The Use of Family Career Genogram in Assessing Undergraduate Engineering Student Success

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Abstract

Families influence the formation of future workforce career choices and interests. Family values and relationships influence an individual's academic and career decision-making processes. Bowen's family systems theory posits an individual's attitudes and behaviors as a product of intergenerational family patterns. The Bowenian family genogram, a visual representation tool, is used to depict patterns of attitudes and behaviors that are transmitted across multiple generations. To the authors' best knowledge, Bowen's theory is used in this paper for the first time in engineering education. We sought to identify how exemplar engineering students describe family patterns that influence their engineering success. Career genogram construction and semi-structured interviews reflected intergenerational family patterns that contributed to the success of three exemplar senior students in engineering. Case-studies were selected using Exemplar Methodology (ExM). Data was collected on familial career exposure and attitudes, resulting in the development of genograms. Findings reflect supportive communication, encouraged help-seeking, and reliable support were normed in each family system. Observing family members with engineering experience, engaging in pre-college STEM-related activities, and family attitudes about the value of career were integral to engineering selection and success. Genograms reflected use of family system communication to resolve the stressors of career pursuit. The findings have the potential to inform undergraduate engineering recruitment and retention planning efforts, enhancing academic career services, advising, and counseling.

1. Introduction

Traditional conceptualizations of engineering success have included aptitude tests, demographics, and high school performance [1]. However, outstanding achievement, or exemplary student performance, has been attributed to additional factors including personal motivation, emotional development, and influence of family and teachers [2]. Exemplary research suggests exemplar students can serve as a source of inspiration for peers and colleagues to strive in their own path [3]. This highlights the need to identify factors that foster and maintain engineering students' inner strengths. Family systems can play a major role in assisting students to thrive and flourish, not only through emotional and financial support but also through the transmission of knowledge and attitudes.

1.1 Engineering Success and Social Capital

Career choices are directly influenced by student's social interactions, family influence, and academic satisfaction [4]. Engineering selection and success are impacted by family relationships and accrued social capital [5], [6]. Parental encouragement, engineering exposure within the family or extended kinship network, and having college-educated parents are factors that promote engineering interest [7], [8]. Pre-college experiences, familial support, and social support promote engineering student's growth throughout academic rigors [9], [8], [10]. Social networks aid the appraisal of future directions and contribute significantly to academic excellence [2]. Parents who provide opportunities for childhood exposure to careers develop a firm foundation for their child's entry and success in academics, including STEM majors [11], [12], [13].

The rigors of engineering entail academic and interpersonal challenges, with students noting the impact of program climate and relationships on persistence [14]. The presence of relationships that facilitate resource access and inculcate career promotive attitudes are important factors to student success [14]. Relationship skills develop through bonding and bridging within familial contexts [15], [16], [17]. The critical role of social networks in promoting achievement necessitates a closer review of how formative generational patterns and social systems shaped engineering success [6], [18], [19]. Researchers have identified encouragement, provision of early STEM engagement, and financial assistance as critical family factors that promote student success in engineering [20], [21]. Family systems theory provides a lens through which the intergenerational patterns of successful engineering students can be identified and their role in student outcomes understood.

1.2 Family Systems Theory

Family systems theory was built upon general systems theory, conceptualizing complex interactions between interrelated components of a singular environment as vital components of a larger system [22]. Systemic theories posit individual functioning as indivisible from their social contexts. Individuals hold multiple and sometimes competing goals, integrating social and environmental factors to their appraisal of future directions [15], [22]. Social networks strive to maintain homeostasis, establishing norms of functioning through communication and carefully weighing alterations to the status quo posed by individuals within and outside of the system [23]. Familial rules and processes instilled through feedback loops, influence career development [24]. Systemic feedback loops convey information about goal acquisition and stressors [22]. In a positive feedback loop, accepted information is actualized in the survival process and yields progress away from the initial state of functioning [25], [22]. Flexible and permeable boundaries characterize an ‘open system’ and positive feedback loop [22]. A negative feedback loop occurs when information is rejected to maintain functioning, yielding a ‘closed system’ [22]. The rules for information sharing may be explicit or implicit, members must be socialized into awareness of their presence [25], [22]. Positive family relationships are comprised of mutual communication and shared investment goal acquisition, bolstering individual members through life’s stressors [26], [24]. Supportive family systems buffer stress amidst the network expansion posed by coupling, child-rearing, and career adjustment [27]. Family systems theorists capture these patterns through a family mapping instrument, the genogram.

1.3 Genogram

A genogram is a visual graph that reflects the family genealogy, extended kinship networks, psychosocial functioning of individual members, and the communication patterns that ensue throughout the systems [26], [28]. Bowens’ approach to family systems encourages the employment of genograms, or three-generation graphic models, to conceptualize the family patterns and interactions [29]. Family systems navigating the macrosystem they inhabit incur vertical and horizontal stressors in the process [30], [31]. Vertical stressors are patterns of relating and functioning transmitted historically through generations in a family system (e.g., family attitudes, stories, expectations, secrets, etc.), while horizontal stressors encompass events experienced by the family as they move forward through time (e.g., migration, war, economic depression, political climate, natural disasters, etc.). The family genogram is widely used in a myriad of disciplines to explore vertical and horizontal stressors that shape psychological functioning across multiple generations [32], [33]. The utility of additional perspective and

flexible mapping structure extends to the creation of career genograms, which examine the multigenerational career-decision making of a family system [31].

1.4 Family Career Genogram

Relationships exist between career identity development and early identification with the occupation of proximate adults, especially maternal careers. Parental support and expectations are key familial factors that promote college aspirations [24]. Career genograms capture family system influences by highlighting details of educational attainment, credentials, and occupational history [24]. Family attitudes towards achievement, success, and survivability can be accepted as a guiding mechanism or rejected in favor of preferred outcomes [24]. Genogram analysis enhances recognition of cultural influences, family support and values, critical transitions, navigation of the unknown, and pursuit of an aspirational future [34]. Using a genogram, exploratory undergraduate students reported familial values and events associated with occupational gender roles, generational differences, and efficacy in career development [34].

2. Theoretical Framework

2.1 Bowen's Family Systems Theory

The current study utilizes Bowen's Family Systems Theory to explore the impacts of intergenerational familial patterns on a student's engineering success [26]. Bowenian theory explores multigenerational patterns of functioning and conceptualizes the unified emotional system of family to elucidate underlying drives of individual members [35]. The focus of this article is to explore the impact of the family system's multigenerational transmission process on student's engineering success.

Social Capital Theory and Bowen's family systems posit familial relationships as foundational to interpersonal pattern instillation and ensuing outcomes in other relationships [17], [36]. Rigorous research proposes that inequitable social forces historically gatekept engineering education [36], [37], [38]. Racial and gender minorities who experience lessened access to social resources may be subjected to isolation or exclusion in engineering education program climates [11]. Such isolation and exclusion are not solely the results of overt systemic flaws; they reflect the discrepant social wealth of persons whose identities are underrepresented within the profession [39]. Students whose identities hold majority status incur the benefits of linguistic, navigational, and resistant capital throughout engineering studies [40]. Healthy interpersonal development within a family improves one's capacity to effectively communicate and function in the extended social network of college [41], [42]. A feature that differentiates social capital analysis and Bowenian system conceptualization is the degree of attention paid to emotional processes within the social network. Bowenian theory posits parallels between the emotional patterns developed in family interaction and the resultant capacity to thrive in social environments.

2.2 Intergenerational Family Pattern

Interactions between system members shape attitudes and beliefs that inform communicative patterns with extended social systems [24]. Self-efficacy emerges from successful familial interactions and manifests in secure communication/interaction with others, individual satisfaction, and goal persistence [43], [44]. The family system and its attitudes toward lifestyle are held concurrently with the individual's immersion in selected societal contexts [23]. The communicative feedback loop that emerges from contact with family and societal systems

engages the self in ongoing refinement of their approach to both [23]. These patterns and the associated relational alignments are captured and conveyed in Bowenian genograms.

4. Methodology

The research question for this project was: "How do exemplary students involved in this study describe intergenerational family patterns that influence engineering success?" This work was part of a larger mixed method study that aims to explore the impacts of intergenerational family patterns on engineering students academic and career decisions. The research setting was a large, public, predominately white (PWI) southeastern university that has a College of Engineering and Computing with six engineering programs: aerospace, biomedical, chemical, civil and environmental, computer, electrical, and mechanical. The research study was approved by the institutional review board (IRB) of the university and qualified for exempt review. The research method utilized in this paper was qualitative case study to "… reveal an in-depth understanding of a case or bounded system, which involves understanding an event, activity, process, or one or more individuals" [45]. Exemplar Methodology (ExM) was used in this research to identify and select cases of exemplary students. ExM is a systematic sampling approach prevalent in developmental psychology with a growing use in social sciences for selecting outlier cases to study [46]. ExM is defined as "…a sample selection technique that involves the intentional selection of individuals, groups, or entities that exemplify the construct of interest in a particularly intense and highly developed manner" [47]. Exemplars exhibit giftedness in a particular domain, while in others their development may be similar or even deficient compared to other people [48]. For instance, a student with a high GPA could be considered an exemplar, but that does not necessarily mean they are more compassionate, sociable, or better team players. We used the ExM approach to define a set of attributes that could holistically reflect student performance in college. We implemented the following sampling procedures.

A poll was sent to engineering faculty describing research goals and requesting names of junior or senior students with exemplary performance in classes. Faculty were requested to consider a variety of student competencies and skills such as communication, quality of interaction with faculty and peers, and critical thinking in addition to student grades. The faculty observation data coupled with student academic success data [GPA, and re-enrollment data (persistence/no persistence)] resulted in a pool of 23 junior and senior students. Additional data collected on student involvement in co-curricular activities include (1) undergraduate research, (2) internship/co-op, and (3) student organizations on campus. At the final step, a diverse sample of students from varied intersectional identities of gender, race, ethnicity, and socioeconomic status were selected for the study. The nomination criteria and sampling procedure were determined through a collective decision-making process among the project team with background and expertise in engineering education, undergraduate engineering recruitment and retention programming, advising, counselor education, career counseling, and educational research design and program evaluation. Homogeneous purposive sampling out of the diverse final participants was conducted to mitigate variability attributable to demographic differences. The studied participants are three senior-level White male engineering students recommended by engineering faculty who have undergraduate research, internship, student organizations experience, and maintained a GPA higher than 3.60. One of the participants in this study, Anderson, was recommended simultaneously by two faculty. An invitation letter describing the goals of the research and interview procedures was sent to potential participants via email. Students who responded were invited to participate in interviews. Data collection included two research

instruments: semi-structured interviews and a family career genogram. Semi-structured in-depth interviews were conducted in two rounds between 45 minutes to 75 minutes. Participants received a $50 cash card as an incentive upon participation in each round. Interviews were recorded, transcribed, and double-checked with another member of the research team. A family career genogram was drawn by hand by the interviewer during interviews and later digitized through GenoPro 2020 software. The team member who conducted the interviews is a licensed professional counselor. Pseudonyms assigned to protect participant identity in this paper are Chris, Anderson, and John. Data analysis was conducted through thematic analysis emerging in two major themes.

5. Results

5.1 “Chris”

Chris is a 22-year-old White male. He is a college senior, currently maintaining a 3.6 grade point average in engineering. Chris is raised in a two-parent home with a younger brother.

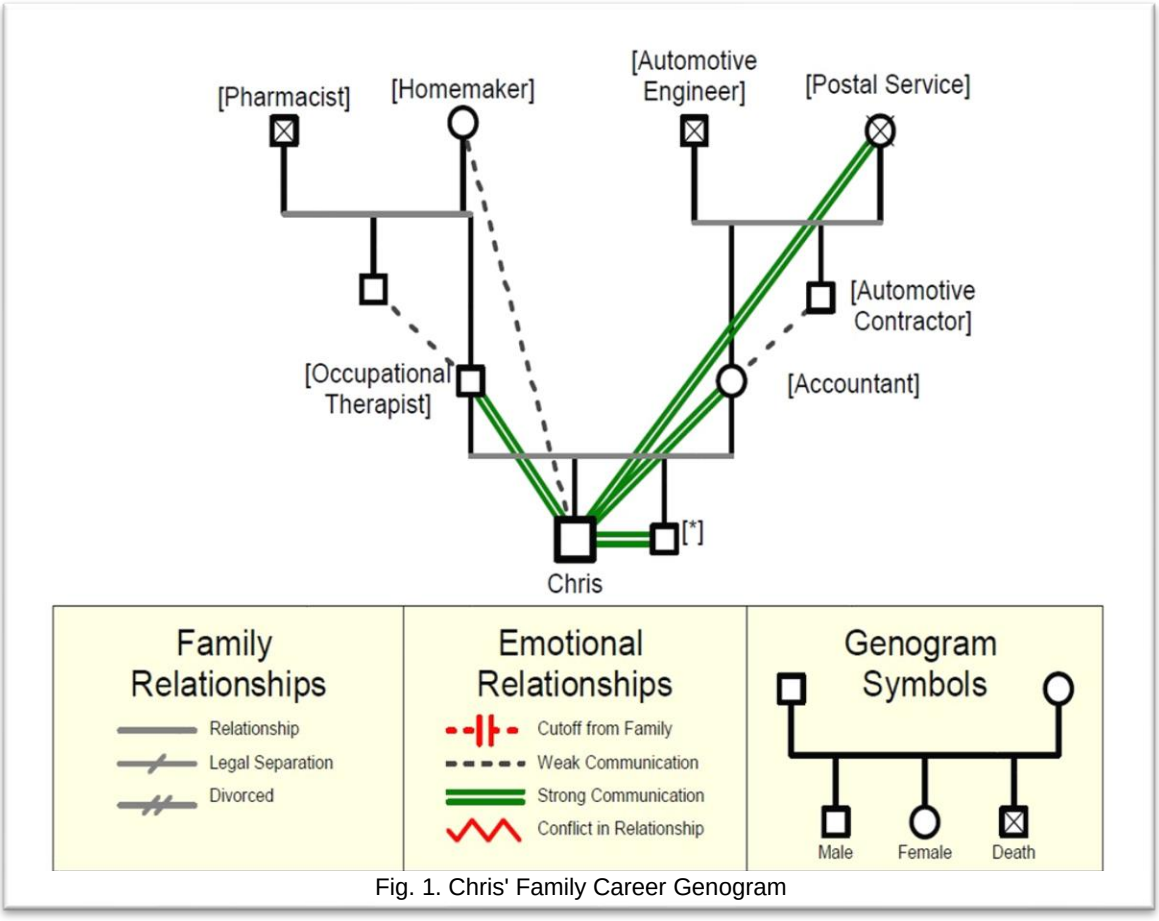

Fig. 1. Chris' Family Career Genogram

Career Attitudes and Communication Early exposure to engineering practices were provided by his maternal grandfather's construction and automotive work. Athletic camps comprised most family summers, with little STEM-related involvement apart from small construction projects with his family. Positive career attitudes espoused by his mother "inspired" academic focus. Chris described a family value for improving each generation's standard of living and promoting accomplishments. His parents were the first among recent generations to attend college, continued education became synonymous with success. Chris' early academic success was praised and promoted through parental financial incentives. He appreciated the uncoercive nature of the financial incentive, noting that encouragement of career was paramount. Chris reported the importance of the "possibilities" and autonomy offered by career. He was determined to choose something that "opened up so many roads, I could do whatever I wanted." Engineering emerged as a choice that could facilitate needs for freedom and provide diverse career paths. Chris values the social contribution and autonomy experienced in engineering. "Just do whatever you do, do it in your best way," characterized familial attitudes toward career. The family system feedback loop entailed constructive feedback on missed objectives and consideration for their impact on family functioning. He was guided to see challenges as necessary for growth and describes "leaning into discomfort" as a habit that promoted engineering success.

Family System Factors Contributing to Student Success Family values included sustainability of growth, availability for support, and open communication across generations. Chris noted that parental modeling "inspired" him to pursue a career that promoted family growth. Familial pride formed around their history of military engineering service during World War I and World War II. His purpose in entering engineering was to "maintain that higher standard" that his family inculcated through diligence and mutual support across career efforts. Collaborating on construction projects from childhood into mid-adolescence developed into a deeper fascination with engineering professions. Chris was encouraged to "do something that can provide for you and your family," and noted the modeling provided by past generations. Family values for success were matched by parental financial support and provision of lodging during engineering education. Financial considerations presented a barrier in the appraisal of higher education. Scholarship pursuit was encouraged by his parents, resulting in Chris' covered tuition. Compensation for work he does through the family businesses is vital supplemental income during college. Chris manages his family business obligations concurrently with engineering pursuits, demonstrating the strength of family collaboration and his commitment to both goals. Exploration of family communication patterns reflected that "casual and business-related" discussions were normed across generational levels. The intersection of financial support, individual interest, and family requirements for college promoted engineering selection. Family collaboration values extend to Chris' engineering success, with him noting the support of peers is critical during stuck points in engineering knowledge. The support exhibited by his family during career appraisal and peer assistance during engineering academics are sources of social capital. Chris considers how his decisions may impact the family and contribute to the betterment of them and his engineering peers. Family trust developed with repeated successful outcomes, enabling Chris' autonomy during launching. Family pride in their engineering legacy and availed relational support cultivated career attitudes that enabled Chris' success. Chris strives for financial strength, professional mastery, and social contribution through his engineering success.

5.2 “John”

John is a 22-year-old White male. He is a senior-level engineering student, maintaining a 4.0 grade point average. John was raised in a two-parent household, alongside a two-year younger brother. His family transitioned to their current state of residence when he was six.

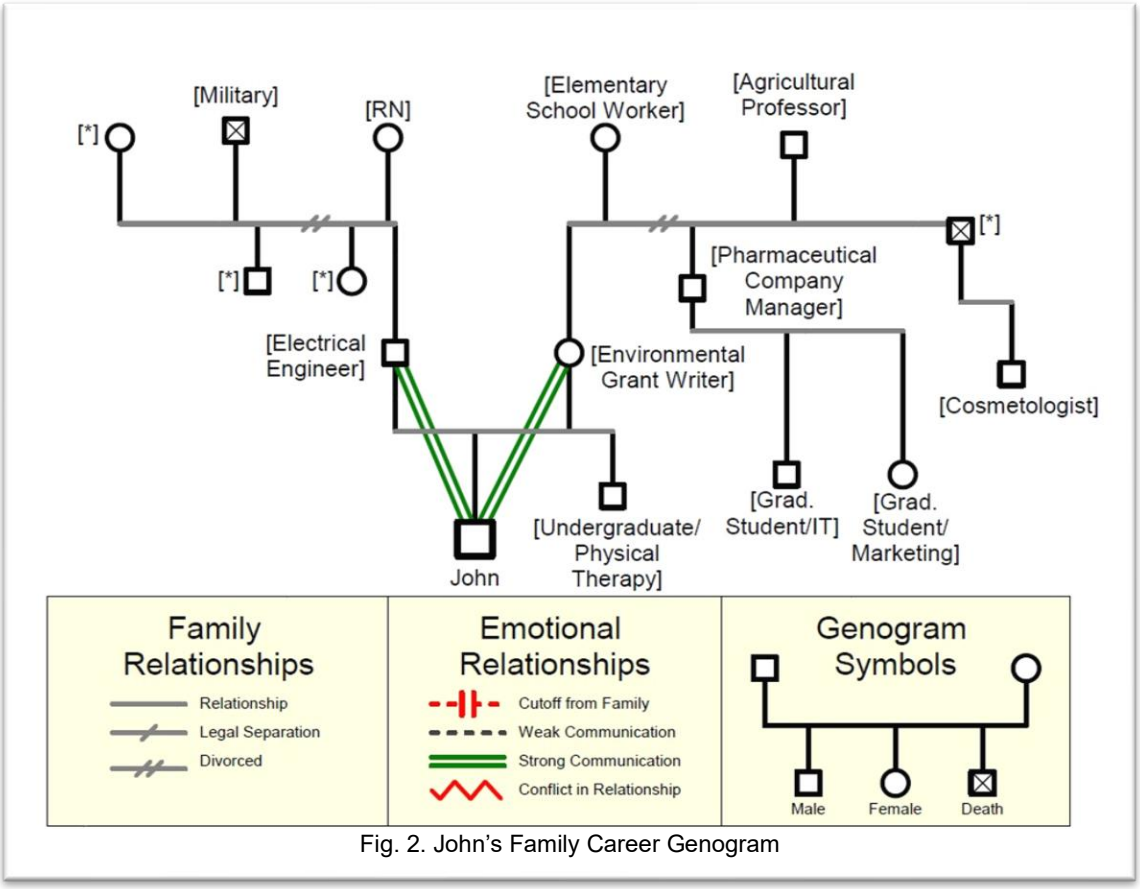

Fig. 2. John’s Family Career Genogram

Career Attitudes and Communication Non-coercive approaches to learning and encouragement of success were vital to John’s parents, he stated “providing a lot of opportunities” was critical to them. John stated they were implored to “do good in school” and “work hard” without coercion towards a profession. His mother instilled a value for open communication, noting its importance in help-seeking, and career guidance emerged as a natural extension of the family’s interpersonal process. He reports his dad is most helpful with “technical problems” and his mom with emotional support. Parental availability for support is the norm and bolsters his success in the transition to adulthood and engineering progress. Their communication was informative during the major selection process. Ahead of major selection, his father noted preference without coercion. Paternal guidance was received as “affirmation,” with John noting a value for informative processes ahead of undertaking choices. He regarded the aptitude tests and exhibited competence in related subjects to be further confirmation that engineering was the right choice. Familial guidance and exhibited competence were described as social motivators for engineering selection, John’s friends were supportive of his profession

selection noting its strong fit with his exhibited abilities and interests. Entering engineering, John reflected on his father's example and felt confident that "I could do it as well." John's "good household" and "encouragement" from social supports were stated contributors to his success. Parental encouragement fostered the extension of John's exhibited athletic diligence to schoolwork, discipline became a standard operating procedure in his approach to life. Skills in STEM were exhibited across educational and recreational settings. Personal motivators included achievement and supporting others. Social acceptance and mutual motivation in his friend group were coupled with family emotional and financial support to form an encouraging foundation from which to select his major. Identifying the factors that promoted his academic success, John returned to these social contributors. He stated appreciation for the modeling provided by graduate student mentors, research PI, and father.

Family System Factors Contributing to Student Success John's mother's affinity for environmental improvement is also reflected in his maternal grandfather's field and professorial work on promoting agriculture in developing countries. Witnessing his father's electrical engineering career inculcated a sense of "possibility" in John. Noticing his own affinity for engineering, he formed positive associations with his father's work. John recalls working on math problems with his grandmother and a formative feeling of empowerment from her noting his ability and praising success. Experiences working alongside his maternal grandmother primed his interests heading into the school system, where he formed logical connections between STEM concepts and his father's routine application of them in engineering. Exposure to engineering was consistent and without expectation**.** John's fascination with construction equipment and toys matched his burgeoning need to "create." John was immersed in self-selected summer camps that were split between recreation and academics, noting high school attendance at a college-setting STEM camp. John's family prioritized exposure to options over explicit expectations throughout his development. Cherished recollections of shooting model rockets with his father influenced the development of his engineering interest.

John noted the tools and procedures gleaned through these relationships were edified by their supportive attitudes, promoting a sense of meaning in the work. Personal growth and social contribution are values that underpin John's exhibited success. John works to resolve academic tasks autonomously before recruiting assistance, stress is mitigated through recruitment of social support when challenged beyond his current capacity or knowledge. John's family normed collaboration, help-seeking, and positive career attitudes. He indicated that early experiences with engineering were formative. Non-coercive career attitudes and a breadth of social encouragement were important to John's academic success. When asked what other careers were considered, the decision was clear: "engineering is all I see myself doing."

5.3 "Anderson"

Anderson is a 22-year-old White male. He is a senior-level engineering student with a 4.0 GPA. Anderson was raised in a two-parent blended family. The blending of families ensues when both spouses bring with them children from prior relationships [49]. Anderson characterized his blended family as "inclusive" in relation to his older sisters and their biological mother.

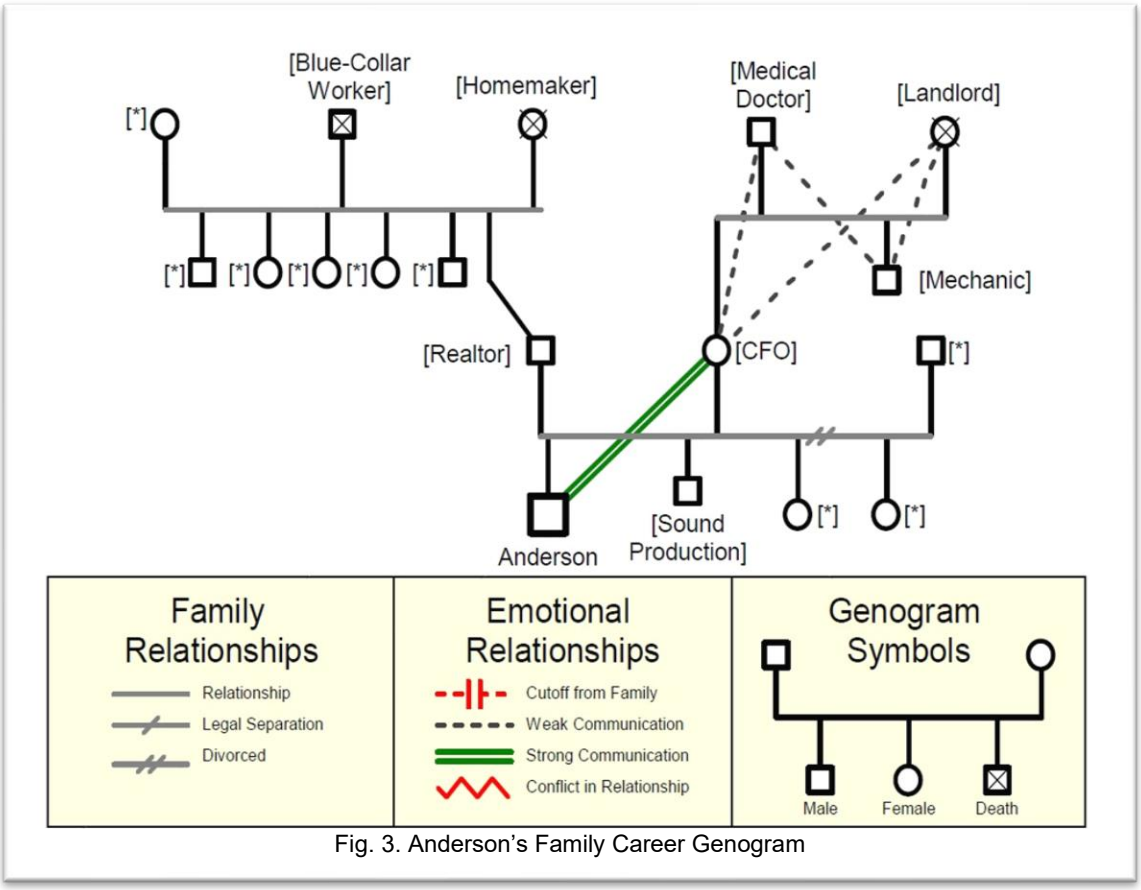

Fig. 3. Anderson's Family Career Genogram

Career Attitudes and Communication Anderson's mother provided vital encouragement from an early age, noting and nurturing his natural proclivity towards math and science. The largest impact on his engineering pursuit is an early childhood memory of a family trip to Cape Canaveral, "seeing that just struck me with a sense of awe." Personal needs for "adventure" are met through aerospace engineering. The trip demonstrated the willingness of his family to cultivate his early interests and instilled a lasting value for engineering careers. Anderson's passions for construction and design were honed through toys given to him as a child that promoted working with his hands and following instructions. The availability of social support and resources provided enriching experiences with engineering and collaboration at an early age.

Family System Factors Contributing to Student Success Anderson was availed to lifelong familial support through finances, education, and emotions. Anderson reported family input to be critical in broaching decisions with substantial implications for the family system's future. An open feedback loop was established early in their communication pattern. Anderson felt confidence in his ability to broach the family system with needs for support or guidance, noting that the resulting encouragement was integral to his career-decision making processes. During a search for mental health providers Anderson was met by unconditional willingness family aid, "they'll always cover me." The family's process for mitigating the vertical stressors experienced by individual members encompassed resources outside the system, with established patterns of open communication playing a vital role in the recruitment of help. Anderson stated help-seeking as essential to academic success, noting the support of the professor he works for and regular

peer assistance. He expressed that his family nurtured his interests, offered guidance through stressors, and promoted his capacity for engineering achievement through unwavering encouragement. Anderson strives to extend his received support to others, valuing the capacity for supporting others imbued by engineering mastery and success.

6. Discussion

The three cases and genograms reflect family processes that shaped high achieving student's engineering success. Transgenerational career exposure, career promotive attitudes, collaborative social support, and individual engineering efficacy emerged in each case. The impact of family occupations and relational processes on the development of student self-efficacy, autonomy, and career attainment have been noted across multiple professions and diverse family demographics [24]. This research deepens awareness of family system factors that influence engineering success through career genogram analysis of relational processes and career constructs. Familial exposure to STEM and encouragement of autonomy is prominent throughout the narratives, contributing to existing research on the role of social capital and family process in promoting academic outcomes and career attainment [5], [24]. Family system supportive feedback loops extended to the interpersonal efficacy exhibited within engineering social networks. Proliferation of family system social support attitudes is evinced through programmatic peer collaboration. Prior research has revealed significant relationships between interdependent family structure and family process, noting their impact on career development [24]. Our study assessed the presence of these underreported constructs in high-performing engineering students. Formative factors covered in our research are corroborated by previous findings that parental support promotes career development. Support of student help-seeking and integrating feedback reflected symmetrical communication within the family, contributing to student success in their extended professional network. Parental-encouraged autonomy and guidance availability can facilitate engineering success. Participants stated family financial and emotional support were critical in their development, mitigating the impact of engineering stress.

The breadth of support from Anderson's family has been a significant contributor to engineering success. Implicit expectations and explicit attitudes were accompanied familial encouragement. Supportive experiences prompted Anderson to pursue a career linked to his personal interests and natural skill, developing an affinity for engineering, math, and science. His parents maintained a supportive stance on academic achievement and provided invaluable encouragement deemed critical to his success. STEM-related family trips and educational gifts were formative of engineering interest. Family career attitudes and promoted work ethic have informed Anderson's approach to entry and success in engineering.

Valuing family advancement encouraged Chris's engineering selection. The family's engineering and medical pedigree provided early exposure to academic challenges and success. Supporting college degree attainment was a family norm. Chris reports confidence in his ability to broach challenges, noting early success in family collaborative projects that applied STEM concepts. The family's planning is open to trajectory changes by Chris and his brother. He stated appreciation for family trust and flexibility, noting the value for avoiding the horizontal stress of career instability through diligent navigation of engineering's stress. Familial financial and emotional support promote engineering feasibility. Collaborative efficiency enables the family to manage concurrent career goals. Their open communication aids in overcoming challenges and

parallels Chris' navigation of engineering difficulties with classmates. His lifelong reliability and determination in academic pursuits earned the respect and trust of his family system. Family encouragement and trust have promoted Chris' progress through the rigor of engineering.

The exposure to engineering provided by John's family system is vital to his success. John's genograms reflect strong relationships with supportive parents. Family system communication promoted collaboration toward mutual goals. Open communication is an explicit family value, encouraging John to seek social support for stressors. The familial positive feedback loop and noncoercive attitude promoted lasting, positive associations with STEM professions. They provided support and guidance without dictating John's choices throughout engineering progress. He reports experiencing lifelong social support and competence in engineering, transitioning childhood interests into a career. Childhood experiences marked the first instance of motivation for STEM careers and the supportive attitude employed by his social network nurtured this drive through each season of his career development.

Transgenerational patterns cultivated engineering motivation. Each family espoused supportive career attitudes and implemented communication patterns that promoted resource acquisition. Family value for professional occupation and the presence of an engineering-related profession informed student choices. Parent-child involvement in occupation-related activities formed participant interest towards similar STEM subjects. The participants regarded the selection of engineering as uncoerced while respecting the family expectation of career acquisition and success. Each had childhood memories involving attending or completing engineering-related tasks. Competence in STEM-related coursework was matched by familial encouragement, providing a supportive feedback loop between school and family systems. Family provision of guidance, emotional support, and financial resources bolstered student success. Our review of family factors attended to the formative experiences, expectations, and attitudes that underpin academic motivation and success. The achievements promoted by the families' interactional patterns are uniform, despite significant differences in the stressors navigated by each system.

A key difference in the assessed systems is the blended family status and instances of emotional distance within Anderson's family. Two participants reported significant maternal influences on career orientation. These findings are consistent with other studies highlighting the impact of maternal occupation on career appraisal [50]. Differences in pre-engineering experience were notable, with two participants attending edifying STEM-related camps prior to major selection. The participant who reported prioritizing athletics prior to college didn't regret declining STEM camp. John's state transition contrasts with the local familiarity of Anderson and Chris, lifelong inhabitants of their university's state. Impactful bereavements were reported in two cases but remained unexplored to promote a focus on patterns promoting engineering success. Divorces were present in the three-generational genogram of two participants, their impact on family patterns were unexplored during this study. Our findings implore the exploration of additional psychological constructs and family system factors that influence career disposition. An awareness of family patterns that improve student functioning during engineering academics may bolster retention. Researchers have highlighted the effects of parental attachment on vocational exploration, career decidedness, and career commitment. Mental health professions are uniquely situated to explore these attachment effects further, promoting an enriched understanding of attachment's role in calibrating motivation and persistence.

Our present study reflects a homogenous sample, three white males in their 20s at a Southeastern university were selected to mitigate family pattern variability attributable to diverse intersectional identity. No claims of generalizability are made, future research attending to minority populations' intergenerational patterns is vital. Relational contexts are multidimensional, their effects extend beyond the categorical "supportive" or "non-supportive" dimensions reviewed in our study. Exploring socioeconomic status, biological sex, gender, race, ethnicity, and other intersecting identities' impacts on the relational experiences within the student's social systems can enrich future research on interactional patterns. Numerous fields employ the general genogram structure to elucidate social and biological concepts. Our process featured multiple interviews and genogram edits to saturate data related to career exposure and interpersonal patterns.

Research findings highlight the impact of family on engineering students' success. Our research reflects familial career attitudes and supports that contribute to engineering efficacy and persistence. Findings indicate transmitted career attitudes, resource-seeking patterns, and experiences that promote successful programmatic engagement. Engineering programs may benefit from community involvement, empowering student families through the explication of attitudes and support patterns that contribute to success. Pre-enrollment contact with student's families, initiated by engineering programs, may mitigate risk factors for dropout through messaging that promotes autonomy and efficacy. Integrating career attitudes and social capital into messaging around engineering success promotes a holistic view of student achievement factors.

7. Conclusion

We applied Bowen's family systems theory to investigate intergenerational patterns that impact engineering success. Exemplar Methodology was utilized to select case studies of three high-performing students who persisted in their undergraduate studies. Semi-structured interview data and constructed genograms reflect supportive relationships and transgenerational career attitude transmission within engineering student families. Exposure to family members with engineering experience, career promotive attitudes, and normed help-seeking patterns were major themes that impacted student success. Our findings suggest implications for engineering recruitment and retention strategies that promote family support for students. Academic support services for engineering students, namely, mental health support and career services may benefit from assessing the systemic impacts of horizontal and vertical stressors on student academic and career decisions.

8. Acknowledgment

This project was supported through NSF Grant #2225381 and made possible through the contributions of willing participants.

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