Using Career Orientations to Map Professional Formation in Engineering Technology

Kristin K. Frady
Educational and Organizational Leadership Development &
Engineering and Science Education
Clemson University
Clemson, SC, USA
frady@clemson.edu

Karen High
Engineering and Science Education
Clemson Univeresity
Clemson, SC, USA
khigh@clemson.edu

Claretha Hughes
Human Resource & Workforce Development
University of Arkansas
Fayetteville, AR, USA
chbanks@uark.edu

Monica Kosanovich
Educational and Organizational Leadership Development
Clemson University
Clemson, SC, USA
mkosano@g.clemson.edu

***Abstract*—This research category work-in-progress paper provides initial findings from an NSF funded research study to develop a greater theoretical understanding of the professional identity, institutional culture, and formation of engineer technicians and technologists who are prepared at two-year colleges. The study is identifying dimensions of career anchors orientations at various stages of professional preparation and map to engineering technology (ET) career pathways by surveying ET students, transfer students, and early career ET professionals. The complexity of integration of the multiple stages of professional preparation, within diverse environments, has led the researchers to integrate three interdisciplinary theoretical frameworks to examine fundamental questions of professional formation: (1) social cognitive career theory to situate individual attitudes, interests, and experiences within a larger career context; (2) Schein's Career Anchors Theory focused on individual career orientations; and (3) the Hughes Value Creation Model for Organizational Competitive Advantage focused on cultural and organizational contexts. Initial results from the Schein's Career Anchor survey for the two-year college ET students are presented. Findings from this and future work will transform the ET workforce through catalyzing interaction of researchers and practitioners with public support to bolster ET's strategic position in the workforce development infrastructure.**

Keywords— engineering technology, community colleges, career paths, social cognitive career theory

I. Introduction

This research category work-in-progress paper provides initial findings from a study focused on developing greater understanding of professional formation of engineering technology professionals. Currently there exists scant research on the role that engineering technology (ET) education plays in supporting the nation's technical infrastructure and capacity for innovation. Yet, according to the Department of Education's Integrated Postsecondary Education Data System (IPEDS), in 2014 over half of engineering related credentials (53%) awarded were in certificate, two-year degrees, or ET. However, there is little understanding of this important field and role that these workers play in supporting the nation's infrastructure and capacity for innovation [1]. Hence, a 2016 National Academy of Sciences report recommended that the National Science Foundation (NSF) fund more research in ET education [1]. In response to these issues, the NSF funded research presented here will identify dimensions of career anchors orientations at various stages of professional preparation and map ET career pathways by surveying ET students, transfer students, and early career ET professionals. The following research question guided this study:

RQ: For students educated in two-year college ET programs, how do the different dimensions of career anchors orientations, at various phases of professional preparation, impact experiences and development of professional pathways?

The participants in this study represent an under researched population at various stages across the ET professional development continuum including two-year college ET students, four-year college ET transfer students, and early career ET professionals [1]. The continuums represent the processes needed to engage two-year college students and provide a pathway to engineering success for these students.

II. Engineering Technology

Engineering technicians and technologists serve a critical role in the field of engineering [1]. According to the National Institute for Certification in Engineering Technologies, although both are members of the engineering team, there is an important distinction between engineering technicians and engineering technologists [2]. Engineering technicians are knowledgeable about components, operating characteristics, and engineering systems in specific areas of expertise and typically work directly under engineers, scientists, and technologists [2]. Engineering technologists also have specialized area of expertise but tend to have a deeper, more broad knowledge of the equipment and how it is designed, applied, and implemented. Technologists tend to work more closely with and less directly under the engineers and scientists [2]. Engineering technicians and technologists are typically engaged in more applied and "hands-on" applications within the engineering profession. Engineering technology programs encompass both two-year associate degrees and four-year baccalaureate degrees [3]. However, U.S. News & World Report recommends earning an engineering technology degree from a two-year institution not only for the cost savings but also because increasingly high-tech employers are looking for specific skills over degrees [4]. However, there are many job titles and roles which create complexity within the field of

engineering with multiple layers, roles, and points of entry and exit.

The engineering technology sector is largely absent from discussions and research in the engineering literature on the U.S. technical workforce and needs more data on students and workers to better understand the field and labor market [5]. Thus, there is a need to develop a greater understanding of the professional identity, culture, and formation of engineer technicians and technologists who are prepared at two-year colleges across the U.S. and may later become four-year degreed engineers. Developing a deeper understanding of the role engineering technology education plays or should play is critical in supporting the nation's technical infrastructure and capacity for innovation [6].

III. Theoretical Frameworks

The complexity of integration of the multiple stages of professional preparation, within diverse environments, has led the researchers to integrate three interdisciplinary theoretical frameworks: (1) social cognitive career theory (SCCT) to situate individual attitudes, interests, and experiences within a larger career context; (2) Schein's Career Anchors Theory focused on individual career orientations; and (3) the Hughes Value Creation Model for Organizational Competitive Advantage focused on cultural and organizational contexts. In this work-in-progress paper, an overview of all three frameworks with information about how the frameworks will be integrated for future research is analysis is provided. However, at this phase in the research project, in this paper, the focus will primarily be on initial results and their relationship to SCCT and Schein's Career Anchors theories. The Hughes Value Creation Model will be more fully integrated in future phases of this research project. It is not the intention of the authors to provide a full description of these theories in this short paper rather to provide a roadmap demonstrating application of these theories to engineering technology applications and future work. These frameworks provide an evidence base and will seek to analyze and synthesize distinct perspectives into a coordinated and coherent whole focused on ET pathways and understandings of professional identity, professional formation, and culture.

A. Social Cognitive Career Theory

Social cognitive career theory (SCCT) is a widely used theoretical framework for understanding educational and occupational career development [7]. The foundation of the theory draws strongly upon Bandura's social cognitive theory in self-efficacy which focuses on the relationship between people and their environment [8]. SCCT, a framework which has undergone several evolutions, places self-efficacy as the core with interest development, choice-making, performance and persistence, and satisfaction/well-being revolving as four overlapping models around the core [9]. The focus on self-efficacy within a career development context is important because it describes perceptions and beliefs about individual capabilities to produce effects [10]. Lent et al. [7], through their research, have advanced the notion that person, environment, and behavioral variables are all intricately linked and profoundly affect each other. Further, STEM researchers have found that the self-efficacy emphasis of SCCT has provided a strong framework for developing a deeper understanding of educational and occupational development in STEM fields [11, 12].

B. Schein's Career Anchors Theory

Schein's Career Anchors survey was developed in the mid-1970s and is widely recognized as one of the most popular and influential career development tools. [13] Schein's conception of a career [14] combines individual identity and self-concept which includes self-perceived talents and abilities, basic values, and individual motives as they relate to the career [15]. Schein identified eight unique career anchors [13, 14]:

- Technical and functional competence (TF): expertise and competence in an area of specialization, typically not interested in management
- General management competence (GM): motivation to assume positions of managerial responsibility
- Autonomy and independence (AU): values independence and autonomy, typically in career outside of traditional organizations even if that means trading status or income for freedom
- Security and stability (SE): values security, benefits, income and has high levels of trust in the organization and typically less focused on personal career development
- Entrepreneurial creativity (EC): values creativity and opportunities to build or create something new
- Service and dedication to a cause (SV): values doing work for a greater good and which can lead away from organizations to valued activities
- Pure challenge (CH): values problem solving and complex or difficult problems and typically analytical, strategic, and interpersonal
- Lifestyle (LS): values the balance between personal/family needs and career where family may take priority in career/work decisions

Prior studies have demonstrated the importance of career anchors for individual career development and can lead to increased job satisfaction, job stability, organizational commitment, work quality and quantity, and retention [15]. Equally as important is aiding the organization in identification of avenues for development of anchors and the hiring, training, and retention of employees [14, 16].

C. The Hughes Value Creation Model for Organizational Competitive Advantage

The Hughes Value Creation Model for Organizational Competitive Advantage introduces five values of people and technology development and while it includes elements specific to individuals [18], in the context of this study, the organization is the primary focus. This model provides organizations with opportunities for greater innovation, development of measures

to value people and technology to enhance their competitive advantage and can assist organizations in determining the extent to which value creation can be derived from integrating technology development and human resource and workforce development education from the cognitive, behavioral and cultural perspectives in the workplace [19].

The five values (location, use, maintenance, modification, and time value) will be assessed during the institutional culture phase of the study. The location of the institutions within the communities is essential to how students feel about the accessibility that they have to their chosen career field opportunities. Use value relates to how they use resources provided by the institutions and intend to use their acquired ET knowledge at future employers or four-year institutions. Maintenance value relates to how the students will remain knowledge from training provided to students by their employers. Modification value deals with institutions that students choose to use should they decide to invest in self-development. If students who are currently in co-ops, apprenticeships, and other employment situations decide to learn new skills on their own, does their institutional cultures support this self-development and will they be rewarded for their efforts? Time value is essential to the development of students and the pace at which they matriculate through their chosen institutions is important because there is a high demand from employers for students with engineering skills.

D. Integration of the Frameworks

Integrating these three frameworks together represents integration of multiple fields of research, all which have bearing in examination of career development within ET. The multiple perspectives provide a framework for study design as well as interpretation and integration of results.

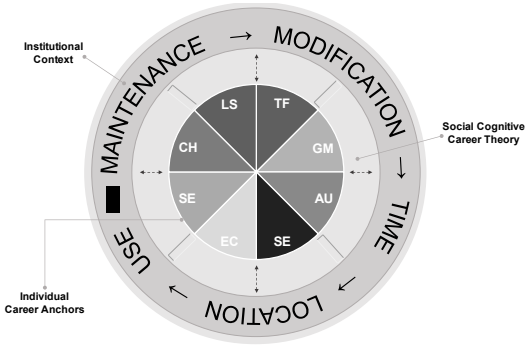

Figure 1. Integration of frameworks

With its ability to integrate culture, social context, and life events into career-related choices and development, SCCT is the conduit through which Schein's Career Anchors and the Hughes Value Framework are connected [7]. This connection is critical for this research because currently there is no single framework or model which explores career development of individuals (described in this work in progress paper) and institutional culture of education and workplace environments (to be linked to the evolving research presented here in future research). Research Methods and Data Collection

E. Student Participants

The population for this study consists of two-year college students from a single technical college who were enrolled in three different programs identified as ET by the two-year college faculty: general engineering technology, mechatronics, and industrial electronics technology. Of the 90 students responding: 61 were male (67.8%), 15 were female (16.7%), and 14 unknown (15.6%); 67 were 18-24 (74.4%), 9 were 25 or older (10%), and 14 were unknown (15.6%); 61 were white (67.8%), 15 were nonwhite (16.7%), and 14 were unknown (15.6%); and 58 were General Engineering Technology (64.4%), 16 were Mechatronics (17.8%), and 16 were Industrial Electronics Technology (17.8%).

F. Research Method and Data Collection

The Schein Career Anchors Survey [20] was administered to students electronically through a Qualtrics link shared via email and utilized in classrooms. The instrument contains 40 questions, each with a Likert six-point scale. The inventory has eight scales which are correlated to career anchors. The validity and reliability of this instrument has been rigorously tested by the instrument authors and many other researchers in the field since its introduction in the mid-1970s [15,16]. Additionally, general demographic questions were asked.

G. Data Analysis

To analyze the data in this study, analyses were conducted using both descriptive and inferential statistical methods. Data were exported from Qualtrics and imported into SPSS Version 24 for analysis. First, reliability was confirmed by running Cronbach's alpha. Then, a descriptive analysis was performed to identify the dominant career anchors of the students. Finally, in order to examine these career anchors with regard to the students' gender, age, ethnicity, full- or part-time status, work experience, and degree program, a one-way analysis of variance (ANOVA) and independent t-tests were used in analysis.

IV. Preliminary Results

Reliability of the scale was confirmed with this group using Cronbach's alpha (40 items; $\alpha = .71$). Initial analysis was descriptive in nature revealing closeness in career anchor scores that will be further explored with additional data from students in future research (Table 1).

TABLE I. Student Career Anchors

Career anchor	***M***	***SD***
Technical and functional	4.84	1.1
General management	4.59	1.22
Autonomy and independence	4.62	1.12
Security and stability	4.78	1.14
Entrepreneurial creativity	4.46	1.23
Service and dedication	4.51	1.03
Pure challenge	4.74	1.00
Lifestyle	4.70	1.08

Based on the results it was observed that technical and functional and security and stability obtained the highest scores

while service and dedication to a cause, entrepreneurial creativity and general management obtained the lowest.

When examining career anchors in regard to gender the results of the independent sample t-test indicated that there was only a significant difference between males and females for the autonomy and independence anchor [$t_{(74)} = 1.53$, $p < .05$]. More specifically males gave more priority to the autonomy and independence anchor. Due to small numbers within the ethnicity groups, students were grouped into white or nonwhite for measuring ethnicity where a t-test revealed no significant difference between groups. Similarly, since over 70% of students were ages 18-24 the ages were grouped as either 18-24 or 25 and older. An independent samples t-test also revealed no significant difference between age groups. An individual one-way ANOVA was run to assess the differences for the career anchors of the students with respect to degree program there was no significant difference found between the three degree programs and preferences for career anchor.

V. Discussion

Prior studies have demonstrated that student knowledge of, attitudes toward, and motivation to pursue STEM and engineering education can not only positively impact academic performance but also indicate future career interest and participation in the STEM workforce [21]. These initial findings begin to describe students' self-efficacy, a core of SCCT, within the eight career anchors as they relate to ET career development and choice making [9]. Initial findings suggest that both the technical and functional competence and security and stability are predominant anchors in determining career paths for ET two-year college students. This preliminary work also indicates that males in ET programs tend to value autonomy and independence over females. Although the female sample was small (n=15), this finding is consistent with findings across other studies [22]. It is important to develop an understanding of career aspirations and motivations because they are essential in forming the inner forces in an individual's career and thus their definition of career success [14]. Prior research using career anchors has found that individuals who have a strong technical and functional career anchor aspire to be deeply knowledgeable and an expert within their field [16]. These individuals value challenges that require them to apply their unique skills to solve [14]. Additionally, those who seek security and stability are more risk adverse with regard to their career and job choices and tend to stay employed with an organization for longer periods of time [14].

Understanding the dimensions of career orientations and anchors of two-year college ET students can aid postsecondary educational professionals in developing recruitment tools, learning experiences and professional pathways customized specifically for unique populations. Learning experiences and person inputs shape self-efficacy, the core of the SCCT model [23]. Based on initial results, learning experiences and curricula should focus on deep problem solving and developing critical thinking abilities related to specific the specific skills and abilities within a specific ET program. Exploration of research in postsecondary STEM education which focuses on incorporation of challenging curricula and innovative problem solving could provide important strategies for creating important learning experiences for ET students. This research also will support important implications for the career development and professional pathway development of ET students. The strong preference for these anchors mirrors the definitions and identity of the ET field as a whole and aligns with existing, general research suggesting that high tech employers value specialized skills over type of degree [2, 4]. Preliminary results indicate that ET identity formation is strongly focused on skills and competencies, rather type of degree/certificate and job title. Traditionally, researchers and career development professionals have focused on development of academic and professional pathways. Many examples of general competency maps and models such as CareerOneStop have been developed. However, within this unique field of ET, more specific skill and competency maps aligned with regional industry demand and projected demand of these skills may provide a adaptable roadmap for learning experiences, opportunities for individual student customization of curricula, guidance for targeted program recruitment, and career development tools which may be modified for unique, personal skill sets.

VI. Conclusions and Future Work

To expand these results, the researchers will continue to collect survey responses from two-year college ET students. Survey data is also being collected from two-year college ET students who have transferred into a four-year university program as well as early career professionals (approximately five years or less in the workforce) who have been students in ET programs. Each of these critical stages of professional formation will be analyzed and compared. The research presented in this paper provides preliminary evidence pointing to ways to bridge ET education to the future in two important ways. First, it provides initial understanding of ET career formation at a two-year college stage of professional development through the lens of the integrated theoretical frameworks to reveal future ET pathways and critical transition points. Second, it contextualizes the research to provide practical insights into shaping future educational programs, career counseling, professional development, and new policies and strategies to support ET students and professionals. These new strategic ET pathways specifically aim to bridge the gap between education and the ET workforce and may improve recruitment and retention of students and early career professionals.

Next steps will also focus on collection of qualitative data which will incorporate the Hughes Value Creation Model for Organizational Competitive Advantage. The qualitative data to be collected will include historical document analysis of each ET program and interviews and/or surveys with key stakeholders associated with ET education and employment. The combination of the qualitative data sources will provide increased understanding of the culture and external influences shaping ET identity and career formation. These insights will aid in shaping targeted educational programs, career counseling, educator professional development, and new policies and strategies to support ET students, promote targeted career guidance, and increase professional satisfaction. This research will inform future research and development of pilot interventions to support initial efforts to translate the research of this study into practice in the field of engineering education.

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