is possible that these students learned about professions in the energy industry from other sources, such as family members, the internet, or school-related experiences. However, it seems more likely that their experiences were not as effective at exposing them to professions in the energy industry compared to the other group. The socialization theory may serve to explain how co-curricular experiences may influence students' industry fit differently and describe the challenges faced by college students as they enter a new workplace.

Early research on socialization identified the importance of the environment in shaping the experience of individuals and perceptions of person-environment fit. Van Maanen and Schein (1977) described organizational socialization as the process in which new employees learn the social knowledge and skills needed to perform a particular job and integrate socially within the organization. The socialization theory posits that new employees (or interns) come to learn and adopt the values and goals of an organization through the way in which they are socialized into the workplace (Kristof, 1996). Socialization practices, such as social support and structured support, can help reduce the uncertainty and stress of new employees when they enter a new work environment, and can foster learning and adaption to the workplace (Harrison, 2010).

In general, "social support is conceptualized as the number and quality of friendships or caring relationships which provide either emotional reassurance, needed information, or instrumental aid in dealing with stressful situations" (Fisher, 1985, p. 40). In the workplace, social support refers to attempts made by members of the organization (e.g., colleagues, supervisors, subordinates) to support and guide new employees as they acclimate to their role in the workplace (Van Maanen & Schein, 1977). Empirical research has shown that social support can help to reduce employees' stress (Fisher, 1985), and can impact employees' commitment to their organization (Dixon, Turner, Cunningham, Sagas, & Kent, 2005).

Structured support refers to an employee's access to meaningful work assignments that are designed to improve learning outcomes (Harrison, 2010). When new employees join a work environment, having a planned set of activities have been shown to facilitate skill development and can help them learn about the values and goals of the organization (Gruman, Saks, & Zweig, 2006). Other studies have found that providing new employees with structured and challenging tasks can improve their level of commitment (Dixon et al., 2005), self-efficacy, role clarity, social integration, and person-job fit (Gruman et al., 2006).

Based on the findings from these studies, it is conceivable that students who perceive greater social and structured support during their internship or co-op experiences will have greater perceived industry fit. To better understand the value of internships and co-ops and their effects on students' career intentions, future studies are encouraged to explore the effects of social and structured support on students' perception of fit with the energy industry. Furthermore, post internship and co-op debriefs by faculty or career services professionals are encouraged to identify strong and weak experiences.

5.3. Research Question #3

What is the relationship between industry fit, industry attraction, and energy industry pursuit intentions? The theoretical framework for this study provided a basis for hypothesizing a direct relationship between industry fit and industry attraction, and a direct relationship from industry attraction to energy industry pursuit intentions. Results from this study not only supported these hypothesized relationships, but they showed that the relationships between industry fit, industry attraction, and energy industry pursuit intentions are very strong.

Person-environment fit theory and Schneider's (1987) attraction-selection-attrition (ASA) model helped inform the hypothesized relationship between industry fit and industry attraction. According to these theories, a person's attraction to an environment is a function of their perceived level of congruence, or fit, with that environment. In this study, it was found that the direct effect of industry fit on industry attraction was statistically significant, and had an unstandardized path coefficient of .931 in both models (standardized effect = .963 and .962 in models 1 and 2, respectively). This means that a 1-point increase in industry fit predicts almost a 1-point increase in industry attraction. This finding indicates that students' level of perceived fit with the energy industry highly impacts their attraction to careers in the energy industry. Furthermore, industry fit explained 93% of the variance in industry attraction, which, from a practical standpoint, suggests that the most effective way to increase students' attraction to careers in the energy industry is to increase their perception of fit with the goals and values of the energy industry.

The theory of reasoned action was used as a framework to examine the relationship between industry attraction and energy industry pursuit intentions. The theory of reasoned action suggests that an individual's intention to engage in a behavior is a function of the individual's attitude toward the behavior and subjective norms (Fishbein & Ajzen, 1975). The results of this study are in accord with this theory. In fact, results from testing the second model revealed that industry attraction (i.e., attitude) and peer influence (i.e., subjective norm) had significant direct effects on energy industry pursuit intentions. Overall, these two factors explained 77% of the variance for energy industry pursuit intentions. The influence of industry attraction, however, had a much greater effect on energy industry pursuit intentions than peer influence (standardized path coefficients = .868 and .104, respectively). The direct effect of industry attraction on energy industry pursuit intentions had an unstandardized path coefficient of .998, which means that a 1-point increase in industry attraction predicts an equivalent increase in energy industry pursuit intentions. These results provide evidence to support the claim that increasing students' attraction to careers in the energy industry can have an impact on their intentions to pursue careers in the energy industry after graduation.

The findings described in this study are also consistent with previous research. For instance, a study by Kristof-Brown et al. (2005) found that recently hired employees who identified with the culture of their organization had an increased level of attraction, commitment, and intentions to remain with the organization. In addition, a study by Harrison (2010) found that changes in nursing students' professional fit predicted higher levels of job and organizational attraction and career choice intentions. A novel feature of the present study, however, is that it investigates relationships between attitudes and intentions at the industry level rather than at the job, organizational, or professional level, which have previously been examined. By expanding the scope of this study to the entire energy industry, the findings are relevant to a broader group of stakeholders from both academic institutions as well as industry partners. The results presented in this study are meant to provide stakeholders with new insights to improve the welfare of the energy industry workforce and its role in sustaining a strong and competitive economy.

5.4. Implications of Results

The findings of this study support the use of university-industry partnerships as a means to prepare engineering students to fill available positions in the energy industry. However, there are several key areas that can be improved in order to increase engineering students' intentions to work in the energy industry after graduation. The following recommendations are meant to help academic institutions, energy companies, and other stakeholders develop effective strategies to attract and engage the industry's next generation of human capital.

Since students' energy industry pursuit intentions are strongly related to their industry fit and attraction, stakeholders must find new ways to connect students' goals and values with that of the energy industry. The goals and values of Generation Y, also known as millennials, differ from those of retiring Baby Boomers. As a workforce generation, millennials value flexibility, balance, respect, and feedback, as well as access to people, tools, and technology (Sampath & Robinson, 2005). According to Sampath and Robinson (2005), millennials tend to seek out opportunities for long-term career development, a variety of experiences within a single organization, availability and access to mentors, a sense of purpose and meaning in their work, open social networks, a tech-savvy work environment, and a work-life balance. Rather than trying to find individuals who fit the energy industry's current culture, stakeholders may want to incorporate the aforementioned values into new recruitment tactics facilitated through university-industry partnerships.

The models tested in this study showed that curricular and co-curricular involvement were significantly related to industry fit, yet these direct effects were relatively weak. The strength of these relationships may have been dampened because of the energy industry's poor image and a lack of available educational and career information. In general, the American public perceives the energy industry as harmful to the environment and providing jobs that are undesirable (National Research Council, 2013). Increasing concerns over pollution, environmental degradation, and health issues may dissuade millennials from pursuing careers in the energy industry. Finding ways to rebrand the energy industry through active learning opportunities, such as mentorship programs, high-quality internship, and scholarship programs, may allow stakeholders to better communicate similarities between students' values and those of the energy industry. Engaging in more corporate social and environmental responsibility initiatives may be another way for energy companies to improve their image and build a positive rapport with Generation Y.

Energy companies may also have difficulties hiring engineering students due to heavy competition for talented STEM graduates. When asked in this study if students were more likely to look for a job in the energy industry than any other occupational sector, 29% of participants said no (definitely not = 8.8%, probably not = 20.2%) and about 21% were not sure. Engineering students may be more attracted to other career fields, such as medicine, law, and business, which appear to offer more influence, reward, and stability than jobs in the energy industry. In order for energy companies to compete for STEM-talent, students must be able to make connections between what is learned both in and out of the classroom, and how it can be applied to real-world situations. It is crucial for stakeholders to present content knowledge in a relatable manner, so that students can develop a deeper understanding of the material in a more meaningful way. Innovative pedagogies, such as active learning, project-based learning, and service learning, can often result in higher quality engagement compared to conventional methods of instruction. In addition, internship and co-op experiences have been shown to improve students' understanding of the work environment and lead to greater certainty about their career choices (Anderson et al., 2011).

This study showed that high quality internship and co-op experiences can directly influence students' perceived industry fit, and indirectly affect their intentions to work in the energy industry after graduation. These types of co-curricular involvement allow students to not only gain content knowledge, but also provide an opportunity for self-evaluation and the establishment of a personal belief system (Kolb et al., 2001). Findings from this study suggest that stakeholders need to provide students with more opportunities to gain a greater sense of self in order to make more purposeful and strategic career decisions. In order to improve engineering students' industry fit, attraction, and intentions to pursue careers in the energy industry, universities and industry partners must work together to create more inclusive environments that resonate with the values of the current generation of students.

5.5. Limitations

There are several limitations that pose threats to internal validity. The first limitation is that participants were not randomly selected. The sample was limited to a convenience sample of undergraduate engineering students who self-selected to participate in the study. However, the sample includes students from colleges and universities across the country, which is believed to improve the generalizability and external validity of the study. The response rate was also relatively low (16%), which was partly due to the ineligibility of 24% of participants who responded to the survey. The response rate may have also been affected by the timing of data collection. The online survey was administered over the summer when many students were not taking classes and may have neglected to keep up with their university e-mail. Furthermore, the site university switched e-mail providers during the period of data collection, which may have caused issues or confusion as students transitioned to the new system.

Other limitations relate to the number and type of variables included in the hypothesized models tested. In an effort to make the models as parsimonious as possible, student input characteristics were limited to students' knowledge about careers in the energy industry before coming to college. Future studies are encouraged to include more demographic variables in the model to analyze the effects of other student inputs (e.g., gender, age, ethnicity, first-generation college student status, financial need, off-campus employment) on student involvement, attitudes, and energy industry pursuit intentions. Similarly, only two sources of student involvement and two additional environmental factors (i.e., peer influence and institutional emphasis) were used to represent influences from the university-industry environment. Although these account for important aspects of the engineering college experience, there are other factors that were not included in this study that could also be significant. It is recommended that other environmental factors, such as student involvement in energy-related research, quality of student-faculty interaction, and student interaction with professionals in the energy industry, be included in future research.

Furthermore, this study is limited in its ability to describe the internship and co-op experiences had by participants and their effects on industry fit. The data collected for this study is able to identify participants that were involved in an internship or co-op at an energy-related company at the time of the study, but the data is unable to identify students who had previously participated in these activities. It is also possible that some internship and co-op experiences were more closely related to the energy industry than others. This could explain some of the variability observed for the item used to measure whether or not students gained knowledge about professions in the energy industry through an internship or co-op. Using this variable in the model provides limited information to identify qualities of internship or co-op experiences that have the greatest impact on students' perceived industry fit. Therefore, future studies are encouraged to further investigate the effects of internships and co-ops on industry fit by examining characteristics of these experiences, such as level of social and structured support, frequency and duration of appointment, and specific job responsibilities.

Lastly, one of the participating energy-related companies would not disclose its employees' e-mail addresses, so an e-mail with a generic link to the survey was sent to a company representative who forwarded the link to their intern and co-op students. Although it is believed that participants from this company took the survey with integrity, there is still a chance that this agreement could have been breached. Without having unique links, it was not possible to control how many times each participant from this company took the survey. As a precaution, however, there was a question in the survey that asked participants if they had already taken the survey. If the student responded yes, the survey was automatically terminated. Despite these limitations, this study delivers a novel approach that enhances the current state of knowledge regarding the effects of involvement and attitudes on engineering students' career intentions within the university-industry environment.

5.6. Conclusion

The recent energy boom, made possible by the emergence of new extraction techniques, has made the United States a global leader in the production and supply of energy (U.S. Energy Information Administration, 2015a). However, the long-term sustainability of this growth trajectory is in question due to widespread concerns over a growing skills gap and an aging energy workforce. The pressure felt by the energy industry to replace about half of its engineers and engineering technicians in the next decade will continue to threaten the nation's global economic competitiveness unless a strategic plan is developed to tackle these issues.

One approach to improve the current energy workforce crisis is to build partnerships between energy companies and educational institutions. Bringing together the strengths of these two major stakeholders can help increase the flow of new talent into the energy workforce by addressing the shortfalls in engineering education through innovative approaches to expand workforce preparation. However, there is a dearth of empirical research that measures the success of university-industry partnerships by improving engineering students' intentions to pursue careers in the energy industry after graduation. This study, therefore, seeks to fill in this gap in knowledge by conducting a systems analysis of the university-industry environment to investigate the effects of student involvement and attitudes on energy industry pursuit intentions.

The purpose of this study is to generate a statistical model, based on theories from college student development and vocational psychology, to identify factors within the university-industry environment that influence engineering students' intentions to pursue careers in the energy industry after graduation. The sample consists of 381 engineering students from across the country that took the Career Assessment for Students in Energy (CASE) survey. Structural equation modeling was used to identify the effects of student involvement and attitudes on energy industry pursuit intentions.

Results from the study suggest that students who gained knowledge about professions in the energy industry from participating in internships or co-ops at energy-related companies perceived greater fit with the goals and values of the energy industry. In addition, this study found that students who perceive high levels of fit with the energy industry also have high industry attraction, which directly affects their energy industry pursuit intentions. The direct effect of peer influence on energy industry pursuit intentions was also significant, but this relationship was very weak.

Overall, this research indicates that high quality internship and co-op experiences have the potential to directly influence students' perceived industry fit, and indirectly affect their intentions to work in the energy industry after graduation. Involvement in these types of co-curricular experiences allows students to gain content knowledge, explore new professional environments, and provide opportunities for self-evaluation and the establishment of a personal belief system. Creating more inclusive environments that resonate with the values of the current generation of students could improve engineering students' industry fit, attraction, and intentions to pursue careers in the energy industry after graduation. Therefore, stakeholders are encouraged to provide students with more opportunities to gain a greater sense of self in order to make more purposeful and strategic career decisions.

The future implications of this study include 1) suggestions for stakeholders to improve curricular and co-curricular experiences to increase students' career persistence in the energy industry, 2) a model that can be used by other industries, such as manufacturing, to improve recruitment and workforce development practices, and 3) the development of three new constructs (i.e., industry fit, industry attraction, and energy industry pursuit intentions) that expand the current state of knowledge about relationships between attitudes and intentions at the job, organization, and professional level to include the impacts of these relationships at the industry level.

Limitations of this study include the amount of variables included in the hypothesized models, and the study's ability to reveal specific aspects of internship and co-op experiences that had the greatest effect on students' industry fit. Therefore, future research is encouraged to investigate other aspects of the university-industry environment that could influence students' perception of fit with the energy industry. Outcomes of this study are expected to provide stakeholders with new insights to improve practices within the university-industry environment that will educate, promote, and sustain a strong energy workforce for years to come.

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APPRENDIX A: CAREER ASSESSMENT FOR STUDENTS IN ENERGY (CASE) SURVEY

Page - Career Assessment for Students in Energy (CASE)

Welcome to the "Career Assessment for Students in Energy," an online survey about college experiences and careers in the energy industry. Please read the consent form below and click on the "I Agree" button at the bottom of the page if you understand the statements and freely consent to participate in the study.

Required answers: 0 *Allowed answers: 0*

You are being asked to participate in a research study, "Career Assessment for Students in Energy." The purpose of this research study is to better understand what influences college students to pursue careers in the energy industry after graduation. Jordan Gross, a doctoral student at UNC Charlotte, and Dr. Patricia Tolley, Associate Professor and Associate Dean in the Lee College of Engineering at UNC Charlotte, are conducting the research study.

You will be asked to respond to an online survey consisting of approximately 30 questions related to your academic and co-curricular involvement in college, your perceptions of the energy industry, and your intentions to pursue a career in the energy industry after graduation. **The survey should take about 10 minutes**.

The research team will **protect your privacy** as required by the Family Educational Rights to Privacy Act (FERPA). All individual responses will be kept confidential. Survey results will be summarized and the data will have no direct personal identifying information. Data will be stored on a password protected network only available to the researchers.

There are no expected physical, emotional, social, professional, or financial risks associated with participation in this study. There are also no direct benefits for participating in the study. In general, the research may result in better understanding of how students' college experiences relate to their intentions to pursue a career in the energy industry.

You are a volunteer. The decision to participate in this study is completely up to you. If you decide to be in the study, you may stop at any time. You will not be treated any differently if you decide not to participate in the study or if you stop once you have started.

UNC Charlotte wants to make sure that all research participants are treated in a fair and respectful manner. Contact the university's Office of Research Compliance at (704-687-1871) if you have questions about your rights as a study participant. If you have any questions about the purpose, procedures, and outcome of this project, contact the principal investigator of the study, Jordan Gross (315-420-9213, jgross18@uncc.edu).

This form was approved for use on *June 8, 2015* for a period of one (1) year.

You may screen print a copy of this form.

Required answers: 0 *Allowed answers: 0*

Q1 If you are 18 years of age or older, understand the statements above, and freely consent to participate in the study, click on the "I Agree" response to begin the survey.

I agree*[Code = 1]*

I do not agree*[Code = 2] (Go To End)*

Required answers: 1 *Allowed answers: 1*

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Q2 In this survey, the terms "*energy industry*" or "*energy-related company*" are used to describe all sub-sectors industries (e.g., petroleum, natural gas, coal, nuclear, renewable) involved in energy exploration and production, organizations involved in energy generation, transmission, and distribution infrastructure, and companies involved in the research and development of energy-related technologies.

Are you currently participating in an internship or co-op at an energy-related company?

Yes*[Code = 1]*

No*[Code = 2]*

Required answers: 1 *Allowed answers: 1*

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Q3 Have you already responded to the Career Assessment for Students in Energy (CASE) survey?

Yes*[Code = 1] (Go To End)*

No*[Code = 2]*

Required answers: 1 *Allowed answers: 1*

Display if Q2='Yes'

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Q4 Is this your first internship or co-op at an energy-related company?

Yes*[Code = 1]*

No*[Code = 2]*

Required answers: 1 *Allowed answers: 1*

Display if Q3='No'

Prior to enrolling in college, please indicate your level of knowledge in the following areas:

Q5 How much knowledge did you have about jobs in the energy industry?

None*[Code = 1] [Numeric Value = 1]*

Very little*[Code = 2] [Numeric Value = 2]*

Some*[Code = 3] [Numeric Value = 3]*

Quite a bit*[Code = 4] [Numeric Value = 4]*

A great deal*[Code = 5] [Numeric Value = 5]*

Required answers: 1 *Allowed answers: 1*

Q6 How much knowledge did you have about corporations in the energy industry?

None*[Code = 1] [Numeric Value = 1]*

Very little*[Code = 2] [Numeric Value = 2]*

Some*[Code = 3] [Numeric Value = 3]*

Quite a bit*[Code = 4] [Numeric Value = 4]*

A great deal*[Code = 5] [Numeric Value = 5]*

Required answers: 1 *Allowed answers: 1*

Q7 How much knowledge did you have about employment opportunities in the energy industry?

None*[Code = 1] [Numeric Value = 1]*

Very little*[Code = 2] [Numeric Value = 2]*

Some*[Code = 3] [Numeric Value = 3]*

Quite a bit*[Code = 4] [Numeric Value = 4]*

A great deal*[Code = 5] [Numeric Value = 5]*

Required answers: 1 *Allowed answers: 1*

Q8 How much knowledge did you have about how to get a job in the energy industry?

None*[Code = 1] [Numeric Value = 1]*

Very little*[Code = 2] [Numeric Value = 2]*

Some*[Code = 3] [Numeric Value = 3]*

Quite a bit*[Code = 4] [Numeric Value = 4]*

A great deal*[Code = 5] [Numeric Value = 5]*

Required answers: 1 *Allowed answers: 1*

Prior to enrolling in college, please indicate your exposure to jobs in the energy industry through the following experiences:

Q9 Visited an energy company or utility

Never*[Code = 1] [Numeric Value = 1]*

Once*[Code = 2] [Numeric Value = 2]*

More than once*[Code = 3] [Numeric Value = 3]*

Required answers: 1 *Allowed answers: 1*

Q10 Had a high school internship or summer job at an energy company

Never*[Code = 1] [Numeric Value = 1]*

Once*[Code = 2] [Numeric Value = 2]*

More than once*[Code = 3] [Numeric Value = 3]*

Required answers: 1 *Allowed answers: 1*

Q11 Attended a presentation/information session from someone who worked in the energy industry

Never*[Code = 1] [Numeric Value = 1]*

Once*[Code = 2] [Numeric Value = 2]*

More than once*[Code = 3] [Numeric Value = 3]*

Required answers: 1 *Allowed answers: 1*

Q12 Attended a job fair where there were representatives from the energy industry

Never*[Code = 1] [Numeric Value = 1]*

Once*[Code = 2] [Numeric Value = 2]*

More than once*[Code = 3] [Numeric Value = 3]*

Required answers: 1 *Allowed answers: 1*

Q13 Have you taken or do you plan to take energy-related technical elective courses in college (e.g., energy systems, power systems analysis, electrical machinery, power generation operation and control, nuclear engineering, sustainable energy production, etc.)?
Yes*[Code = 1]*
No*[Code = 2]*
Not sure*[Code = 3]*
Required answers: 1 *Allowed answers: 1*

Q14 How many energy-related technical elective courses have you taken so far in college?
None*[Code = 1]*
1*[Code = 2]*
2*[Code = 3]*
3*[Code = 4]*
4*[Code = 5]*
More than 5*[Code = 6]*
Required answers: 1 *Allowed answers: 1*

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Q15 Are you currently enrolled or plan to enroll in an energy concentration at your college or university?
Yes*[Code = 1]*
No, but my college offers an energy concentration*[Code = 2]*
No, my college does not offer an energy concentration*[Code = 3]*
Not sure*[Code = 4]*
Required answers: 1 *Allowed answers: 1*

Q16 How often are you involved in engineering activities, such as engineering clubs or professional societies?
Never*[Code = 1] [Numeric Value = 1]*
Rarely*[Code = 2] [Numeric Value = 2]*
Occasionally*[Code = 3] [Numeric Value = 3]*
Frequently*[Code = 4] [Numeric Value = 4]*
Required answers: 1 *Allowed answers: 1*

Q17 **Since coming to college**, have you worked with a professor on a STEM-related research project outside of class? (STEM stands for Science, Technology, Energy, and Math)
Yes*[Code = 1]*
No*[Code = 2]*
Required answers: 1 *Allowed answers: 1*

Q18 **Since entering college**, how much knowledge have you gained about professions in the energy industry?
No knowledge*[Code = 1] [Numeric Value = 1]*
Limited knowledge*[Code = 2] [Numeric Value = 2]*
Moderate knowledge*[Code = 3] [Numeric Value = 3]*
Extensive knowledge*[Code = 4] [Numeric Value = 4]*
Required answers: 1 *Allowed answers: 1*

Q19 How did you gain your knowledge about professions in the energy industry? (Check all that apply)
From being a visitor at an energy company*[Code = 1]*
From being a co-op student or intern at an energy company*[Code = 2]*
From being an employee at an energy company (not an internship or co-op)*[Code = 3]*
From a family member*[Code = 4]*
From a close friend*[Code = 5]*
From school-related experiences (i.e., a professor or class)*[Code = 6]*
Other (please specify)*[Code = 7] [Textbox]*
Required answers: 1 *Allowed answers: 7*

Q20 Do any of your family members or close friends work in the energy industry?
Yes*[Code = 1]*
No*[Code = 2]*
Required answers: 1 *Allowed answers: 1*

How much does your college or university emphasize the following?

Q21 Connecting academic knowledge to solve real-world problems
None*[Code = 1] [Numeric Value = 1]*
Very little*[Code = 2] [Numeric Value = 2]*
Some*[Code = 3] [Numeric Value = 3]*
Quite a bit*[Code = 4] [Numeric Value = 4]*
Very much*[Code = 5] [Numeric Value = 5]*
Required answers: 1 *Allowed answers: 1*

Q22 Networking with professionals in your field of interest
None*[Code = 1] [Numeric Value = 1]*
Very little*[Code = 2] [Numeric Value = 2]*
Some*[Code = 3] [Numeric Value = 3]*
Quite a bit*[Code = 4] [Numeric Value = 4]*
Very much*[Code = 5] [Numeric Value = 5]*
Required answers: 1 *Allowed answers: 1*

Q23 The importance of the energy industry to society
None*[Code = 1] [Numeric Value = 1]*
Very little*[Code = 2] [Numeric Value = 2]*
Some*[Code = 3] [Numeric Value = 3]*
Quite a bit*[Code = 4] [Numeric Value = 4]*
Very much*[Code = 5] [Numeric Value = 5]*
Required answers: 1 *Allowed answers: 1*

Q24 Employment opportunities in the energy industry	
None*[Code = 1] [Numeric Value = 1]*	
Very little*[Code = 2] [Numeric Value = 2]*	
Some*[Code = 3] [Numeric Value = 3]*	
Quite a bit*[Code = 4] [Numeric Value = 4]*	
Very much*[Code = 5] [Numeric Value = 5]*	
Required answers: 1	*Allowed answers: 1*

Q25 Current workforce demands within the energy industry	
None*[Code = 1] [Numeric Value = 1]*	
Very little*[Code = 2] [Numeric Value = 2]*	
Some*[Code = 3] [Numeric Value = 3]*	
Quite a bit*[Code = 4] [Numeric Value = 4]*	
Very much*[Code = 5] [Numeric Value = 5]*	
Required answers: 1	*Allowed answers: 1*

Q26 Current technological needs in the energy industry	
None*[Code = 1] [Numeric Value = 1]*	
Very little*[Code = 2] [Numeric Value = 2]*	
Some*[Code = 3] [Numeric Value = 3]*	
Quite a bit*[Code = 4] [Numeric Value = 4]*	
Very much*[Code = 5] [Numeric Value = 5]*	
Required answers: 1	*Allowed answers: 1*

Q27 Environmental impacts related to the energy industry	
None*[Code = 1] [Numeric Value = 1]*	
Very little*[Code = 2] [Numeric Value = 2]*	
Some*[Code = 3] [Numeric Value = 3]*	
Quite a bit*[Code = 4] [Numeric Value = 4]*	
Very much*[Code = 5] [Numeric Value = 5]*	
Required answers: 1	*Allowed answers: 1*

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Q28 How many of your peers/friends are interested in studying energy?	
None*[Code = 1] [Numeric Value = 1]*	
Some*[Code = 2] [Numeric Value = 2]*	
Most*[Code = 3] [Numeric Value = 3]*	
All*[Code = 4] [Numeric Value = 4]*	
Required answers: 1	*Allowed answers: 1*

Q29 How many of your peers/friends take energy-related technical elective courses in college (e.g., energy systems, power systems analysis, electrical machinery, power generation operation and control, nuclear engineering, sustainable energy production)?
None*[Code = 1] [Numeric Value = 1]*
Some*[Code = 2] [Numeric Value = 2]*
Most*[Code = 3] [Numeric Value = 3]*
All*[Code = 4] [Numeric Value = 4]*
Required answers: 1 *Allowed answers: 1*

Q30 How many of your peers/friends want to work in the energy industry after graduation?
None*[Code = 1] [Numeric Value = 1]*
Some*[Code = 2] [Numeric Value = 2]*
Most*[Code = 3] [Numeric Value = 3]*
All*[Code = 4] [Numeric Value = 4]*
Required answers: 1 *Allowed answers: 1*

Rate your agreement with the following statements about jobs in the energy industry:

Q31 I find jobs in the energy industry interesting.
Strongly disagree*[Code = 1] [Numeric Value = 1]*
Disagree*[Code = 2] [Numeric Value = 2]*
Neutral*[Code = 3] [Numeric Value = 3]*
Agree*[Code = 4] [Numeric Value = 4]*
Strongly agree*[Code = 5] [Numeric Value = 5]*
Required answers: 1 *Allowed answers: 1*

Q32 Most jobs in the energy industry are low skilled.
Strongly disagree*[Code = 1] [Numeric Value = 1]*
Disagree*[Code = 2] [Numeric Value = 2]*
Neutral*[Code = 3] [Numeric Value = 3]*
Agree*[Code = 4] [Numeric Value = 4]*
Strongly agree*[Code = 5] [Numeric Value = 5]*
Required answers: 1 *Allowed answers: 1*

Q33 I would feel independent and free in an energy industry job.
Strongly disagree*[Code = 1] [Numeric Value = 1]*
Disagree*[Code = 2] [Numeric Value = 2]*
Neutral*[Code = 3] [Numeric Value = 3]*
Agree*[Code = 4] [Numeric Value = 4]*
Strongly agree*[Code = 5] [Numeric Value = 5]*
Required answers: 1 *Allowed answers: 1*

Q34 Jobs in the energy industry are in high demand.
Strongly disagree*[Code = 1] [Numeric Value = 1]*
Disagree*[Code = 2] [Numeric Value = 2]*
Neutral*[Code = 3] [Numeric Value = 3]*
Agree*[Code = 4] [Numeric Value = 4]*
Strongly agree*[Code = 5] [Numeric Value = 5]*
Required answers: 1 *Allowed answers: 1*

Q35 Jobs in the energy industry are generally boring.
Strongly disagree*[Code = 1] [Numeric Value = 1]*
Disagree*[Code = 2] [Numeric Value = 2]*
Neutral*[Code = 3] [Numeric Value = 3]*
Agree*[Code = 4] [Numeric Value = 4]*
Strongly agree*[Code = 5] [Numeric Value = 5]*
Required answers: 1 *Allowed answers: 1*

Q36 Most jobs in the energy industry are dirty.
Strongly disagree*[Code = 1] [Numeric Value = 1]*
Disagree*[Code = 2] [Numeric Value = 2]*
Neutral*[Code = 3] [Numeric Value = 3]*
Agree*[Code = 4] [Numeric Value = 4]*
Strongly agree*[Code = 5] [Numeric Value = 5]*
Required answers: 1 *Allowed answers: 1*

Q37 I find jobs in the energy industry to be male-dominated.
Strongly disagree*[Code = 1] [Numeric Value = 1]*
Disagree*[Code = 2] [Numeric Value = 2]*
Neutral*[Code = 3] [Numeric Value = 3]*
Agree*[Code = 4] [Numeric Value = 4]*
Strongly agree*[Code = 5] [Numeric Value = 5]*
Required answers: 1 *Allowed answers: 1*

Q38 Jobs in the energy industry can be difficult to secure.
Strongly disagree*[Code = 1] [Numeric Value = 1]*
Disagree*[Code = 2] [Numeric Value = 2]*
Neutral*[Code = 3] [Numeric Value = 3]*
Agree*[Code = 4] [Numeric Value = 4]*
Strongly agree*[Code = 5] [Numeric Value = 5]*
Required answers: 1 *Allowed answers: 1*

Q39 I think that jobs in the energy industry are worth doing.	
Strongly disagree*[Code = 1] [Numeric Value = 1]*	
Disagree*[Code = 2] [Numeric Value = 2]*	
Neutral*[Code = 3] [Numeric Value = 3]*	
Agree*[Code = 4] [Numeric Value = 4]*	
Strongly agree*[Code = 5] [Numeric Value = 5]*	
Required answers: 1	*Allowed answers: 1*

Q40 Most jobs in the energy industry are not safe.	
Strongly disagree*[Code = 1] [Numeric Value = 1]*	
Disagree*[Code = 2] [Numeric Value = 2]*	
Neutral*[Code = 3] [Numeric Value = 3]*	
Agree*[Code = 4] [Numeric Value = 4]*	
Strongly agree*[Code = 5] [Numeric Value = 5]*	
Required answers: 1	*Allowed answers: 1*

Rate your agreement with the following statements about jobs in the energy industry:

Q41 The energy industry is a respected (prestigious) occupational field.	
Strongly disagree*[Code = 1] [Numeric Value = 1]*	
Disagree*[Code = 2] [Numeric Value = 2]*	
Neutral*[Code = 3] [Numeric Value = 3]*	
Agree*[Code = 4] [Numeric Value = 4]*	
Strongly agree*[Code = 5] [Numeric Value = 5]*	
Required answers: 1	*Allowed answers: 1*

Q42 Jobs in the energy industry are important to our society.	
Strongly disagree*[Code = 1] [Numeric Value = 1]*	
Disagree*[Code = 2] [Numeric Value = 2]*	
Neutral*[Code = 3] [Numeric Value = 3]*	
Agree*[Code = 4] [Numeric Value = 4]*	
Strongly agree*[Code = 5] [Numeric Value = 5]*	
Required answers: 1	*Allowed answers: 1*

Q43 Employees in the energy industry are valuable to society.	
Strongly disagree*[Code = 1] [Numeric Value = 1]*	
Disagree*[Code = 2] [Numeric Value = 2]*	
Neutral*[Code = 3] [Numeric Value = 3]*	
Agree*[Code = 4] [Numeric Value = 4]*	
Strongly agree*[Code = 5] [Numeric Value = 5]*	
Required answers: 1	*Allowed answers: 1*

Q44 Jobs in the energy industry are immoral.

Strongly disagree*[Code = 1] [Numeric Value = 1]*
Disagree*[Code = 2] [Numeric Value = 2]*
Neutral*[Code = 3] [Numeric Value = 3]*
Agree*[Code = 4] [Numeric Value = 4]*
Strongly agree*[Code = 5] [Numeric Value = 5]*

Required answers: 1 *Allowed answers: 1*

Q45 My family would be proud if I worked in the energy industry.

Strongly disagree*[Code = 1] [Numeric Value = 1]*
Disagree*[Code = 2] [Numeric Value = 2]*
Neutral*[Code = 3] [Numeric Value = 3]*
Agree*[Code = 4] [Numeric Value = 4]*
Strongly agree*[Code = 5] [Numeric Value = 5]*

Required answers: 1 *Allowed answers: 1*

Q46 I would have pride in my job if I worked in the energy industry.

Strongly disagree*[Code = 1] [Numeric Value = 1]*
Disagree*[Code = 2] [Numeric Value = 2]*
Neutral*[Code = 3] [Numeric Value = 3]*
Agree*[Code = 4] [Numeric Value = 4]*
Strongly agree*[Code = 5] [Numeric Value = 5]*

Required answers: 1 *Allowed answers: 1*

Rate your agreement with the following statements about career prospects in the energy industry:

Q47 Promotion opportunities are satisfactory in the energy industry.

Strongly disagree*[Code = 1] [Numeric Value = 1]*
Disagree*[Code = 2] [Numeric Value = 2]*
Neutral*[Code = 3] [Numeric Value = 3]*
Agree*[Code = 4] [Numeric Value = 4]*
Strongly agree*[Code = 5] [Numeric Value = 5]*

Required answers: 1 *Allowed answers: 1*

Q48 Learning about energy at the university level is a good investment in my career development.

Strongly disagree*[Code = 1] [Numeric Value = 1]*
Disagree*[Code = 2] [Numeric Value = 2]*
Neutral*[Code = 3] [Numeric Value = 3]*
Agree*[Code = 4] [Numeric Value = 4]*
Strongly agree*[Code = 5] [Numeric Value = 5]*

Required answers: 1 *Allowed answers: 1*

Q49 One can make good money by working in the energy industry.
Strongly disagree*[Code = 1] [Numeric Value = 1]*
Disagree*[Code = 2] [Numeric Value = 2]*
Neutral*[Code = 3] [Numeric Value = 3]*
Agree*[Code = 4] [Numeric Value = 4]*
Strongly agree*[Code = 5] [Numeric Value = 5]*
Required answers: 1 *Allowed answers: 1*

Q50 One can make more money in the energy industry than in other occupational sectors.
Strongly disagree*[Code = 1] [Numeric Value = 1]*
Disagree*[Code = 2] [Numeric Value = 2]*
Neutral*[Code = 3] [Numeric Value = 3]*
Agree*[Code = 4] [Numeric Value = 4]*
Strongly agree*[Code = 5] [Numeric Value = 5]*
Required answers: 1 *Allowed answers: 1*

Q51 Working in the energy industry provides a secure future.
Strongly disagree*[Code = 1] [Numeric Value = 1]*
Disagree*[Code = 2] [Numeric Value = 2]*
Neutral*[Code = 3] [Numeric Value = 3]*
Agree*[Code = 4] [Numeric Value = 4]*
Strongly agree*[Code = 5] [Numeric Value = 5]*
Required answers: 1 *Allowed answers: 1*

Q52 It is easy to find jobs in the energy industry.
Strongly disagree*[Code = 1] [Numeric Value = 1]*
Disagree*[Code = 2] [Numeric Value = 2]*
Neutral*[Code = 3] [Numeric Value = 3]*
Agree*[Code = 4] [Numeric Value = 4]*
Strongly agree*[Code = 5] [Numeric Value = 5]*
Required answers: 1 *Allowed answers: 1*

Q53 It is easy to find a job in the energy industry that is desirable to me.
Strongly disagree*[Code = 1] [Numeric Value = 1]*
Disagree*[Code = 2] [Numeric Value = 2]*
Neutral*[Code = 3] [Numeric Value = 3]*
Agree*[Code = 4] [Numeric Value = 4]*
Strongly agree*[Code = 5] [Numeric Value = 5]*
Required answers: 1 *Allowed answers: 1*

Q54 Finding a good job in the energy industry requires many social networks and connections.	
Strongly disagree*[Code = 1] [Numeric Value = 1]*	
Disagree*[Code = 2] [Numeric Value = 2]*	
Neutral*[Code = 3] [Numeric Value = 3]*	
Agree*[Code = 4] [Numeric Value = 4]*	
Strongly agree*[Code = 5] [Numeric Value = 5]*	
Required answers: 1	*Allowed answers: 1*

Q55 In general, the advantages of working in the energy industry outweigh the disadvantages.	
Strongly disagree*[Code = 1] [Numeric Value = 1]*	
Disagree*[Code = 2] [Numeric Value = 2]*	
Neutral*[Code = 3] [Numeric Value = 3]*	
Agree*[Code = 4] [Numeric Value = 4]*	
Strongly agree*[Code = 5] [Numeric Value = 5]*	
Required answers: 1	*Allowed answers: 1*

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Rate the following items related to the energy industry:

Q56 I feel that the energy industry is a good fit for me professionally.	
Strongly disagree*[Code = 1] [Numeric Value = 1]*	
Disagree*[Code = 2] [Numeric Value = 2]*	
Neutral*[Code = 3] [Numeric Value = 3]*	
Agree*[Code = 4] [Numeric Value = 4]*	
Strongly agree*[Code = 5] [Numeric Value = 5]*	
Required answers: 1	*Allowed answers: 1*

Q57 I identify with the values of the energy industry.	
Strongly disagree*[Code = 1] [Numeric Value = 1]*	
Disagree*[Code = 2] [Numeric Value = 2]*	
Neutral*[Code = 3] [Numeric Value = 3]*	
Agree*[Code = 4] [Numeric Value = 4]*	
Strongly agree*[Code = 5] [Numeric Value = 5]*	
Required answers: 1	*Allowed answers: 1*

Q58 My professional goals fit with the goals of the energy industry.	
Strongly disagree*[Code = 1] [Numeric Value = 1]*	
Disagree*[Code = 2] [Numeric Value = 2]*	
Neutral*[Code = 3] [Numeric Value = 3]*	
Agree*[Code = 4] [Numeric Value = 4]*	
Strongly agree*[Code = 5] [Numeric Value = 5]*	
Required answers: 1	*Allowed answers: 1*

Q59 I feel that the energy industry represents my own personal values.	
Strongly disagree*[Code = 1] [Numeric Value = 1]*	
Disagree*[Code = 2] [Numeric Value = 2]*	
Neutral*[Code = 3] [Numeric Value = 3]*	
Agree*[Code = 4] [Numeric Value = 4]*	
Strongly agree*[Code = 5] [Numeric Value = 5]*	
Required answers: 1	*Allowed answers: 1*

Rate your agreement with the following statements about your attraction to the energy industry:

Q60 A career in the energy industry is attractive to me.	
Strongly disagree*[Code = 1] [Numeric Value = 1]*	
Disagree*[Code = 2] [Numeric Value = 2]*	
Neutral*[Code = 3] [Numeric Value = 3]*	
Agree*[Code = 4] [Numeric Value = 4]*	
Strongly agree*[Code = 5] [Numeric Value = 5]*	
Required answers: 1	*Allowed answers: 1*

Q61 If I had the opportunity and resources, I would work in the energy industry.	
Strongly disagree*[Code = 1] [Numeric Value = 1]*	
Disagree*[Code = 2] [Numeric Value = 2]*	
Neutral*[Code = 3] [Numeric Value = 3]*	
Agree*[Code = 4] [Numeric Value = 4]*	
Strongly agree*[Code = 5] [Numeric Value = 5]*	
Required answers: 1	*Allowed answers: 1*

Q62 Among various options, I would rather work in the energy industry.	
Strongly disagree*[Code = 1] [Numeric Value = 1]*	
Disagree*[Code = 2] [Numeric Value = 2]*	
Neutral*[Code = 3] [Numeric Value = 3]*	
Agree*[Code = 4] [Numeric Value = 4]*	
Strongly agree*[Code = 5] [Numeric Value = 5]*	
Required answers: 1	*Allowed answers: 1*

Q63 Working in the energy industry implies more advantages than disadvantages to me.	
Strongly disagree*[Code = 1] [Numeric Value = 1]*	
Disagree*[Code = 2] [Numeric Value = 2]*	
Neutral*[Code = 3] [Numeric Value = 3]*	
Agree*[Code = 4] [Numeric Value = 4]*	
Strongly agree*[Code = 5] [Numeric Value = 5]*	
Required answers: 1	*Allowed answers: 1*

Indicate your intentions to work in the energy industry:

Q64 Do you intend to work in the energy industry for at least 3 years after graduation?
Definitely not*[Code = 1] [Numeric Value = 1]*
Probably not*[Code = 2] [Numeric Value = 2]*
Not sure*[Code = 3] [Numeric Value = 3]*
Probably yes*[Code = 4] [Numeric Value = 4]*
Definitely yes*[Code = 5] [Numeric Value = 5]*
Required answers: 1 *Allowed answers: 1*

Q65 Is it likely that you will work in the energy industry after graduation?
Definitely not*[Code = 1] [Numeric Value = 1]*
Probably not*[Code = 2] [Numeric Value = 2]*
Not sure*[Code = 3] [Numeric Value = 3]*
Probably yes*[Code = 4] [Numeric Value = 4]*
Definitely yes*[Code = 5] [Numeric Value = 5]*
Required answers: 1 *Allowed answers: 1*

Q66 Are you more likely to look for a job in the energy industry than any other occupational sector?
Definitely not*[Code = 1] [Numeric Value = 1]*
Probably not*[Code = 2] [Numeric Value = 2]*
Not sure*[Code = 3] [Numeric Value = 3]*
Probably yes*[Code = 4] [Numeric Value = 4]*
Definitely yes*[Code = 5] [Numeric Value = 5]*
Required answers: 1 *Allowed answers: 1*

Q67 Do you plan on going to graduate school before getting a full-time job?
Definitely not*[Code = 1] [Numeric Value = 1]*
Probably not*[Code = 2] [Numeric Value = 2]*
Not sure*[Code = 3] [Numeric Value = 3]*
Probably yes*[Code = 4] [Numeric Value = 4]*
Definitely yes*[Code = 5] [Numeric Value = 5]*
Required answers: 1 *Allowed answers: 1*

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Q68 What college or university do you currently attend?
UNC Charlotte*[Code = 1]*
Other (please specify)*[Code = 2] [Textbox]*
Required answers: 1 *Allowed answers: 1*

Q69 During the Spring 2015 semester, I was a:	
Freshman*[Code = 1]*	
Sophomore*[Code = 2]*	
Junior*[Code = 3]*	
Senior*[Code = 4]*	
Other (please specify)*[Code = 5] [Textbox]*	
Required answers: 1	*Allowed answers: 1*

Q70 When you entered your current college or university, were you:	
A new freshman with no college credit*[Code = 1]*	
A new freshman with college credit*[Code = 2]*	
A transfer student from a two-year institution*[Code = 3]*	
A transfer student from a four-year institution*[Code = 4]*	
An early college high school student*[Code = 5]*	
A second degree student*[Code = 6]*	
Required answers: 1	*Allowed answers: 1*

Q71 What is your major?	
Arts and Humanities (e.g., anthropology, English, fine arts, history)*[Code = 1]*	
Chemical Engineering*[Code = 2]*	
Civil Engineering*[Code = 3]*	
Computer Engineering*[Code = 4]*	
Computer Science*[Code = 5]*	
Construction Management*[Code = 6]*	
Electrical Engineering*[Code = 7]*	
Engineering Management*[Code = 8]*	
Engineering Technology*[Code = 9]*	
Environmental Engineering*[Code = 10]*	
Industrial/Systems Engineering*[Code = 11]*	
Life Sciences (e.g., biology, ecology)*[Code = 12]*	
Mathematics*[Code = 13]*	
Materials and Metallurgical Engineering*[Code = 14]*	
Mechanical Engineering*[Code = 15]*	
Physical Sciences (e.g., chemistry, earth/environmental science, geology, physics)*[Code = 16]*	
Social Sciences (e.g., economics, education, communications, political science)*[Code = 17]*	
Other (please specify)*[Code = 18] [Textbox]*	
Required answers: 1	*Allowed answers: 1*

Q72 What is your gender?	
Male*[Code = 1]*	
Female*[Code = 2]*	
Other gender identification*[Code = 3]*	
Prefer not to answer*[Code = 0] [N/A]*	
Required answers: 1	*Allowed answers: 1*

Q73 What is your age?	
Under 18 years old*[Code = 1]*	
18 - 24 years old*[Code = 2]*	
25 - 34 years old*[Code = 3]*	
35 - 44 years old*[Code = 4]*	
45 or older*[Code = 5]*	
Required answers: 1	*Allowed answers: 1*

Q74 Are you an international student?	
Yes*[Code = 1]*	
No*[Code = 2]*	
Required answers: 1	*Allowed answers: 1*

Q75 Which of the following backgrounds do you most identify with?	
White/Caucasian*[Code = 1]*	
Hispanic/Latino*[Code = 2]*	
Black/African American*[Code = 3]*	
Native American/American Indian*[Code = 4]*	
Asian/ Asian American*[Code = 5]*	
Pacific Islander*[Code = 6]*	
Multiple Any 2 or more (Non-Hispanic)*[Code = 7]*	
None*[Code = 8]*	
Other*[Code = 9]*	
Required answers: 1	*Allowed answers: 1*

Q76 What is the highest level of education completed by either of your parents/guardians?	
Did not finish high school*[Code = 1]*	
Graduated from high school*[Code = 2]*	
Attended college but did not complete degree*[Code = 3]*	
Completed an Associate's degree (AA, AS, etc.)*[Code = 4]*	
Completed a Bachelor's degree (BA, BS, etc.)*[Code = 5]*	
Completed a Master's degree (MA, MS, etc.)*[Code = 6]*	
Completed a Doctoral or Professional degree (JD, MD, PhD, etc.)*[Code = 7]*	
Required answers: 1	*Allowed answers: 1*

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APPRENDIX B: RECRUITMENT E-MAIL SENT TO INTERNS

UNC CHARLOTTE

William States Lee College of Engineering
9201 University City Boulevard, Charlotte, NC 28223-0001

Dear *intern*,
My name is Jordan Gross and I am a PhD student from the College of Engineering at the University of North Carolina at Charlotte. I am writing to invite you to participate in my research study about careers in the energy industry. You're eligible to be in this study because you are currently participating in an internship or co-op at an energy-related company. I obtained your contact information from [*company representative*] at [*company*].
Your input can help provide valuable information to improve interventions intended to prepare students for careers in the energy industry. The survey should take approximately **10 minutes** to complete. Simply click on the link below, or cut and paste the entire URL into your browser to access the survey:

Survey link

We would appreciate your response by *deadline*.

Your input is very important to us and all individual responses will be kept strictly confidential. If you have any questions about the study, please contact me at jgross18@uncc.edu.

Thank you very much.

Sincerely,

Jordan Gross
PhD Student
UNC Charlotte | The William States Lee College of Engineering
9201 University City Blvd. | Charlotte, NC 28223
jgross18@uncc.edu
704-687-5933

APPRENDIX C: RECRUITMENT E-MAIL SENT TO COLLEGE OF ENGINEERING STUDENTS

UNC CHARLOTTE

William States Lee College of Engineering
9201 University City Boulevard, Charlotte, NC 28223-0001

Dear *student*,

In an effort to better understand what influences College of Engineering students to pursue careers in the energy industry, the College of Engineering and the Energy Production and Infrastructure Center (EPIC) are conducting a research study and we would like you to participate. Your input will provide valuable information to identify opportunities to improve our academic programs and support services.

Any information about your participation, including your identity, is completely confidential. You will not be personally identified in any reports that are generated as a result of your participation. Your privacy is protected under the Family Educational Rights and Privacy Act of 1974 (FERPA).

The survey should take approximately **10 minutes** to complete. Simply click on the link below, or cut and paste the entire URL into your browser to access the survey:

Survey link

We would appreciate your response by *deadline*.

If you have any questions about the study, please contact the principal investigator, Jordan Gross (704-687-5933, jgross18@uncc.edu).

Thank you for taking time to provide us with valuable information that will enhance the academic experience and career preparation for all of our students.

Sincerely,

Patricia A. Tolley, Ph.D., P.E.
Associate Professor and Associate Dean
UNC Charlotte | The William States Lee College of Engineering
Smith Building Room 264A
9201 University City Blvd. | Charlotte, NC 28223-0001
Phone: 704-687-1992 | Fax: 704-687-1627
patolley@uncc.edu | http://engr.uncc.edu

APPENDIX D: CASE SURVEY CONCENT FORM FOR INTERNS

UNC CHARLOTTE

William States Lee College of Engineering
9201 University City Boulevard, Charlotte, NC 28223-0001

“Career Assessment for Students in Energy (CASE)”

Welcome to the "Career Assessment for Students in Energy," an online survey about college experiences and careers in the energy industry. Before taking part in this study, please read the consent form below and click on the "I Agree" button at the bottom of the page if you understand the statements and freely consent to participate in the study.

Consent Form

You are being asked to participate in a research study, “Career Assessment for Students in Energy.” The purpose of this research study is to better understand what influences college students to pursue careers in the energy industry after graduation. Jordan Gross, a doctoral student at UNC Charlotte, and Dr. Patricia Tolley, Associate Dean in The William States Lee College of Engineering at UNC Charlotte, are conducting the research study.

You have been contacted about this study because you are currently participating in an internship or co-op at an energy-related company. You must be enrolled at a college or university, and must be at least 18 years old. There will be approximately 1,000 participants in the study.

You will be asked to respond to an online survey consisting of 32 questions related to your academic and co-curricular involvement in college, your perceptions of the energy industry, and your intentions to pursue a career in the energy industry after graduation. **The survey should take about 10 minutes**.

There are no expected physical, emotion, social, professional, or financial risks associated with participation in this study. There are also no direct benefits for participating in the study. In general, the research may result in better understanding of how students’ college experiences relate to their intentions to pursue a career in the energy industry.

You are a volunteer. The decision to participate in this study is completely up to you. If you decide to be in the study, you may stop at any time. You will not be treated any differently if you decide not to participate in the study or if you stop once you have started.

The research team will **protect your privacy** as required by the Family Educational Rights to Privacy Act (FERPA). All individual responses will be kept confidential. Survey results will be summarized and the data will have no direct personal identifying information. Data will be stored on a password protected network only available to the researchers.

UNC Charlotte wants to make sure that all research participants are treated in a fair and respectful manner. Contact the university's Office of Research Compliance at (704-687-1871) if you have questions about your rights as a study participant. If you have any questions about the purpose, procedures, and outcome of this project, contact the principal investigator of the study, Jordan Gross (315-420-9213, jgross18@uncc.edu).

This form was approved for use on *Month Day, Year* for a period of one (1) year.

You may print a copy of this form. If you are 18 years of age or older, understand the statements above, and freely consent to participate in the study, click on the "I Agree" button to begin the survey.

I Agree   I Do Not Agree

APPENDIX E: CASE SURVEY CONSENT FORM FOR COLLEGE OF ENGINEERING STUDENTS

UNC CHARLOTTE

William States Lee College of Engineering
9201 University City Boulevard, Charlotte, NC 28223-0001

"Career Assessment for Students in Energy (CASE)"

Welcome to the "Career Assessment for Students in Energy," an online survey about college experiences and careers in the energy industry. Before taking part in this study, please read the consent form below and click on the "I Agree" button at the bottom of the page if you understand the statements and freely consent to participate in the study.

Consent Form

You are being asked to participate in a research study, "Career Assessment for Students in Energy." The purpose of this research study is to better understand what influences college students to pursue careers in the energy industry after graduation. Jordan Gross, a doctoral student at UNC Charlotte, and Dr. Patricia Tolley, Associate Professor and Associate Dean at in the Lee College of Engineering at UNC Charlotte, are conducting the research study.

You have been contacted about this study because you are currently enrolled in the Lee College of Engineering at UNC Charlotte. All participants must be at the undergraduate level, and must be at least 18 years old. There will be approximately 1,000 participants in the study.

You will be asked to respond to an online survey consisting of 30 questions related to your academic and co-curricular involvement in college, your perceptions of the energy industry, and your intentions to pursue a career in the energy industry after graduation. **The survey should take about 10 minutes**.

The research team will **protect your privacy** as required by the Family Educational Rights to Privacy Act (FERPA). All individual responses will be kept confidential. Survey results will be summarized and the data will have no direct personal identifying information. Data will be stored on a password protected network only available to the researchers.

There are no expected physical, emotion, social, professional, or financial risks associated with participation in this study. There are also no direct benefits for participating in the study. In general, the research may result in better understanding of how students' college experiences relate to their intentions to pursue a career in the energy industry.

You are a volunteer. The decision to participate in this study is completely up to you. If you decide to be in the study, you may stop at any time. You will not be treated any differently if you decide not to participate in the study or if you stop once you have started.

UNC Charlotte wants to make sure that all research participants are treated in a fair and respectful manner. Contact the university's Office of Research Compliance at (704-687-1871) if you have questions about your rights as a study participant. If you have any questions about the purpose, procedures, and outcome of this project, contact the principal investigator of the study, Jordan Gross (315-420-9213, jgross18@uncc.edu).

This form was approved for use on *Month Day, Year* for a period of one (1) year.

You may print a copy of this form. If you are 18 years of age or older, understand the statements above, and freely consent to participate in the study, click on the "I Agree" button to begin the survey.

I Agree   I Do Not Agree

APPENDIX F: CORRELATION MATRIX FOR MODEL VARIABLES

	Q5	Q6	Q7	Q8	Q23	Q24	Q25	Q26	Q28	Q29	Q30
Q5	1	.714**	.657**	.585**	.040	.058	.088	.045	.105*	.121*	.171**
Q6	.714**	1	.645**	.577**	.026	.073	.093	.083	.162**	.092	.150**
Q7	.657**	.645**	1	.750**	.038	.076	.156**	.106*	.142**	.178**	.211**
Q8	.585**	.577**	.750**	1	.029	.038	.088	.087	.191**	.158**	.138**
Q23	.040	.026	.038	.029	1	.696**	.676**	.647**	.153**	.156**	.192**
Q24	.058	.073	.076	.038	.696**	1	.759**	.643**	.127*	.175**	.183**
Q25	.088	.093	.156**	.088	.676**	.759**	1	.719**	.136*	.147**	.217**
Q26	.045	.083	.106*	.087	.647**	.643**	.719**	1	.197**	.208**	.213**
Q28	.105*	.162**	.142**	.191**	.153**	.127*	.136*	.197**	1	.582**	.623**
Q29	.121*	.092	.178**	.158**	.156**	.175**	.147**	.208**	.582**	1	.600**
Q30	.171**	.150**	.211**	.138**	.192**	.183**	.217**	.213**	.623**	.600**	1
Q56	.106	.036	.148**	.123*	.010	-.082	-.017	.029	.214**	.129*	.162**
Q57	.099	.067	.160**	.175**	.060	-.065	.016	.056	.152**	.144**	.122*
Q58	.101	.030	.146**	.154**	.024	-.054	-.009	.031	.140**	.090	.078
Q59	.120*	.047	.152**	.162**	.097	-.032	.028	.052	.127*	.084	.075
Q60	.039	-.028	.096	.063	-.044	-.106	-.051	-.029	.160**	.100	.088
Q61	.032	-.051	.092	.057	.002	-.056	-.041	.023	.156**	.104	.089
Q62	.068	-.011	.105	.081	-.011	-.114*	-.062	-.064	.112*	.088	.074
Q63	.030	-.039	.114*	.079	.026	-.048	-.003	.015	.184**	.095	.101
Q64	.109*	.017	.155**	.109*	-.020	-.077	-.036	-.017	.210**	.143**	.156**
Q65	.083	.018	.140**	.104	.033	-.049	.000	.059	.224**	.144**	.169**
Q66	.078	.031	.127*	.118*	-.003	-.101	-.057	-.013	.232**	.119*	.153**

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

CORRELATION MATRIX FOR MODEL VARIABLES (continued)

	Q56	Q57	Q58	Q59	Q60	Q61	Q62	Q63	Q64	Q65	Q66
Q5	.106	.099	.101	.120*	.039	.032	.068	.030	.109*	.083	.078
Q6	.036	.067	.030	.047	-.028	-.051	-.011	-.039	.017	.018	.031
Q7	.148**	.160**	.146**	.152**	.096	.092	.105	.114*	.155**	.140**	.127*
Q8	.123*	.175**	.154**	.162**	.063	.057	.081	.079	.109*	.104	.118*
Q23	.010	.060	.024	.097	-.044	.002	-.011	.026	-.020	.033	-.003
Q24	-.082	-.065	-.054	-.032	-.106	-.056	-.114*	-.048	-.077	-.049	-.101
Q25	-.017	.016	-.009	.028	-.051	-.041	-.062	-.003	-.036	.000	-.057
Q26	.029	.056	.031	.052	-.029	.023	-.064	.015	-.017	.059	-.013
Q28	.214**	.152**	.140**	.127*	.160**	.156**	.112*	.184**	.210**	.224**	.232**
Q29	.129*	.144**	.090	.084	.100	.104	.088	.095	.143**	.144**	.119*
Q30	.162**	.122*	.078	.075	.088	.089	.074	.101	.156**	.169**	.153**
Q56	1	.676**	.819**	.696**	.845**	.775**	.795**	.769**	.786**	.732**	.753**
Q57	.676**	1	.700**	.732**	.594**	.564**	.625**	.618**	.576**	.552**	.545**
Q58	.819**	.700**	1	.759**	.758**	.716**	.730**	.743**	.719**	.662**	.690**
Q59	.696**	.732**	.759**	1	.638**	.618**	.622**	.633**	.634**	.586**	.601**
Q60	.845**	.594**	.758**	.638**	1	.823**	.803**	.766**	.755**	.722**	.710**
Q61	.775**	.564**	.716**	.618**	.823**	1	.760**	.739**	.700**	.671**	.647**
Q62	.795**	.625**	.730**	.622**	.803**	.760**	1	.764**	.748**	.701**	.745**
Q63	.769**	.618**	.743**	.633**	.766**	.739**	.764**	1	.670**	.650**	.652**
Q64	.786**	.576**	.719**	.634**	.755**	.700**	.748**	.670**	1	.877**	.860**
Q65	.732**	.552**	.662**	.586**	.722**	.671**	.701**	.650**	.877**	1	.841**
Q66	.753**	.545**	.690**	.601**	.710**	.647**	.745**	.652**	.860**	.841**	1

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

APPENDIX G: COVARIANCE MATRIX FOR MODEL VARIABLES

	V1	**V2**	**V3**	**V4**	**V5**	**V7**	**V8**	**V9**	**V10**	**V11**	**V12**
V1	1.000										
V2	1.000	1.000									
V3	1.000	1.000	1.000								
V4	1.000	1.000	1.000	1.000							
V5	.942	.942	.942	.942	.942						
V7	.974	.974	.974	.974	.919	.974					
V8	.974	.974	.974	.974	.919	.974	.974				
V9	.974	.974	.974	.974	.919	.974	.974	.974			
V10	.974	.974	.974	.974	.919	.974	.974	.974	.974		
V11	.932	.932	.932	.932	0.877	.932	.932	.932	.932	.932	
V12	.932	.932	.932	.932	0.877	.932	.932	.932	.932	.932	.932
V13	.932	.932	.932	.932	0.877	.932	.932	.932	.932	.932	.932
V14	.895	.895	.895	.895	0.843	.895	.895	.895	.895	.895	.895
V15	.895	.895	.895	.895	0.843	.895	.895	.895	.895	.895	.895
V16	.895	.895	.895	.895	0.843	.895	.895	.895	.895	.895	.895
V17	.895	.895	.895	.895	0.843	.895	.895	.895	.895	.895	.895
V18	.895	.895	.895	.895	0.843	.895	.895	.895	.895	.895	.895
V19	.895	.895	.895	.895	0.843	.895	.895	.895	.895	.895	.895
V20	.895	.895	.895	.895	0.843	.895	.895	.895	.895	.895	.895
V21	.895	.895	.895	.895	0.843	.895	.895	.895	.895	.895	.895
V22	.895	.895	.895	.895	0.843	.895	.895	.895	.895	.895	.895
V23	.895	.895	.895	.895	0.843	.895	.895	.895	.895	.895	.895

COVARIANCE MATRIX FOR MODEL VARIABLES (continued)

	V13	**V14**	**V15**	**V16**	**V17**	**V18**	**V19**	**V20**	**V21**	**V22**	**V23**
V1											
V2											
V3											
V4											
V5											
V7											
V8											
V9											
V10											
V11											
V12											
V13	.932										
V14	.895	.895									
V15	.895	.895	.895								
V16	.895	.895	.895	.895							
V17	.895	.895	.895	.895	.895						
V18	.895	.895	.895	.895	.895	.895					
V19	.895	.895	.895	.895	.895	.895	.895				
V20	.895	.895	.895	.895	.895	.895	.895	.895			
V21	.895	.895	.895	.895	.895	.895	.895	.895	.895		
V22	.895	.895	.895	.895	.895	.895	.895	.895	.895	.895	
V23	.895	.895	.895	.895	.895	.895	.895	.895	.895	.895	.895