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A Student-Centered, Theory-Informed, Integrated Model to Academic and Career Advising to Educate the Whole Engineer: Transforming Engineering Education and Broadening Participation in Engineering is Possible!

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Transforming Engineering Education Through an Integrated Academic and Career Advising Model: A Theory-Informed Model for Educating the Whole Engineer at Wake Forest Engineering

ABSTRACT - Higher education faces mounting criticism regarding cost, job preparation, curriculum relevance, and advising effectiveness. While engineering education has long been urged to reform, transformation is possible. In this paper, we share the story of launching Wake Forest Engineering and the student-centered practices and strategies that enabled us to rethink academic and career advising. Wake Forest Engineering presents a comprehensive model and approach to integrating academic and career advising towards student success. The model is informed by three theoretical frameworks - self-determination theory, identity theory, and social cognitive career theory - to support holistic student development. Starting with entrance surveys to understand student aspirations, continuing with annual assessments, and embedding advising within the curriculum, this approach enabled customized pathways aligned with evolving student interests. Key outcomes demonstrate the model's effectiveness: 50-75% of graduates pursued minors or second majors across diverse fields, over 50% participated in study abroad, and over 50% engaged in undergraduate research. The advising model integrates curricular experiences with career preparation through strategic partnerships and practices. This paper details the theoretical foundations, implementation strategies, and assessment methods used to create an adaptive advising system that supports diverse student pathways while maintaining engineering rigor. Student insights were powerful in informing not only curricular decisions but also academic and career advising. The strategies herein reflect an intentional commitment to Educate the Whole Engineer by promoting an academic advising model that would both complement the curricular experiences and align with the evolving personal and professional aspirations of students towards career readiness. The approaches described offer valuable insights for both new and existing engineering programs seeking to transform their advising practices to better serve an increasingly diverse student population. There is urgency in this work for the betterment of higher education and engineering education.

I. INTRODUCTION

The value of higher education is under attack and the criticisms are many: cost, inadequate preparation for job-readiness, outdated and inflexible curricula and degrees, outdated pedagogies, ineffective advising, unwelcoming classroom environments, inadequate diversity of faculty, ineffective operational models, etc. Engineering education is not immune from these criticisms and there have been many national reports urging reform of engineering education for decades. Transformation of higher education and engineering education is possible though and exemplar programs that have made positive transformation do exist. Herein, we share the story of launching Wake Forest Engineering and the student-centered practices and strategies that enabled us to rethink academic and career advising. While previous publications have focused on curricular and pedagogical innovations in building Wake Forest Engineering (Pierrakos, 2024), this paper will focus on elements of academic and career advising.

With undergraduate engineering education being an externally-accredited (ABET) professional degree, the importance of academic and career advising is well known. Although ABET does

not specify how programs and institutions should support students towards engineering degree completion and career preparation, the following are some of the criteria that a program evaluator is trained to look for and evaluate against: (1) appropriate evaluation and monitoring of student performance towards degree completion (Criterion 1), (2) appropriate academic advising procedures and practices (Criterion 1), (3) appropriate career advising procedures and practices (Criterion 1 and 6), (4) engagement with engineering professionals (Criterion 1, 6, and 8), (5) meeting curricular requirements around engineering topics, broad education, as well as math and basic science (Criterion 4), (6) attainment of student outcomes (Criterion 3 and 4), (7) alignment of curriculum with program educational objectives (Criterion 2), (8) support services to ensure students can meet program educational objectives, student outcomes, curriculum requirements (Criterion 8), (9) access to appropriate facilities and equipment to support learning and student outcomes (Criterion 7), etc. (ABET 2024). Although many engineering educators may only associate effective advising to ABET's Criterion 1, the reality is that effective academic advising and career advising practices also impact ABET's Criteria 2, 3, 4, 5, 6, 7, and 8. This is a more holistic perspective that can truly benefit engineering programs everywhere.

Beyond ABET criteria around advising, which at the end still are minimal standards to effectively support engineering degree attainment, we must also understand the current practices within higher education. The current practice of academic advising in many higher education institutions is the use of faculty or staff to guide students with academic degree requirements. This model is a more directive approach to advising in order to ensure that general education (i.e. broad education using ABET terminology) requirements are met and other major-specific requirements are met. Academic advising most often happens outside of the classroom with planning happening one semester or two semesters out. In regard to the current practice of career advising in many higher education institutions, career advising centers or offices exist on most campuses to support students. Career advising and academic advising rarely come together except for maybe professional degree programs and the staff that support both aspects of advising are different (e.g. academic advisors being part of the academic side of the university while career advisors being part of the student affairs side of the university). There is certainly room to improve higher education practices around both academic advising and career advising. As student demographics and curricula evolve, so must advising practices, but that is not often the case either. Higher education has revealed effective and ineffective practices around both academic advising and career advising. This paper serves to show strategies deployed within a brand-new engineering program that can be of value to other engineering programs and higher education programs in general (both established and new). Intentional connections between academic advising and career advising can be made. Intentional connections between the curriculum and advising can also be made. This intentionality requires strategic partnerships across a typical university campus and creative practices.

Higher education institutions need to recognize that diverse advising approaches do exist and advising models should be customized based on resources, goals, and student needs. Some of the advising models documented in the literature include the following: (a) ***learning-centered advising approach*** (focused on connecting purpose of education with curriculum and degree), (b) ***engagement approach*** (focused on relationship building between student and advisor), (c) ***developmental advising approach*** (focused on student development and growth), (d) ***prescriptive academic advising approach*** (focused on checklists towards degree completion), (e)

proactive advising approach (focused on students initiating advising meetings and advisors tacking those identified as at academic risk), (f) ***appreciative advising approach*** (focused on creating positive interactions to support growth and academic planning), (g) ***flipped advising approach*** (focused on using the university's learning management system to support advising processes) (Antoney 2020).

II. ACADEMIC AND CAREER ADVISING MODELS IN HIGHER EDUCATION

Academic advising models in higher education have evolved and continue to evolve to cater to diverse student needs. Here are some of the primary models derived from content generated from ChatGPT 4.0 (Sept. 2, 2024) and edited by the lead author: (1) **Prescriptive Advising:** This traditional model follows a top-down approach, with advisors providing specific instructions. While efficient, it can limit student autonomy. (2) **Developmental Advising:** A more collaborative approach, focusing on the student's holistic development. Advisors work with students to set goals and make informed decisions. (3) **Intrusive/Proactive Advising:** This model involves proactive outreach to students, particularly those at risk. Advisors initiate contact to offer support and guidance. (4) **Appreciative Advising:** A positive, strengths-based approach that emphasizes student potential. Advisors use positive questioning to help students envision and achieve their goals. (5) **Group Advising:** This model involves one advisor working with multiple students simultaneously. It can be efficient for sharing information and fostering peer learning. It is important to note that institutions often combine these models to create a comprehensive advising system that best suits their specific needs and student population. Some academic advising models in higher education are showcased in **Figure 1**. We do not suggest that this is an exhaustive list of higher education academic advising models, but this information offers some relevant insights upon which to understand and consider different approaches to academic advising.

Although by no means exhaustive, the following highlight some of the knowledge we have gained about current advising practices in higher education and/or engineering education:

(1) As workforce opportunities evolve, so must curricular as well as academic advising and career advising. College-to-career alignment is a key criticism of higher education (Fischer 2022).
(2) Academic advisors, including faculty advisors, play a critical role in the success of students but require sufficient training to effective support students and balance all the other activities that faculty have to carry out (Chan et al., 2019; He and Hutson, 2017; Khalil et al., 2014; Drake 2011).
(3) Academic advising practices should leverage a diversity of communication methods and tools (Chan et al., 2019; Iatrellis et al., 2017).
(4) Academic advising needs to be seen as a form of student development (Pargett 2011)
(5) Academic advising needs progressive and developmental pathways to support student success (Emekako and Van der Westhuizen, 2021).
(6) Centralized advising models, staffed with professional advisors, have both advantages and disadvantages to supporting student success and retention (Kot 2014; Rowan 2019). Centralized professional advisors offer accessibility but not often depth of knowledge.

Centralized professional advisors were helpful but not a key element to a sense of connectedness to the university (Rowan 2019).

(7) Faculty that support academic advising need to understand their role and the advising process better (Moore 2020).

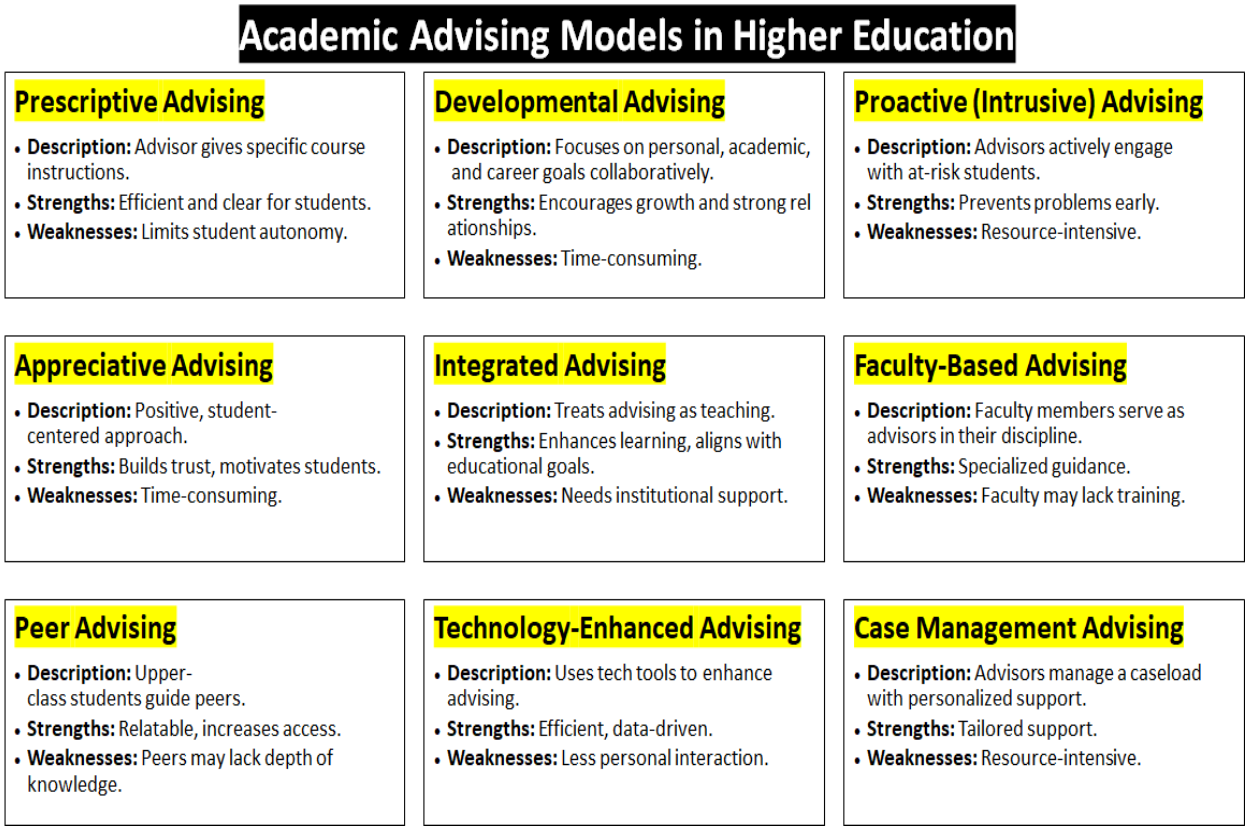


Figure 1: Some of the academic advising models we see across higher education. This is not an exhaustive list or representation. Many existing academic advising models combine elements and features from various of these models.

In regard to career advising models being used across higher education, we see diverse and evolving models to meet the complex needs of students. Traditional models exist offering career counseling and career advising within both centralized and decentralized structures and with short-term and long-term developmental strategies. Strength-based coaching models also exist to identify and leverage students' strengths, passions, and career goals. Advisors vs coaches typically take on different roles within these varying models of career advising. As an example, models exist where advisors take a proactive approach to career advising reaching out to students, while other models position coaches to be available to students when they are ready to offer general support. Sometimes upperclassmen or recent graduates can be the advisors or coaches. The more integrated and innovative models of career advising build connections between academic and career support, provide clear career pathways in alignment with academic programs, encourage students to view their careers as stepping stones to long-term career aspirations, or take a competency-based approach connecting competencies that employers value with advising. These models are often used in combination to create a comprehensive career

advising strategy that meets the needs of diverse student populations and institutional goals. Institutions may also choose or adapt models based on their specific context, resources, and student demographics. By understanding these diverse career advising models, institutions can create effective career advising programs that support student success. Some career advising models in higher education, derived from content generated from ChatGPT 4.0 (Sept. 2, 2024) and edited by the lead author, are showcased in **Figure 2**. We do not suggest that this is an exhaustive list of higher education career advising models, but this information offers some relevant insights upon which to understand and consider different approaches to career advising.

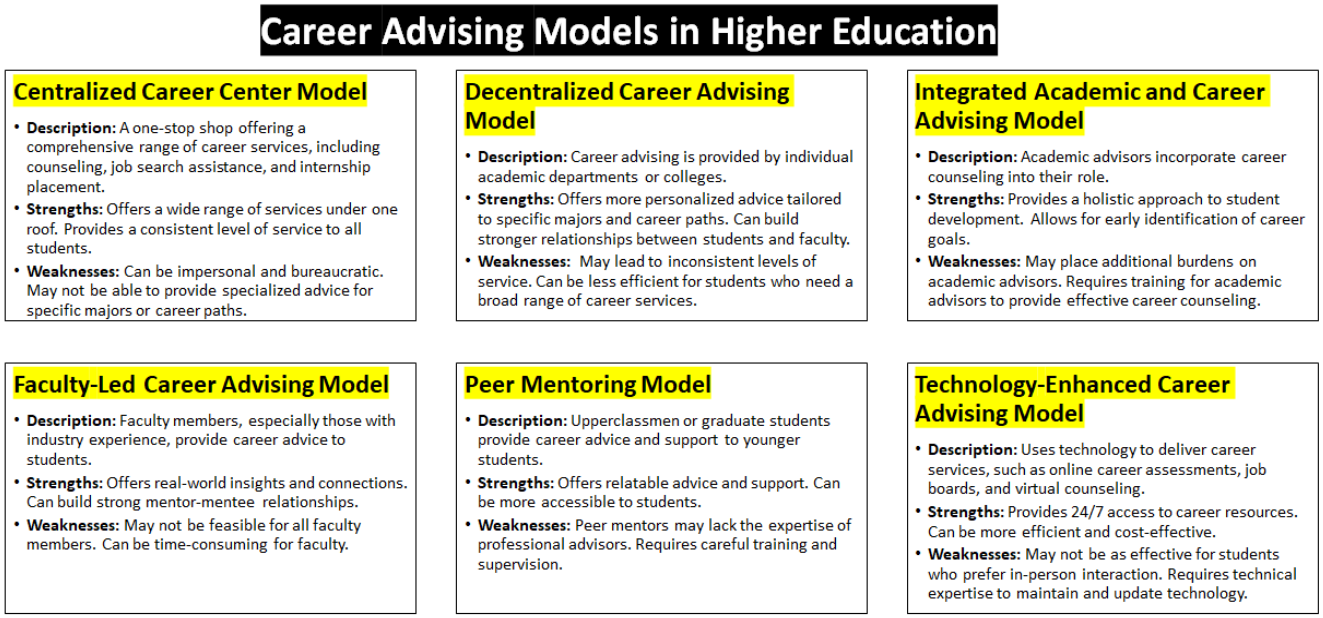


Figure 2: Some of the career advising models we see across higher education. This is not an exhaustive list or representation. Many existing career advising models combine elements and features from various of these models.

III. THEORETICAL FRAMEWORKS GUIDING WHOLE STUDENT DEVELOPMENT

As an engineering education researcher, the lead author (Pierrakos) has been an NSF-funded principal investigator who has worked with social scientists for 20+ years. She has investigated engineering student identity development, self-efficacy, motivation, goal orientation, cognitive flexibility, adaptive expertise, complex problem solving, etcetera in collaboration with social scientists (Pierrakos, 2017; Pierrakos, 2016; Pierrakos et al., 2016a; Pierrakos et al., 2016b; Williamson et al., 2016; Pappas et al., 2013; Pierrakos et al., 2013; Pierrakos et al., 2010a; France et al., 2010; Pierrakos et al., 2010b; Zilberberg et al., 2010b; Pierrakos et al., 2010c; Pierrakos et al., 2009; Pierrakos and Trenor, 2009; Trenor and Pierrakos, 2008). These unique perspectives in understanding engineering students and knowledge gains as an interdisciplinary and cross-disciplinary engineering education researcher guided her as the WFU Engineering Founding Chair.

There is research that points to correlations between academic advising and student development as well as student satisfaction and retention (Troxel 2018; Jordan 2016; Roufs 2015; Drake 2011; Williams 2007). There are several foundational student development theories that can inform and enhance academic and career advising models within higher education. Such theories provide valuable frameworks for understanding student development and improving advising practices. Key insights include: (1) the importance of matching advising approaches to students' developmental stages, (2) the need to consider multiple dimensions of development, (3) the value of integrating different theoretical perspectives (Troxel 2018; Jordan 2016; Roufs 2015; Drake 2011; Williams 2007). Although there are a variety of relevant student development theories that can influence academic and career advising models and practices - cognitive theories, psychosocial theories, motivational theories, identity theories, environmental theories – herein, we focus on social identity theory (identity theory), self-determination theory (motivational theory), and social cognitive career theory (integrative theory). These three theories informed whole student development at Wake Forest Engineering that will be discussed in the remaining sections of this paper.

Identity theory (IT) posits that individuals' sense of self is shaped by their social roles, memberships, and identifications (Stets and Burke, 2014; Stets and Burke, 2000). **Social Identity Theory (SIT)** can be used to understand academic and career advising in higher education, particularly focusing on how students' various social identities intersect with the advising relationship, institutional structures, and career aspirations. There are several important considerations in applying IT and SIT to student advising models. Identity influences how students: (1) perceive and engage with advisors, (2) navigate institutional systems, (3) make academic and career decisions, (4) form support networks, etc. Effective advising models must: (1) acknowledge that students have multiple identities (e.g. gender, race, ethnicity, socioeconomic status, disability, religious affiliation, LGBTQ+ identity, first generation status, motherhood, student athlete, etc.), (2) address systemic barriers to student development and progress, (3) provide culturally responsive support, and (4) foster inclusive environments where students with diverse interests and aspirations can thrive. In the context of academic advising, students' identities as learners and their motivations for pursuing higher education can significantly influence their interactions with advisors and their overall academic experience (Blaney et al., 2022; Dyarbrough 2002). There are several key applications of IT and SIT in higher education advising models: (1) **Student Identity Formation:** Advisors can play a crucial role in helping students develop and explore their academic identities. By understanding a student's background, interests, and goals, advisors can provide guidance and support that aligns with their identity. (2) **Motivation and Engagement:** Students who feel connected to their academic identities are more likely to be motivated and engaged in their studies. Advisors can help students develop a sense of purpose and meaning in their academic pursuits. (3) **Persistence and Success:** A strong academic identity can contribute to students' persistence and success. When students feel connected to their academic goals and see themselves as capable learners, they are more likely to overcome challenges and persevere. (4) **Cultural and Social Context:** Identity theory recognizes the importance of cultural and social context in shaping individuals' identities. Advisors can be mindful of students' cultural backgrounds and experiences to provide culturally relevant guidance and support. **Overall, identity theory provides a valuable framework for understanding the complex relationship between academic advising and student success.** By recognizing the importance of student identity and providing guidance and

support that aligns with their individual needs, advisors can help students achieve their academic goals and develop a strong sense of self. SIT enables us to understand that there will be differences amongst students regarding academic performance, career pathways, campus and academic engagement, resource utilization, and peer group formation. Further, students need to see themselves represented in success stories and in role models in specific fields. Without seeing themselves in these success stories, their confidence to succeed academically and with career aspirations will be impacted. Identity-conscious advising (1) understands intersectionality, (2) recognizes systemic barriers, (3) promotes inclusive excellence, and (4) supports "whole student" identity and development. Best practices for identity-conscious advising requires advisor development across areas of cultural competency, identity awareness, bias recognition, and intersectionality, as well as recruitment of diverse advisors for showcasing broad representation of success to the student body. Identity-conscious advising also requires policy review to ensure equitable practices and procedures, feedback gathering to continuously improve practices and establish accountability, targeted resources, effective communication, and community building.

Self Determination Theory (SDT) was developed by Edward Deci and Richard Ryan (Ryan and Deci 2024; Deci and Ryan 2012) in the 1980s and remains a prominent theory that has been applied across many contexts from higher education (Reeve 2002) to workplace environments (Manganelli et al., 2018; Deci et al., 2017) and even engineering education (Stolk et al., 2018; Trenshaw et al., 2016). SDT focuses on human motivation, well-being, and personality development. SDT is grounded in the idea that individuals have innate psychological needs that, when satisfied, foster motivation and psychological growth. These psychological needs are autonomy, competence, and relatedness. ***Autonomy*** involves being and acting in harmony with one's integrated sense of self and values as well as feeling that one has ownership over one's actions. In educational environments, autonomy is visible when learning environments offer learners opportunities for choice, self-direction, and flexibility rather than imposing strict or rigid direction and demands. Learners are thus motivated when they have choice in their academic pathways, courses, learning topics, classroom projects, etcetera based on their interests and aspirations. ***Competence*** involves mastering tasks and learning new skills and involves a sense of accomplishment derived from successfully overcoming challenges. In educational environments, competence can be achieved when learners are provided challenges that are appropriately matched to the learner's skill level and accompanied with positive feedback and opportunities for growth. In the context of academic and career advising, advisors need to set clear and achievable goals and guidance as well as provide constructive feedback to help students feel competent in achieving their academic and career goals and aspirations. ***Relatedness*** pertains to the need to feel connected to others, to belong, and to be cared for. Relatedness requires forming meaningful relationships and feeling a sense of belonging in a social context. In educational settings, relatedness can be achieved by creating positive social interactions, community building, and support networks. In the context of academic and career advising, it is important to ensure that mentoring is supportive and leads to meaningful and trusting relationships. SDT guides us in understanding that educational practices, including academic and career advising, must foster choice, challenge, and community to enhance students' intrinsic motivation and overall engagement leading to greater well-being, performance, and personal growth. Self-Determination Theory (SDT) has been applied to understand advising models in higher education. The integration of SDT into academic advising models has revealed several key

insights. Different advising models satisfy SDT needs to varying degrees: (1) Developmental and appreciative advising tend to support all three needs well. (2) Prescriptive advising may undermine autonomy. (3) Group advising can enhance relatedness through peer connections. The effectiveness of advising approaches can be evaluated through an SDT lens: (1) How well does the approach support student autonomy? (2) Does it build student competence? (3) Does it foster meaningful relationships? When **autonomy** is present, students who feel they have a sense of control over their academic choices and decisions are more likely to be motivated, engaged, and retained. Effective academic advising practices, such as providing personalized guidance and options, can foster autonomy. Autonomy is also provided when students have choice and options, when students are involved in decision making, when there are explanations to rationales for requirements, when students' perspectives are acknowledged. When **competence** is present, students feel capable and confident in their academic abilities. Advisors support competence by providing clear expectations, offering resources, and recognizing students' achievements. Competence can also happen with constructive feedback, with setting achievable goals and challenges, with celebration of progress and achievement. Even group advising can enhance competence through peer learning. When advising is developmental and focused on skill development and growth, competence is inevitable. When **relatedness** is present, **s**tudents benefit from feeling connected to their peers, faculty, and the institution. Strong advisor-student relationships support student well-being and sense of belonging. When a welcoming environment is created and advisors show genuine interest in students, relatedness increases. Advising can thus play a crucial role in fostering a sense of belonging and community.

Social Cognitive Career Theory (SCCT) is a theoretical framework that helps us understand how individuals make career decisions and achieve career success. SCCT that is derived from Albert Bandura's social cognitive theory (Bandura 1999; Lent, Brown, and Hackett, 1994). SCCT emphasizes the interplay between personal factors (interests, abilities, values), social factors (family, peers, cultural influences), and environmental factors (educational opportunities, job market conditions). A key concept in SCCT is **self-efficacy**, which refers to an individual's belief in their ability to successfully perform a specific task or achieve a particular goal. SCCT suggests that people are more likely to pursue careers they believe they can succeed in.
Other important concepts in SCCT include **outcome expectations**, which are beliefs about the likely consequences of a particular behavior or choice, and **self-regulation**, which is the ability to set goals, monitor progress, and adjust strategies as needed. SCCT has had a significant impact on career counseling and intervention programs. By understanding the factors that influence career development, counselors can help individuals develop their self-efficacy, set realistic goals, and make informed career decisions.

Theory-informed advising practices in higher education can truly be transformative. The intersection of identity theory (IT), self-determination theory (SDT), and social cognitive career theory (SCCT) provides a rich framework for understanding how individuals navigate their academic and career paths. Each of these theories contributes unique insights into the processes of identity formation, motivation, and behavior in educational contexts. Identity Theory and Self-Determination Theory Identity theory posits that individuals derive their self-concept from the social roles they occupy and the identities they hold, which can significantly influence their motivation and behavior (Stets & Burke, 2014) emphasize that the verification of various identities—social, role, and personal—affects self-esteem and motivation, which are crucial for

academic success (Stets & Burke, 2014). This aligns with SDT, which focuses on the psychological needs of autonomy, competence, and relatedness as essential for fostering intrinsic motivation (Ryan & Deci, 2000). When students feel that their identities are validated through supportive academic advising or educational environments, they are more likely to experience enhanced motivation and engagement in their studies. The development of self-determined behaviors is crucial for students as it allows them to take ownership of their educational journeys, aligning with their personal and academic identities. Social Cognitive Career Theory SCCT emphasizes the role of self-efficacy, outcome expectations, and personal goals in career development. This theory complements identity theory (IT) and SDT by highlighting how individuals' beliefs about their capabilities (self-efficacy) can influence their career choices and persistence in the face of challenges.

An integrative framework that connects these theories can be visualized in **Figure 3**. The synthesis of identity theory, self-determination theory, and social cognitive career theory provides a comprehensive understanding of how students navigate their educational and career paths. By recognizing the importance of identity validation, intrinsic motivation, and self-efficacy, educators and advisors can create supportive environments that foster student engagement and success. Positive experiences in academic advising and educational settings can foster a strong sense of identity, intrinsic motivation, and informed career choices.

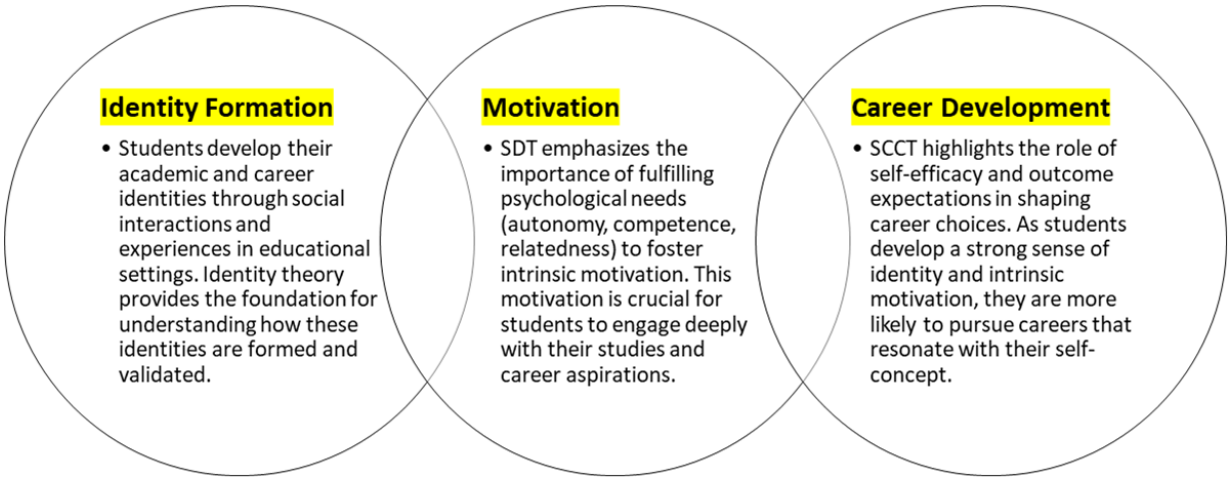


Figure 3: An integrative framework that connects three guiding theories - the synthesis of identity theory, self-determination theory, and social cognitive career theory – to provide a comprehensive understanding of how students navigate their educational and career paths.

II. WAKE FOREST ENGINEERING

Wake Forest Engineering launched in 2017 with the inaugural cohort of faculty and founding chair joining July 2017 and the inaugural cohort of students arriving August 2017. At the time of launch, July 2017, Wake Forest Engineering had no website, no curriculum, no operating budget, no furniture, no equipment, no vision, etc. Wake Forest Engineering was housed and is still housed in a College of Arts and Sciences that housed 30 departments and 26 interdisciplinary programs. Prior publications (Pierrakos, 2025; Pierrakos, 2024) offer more details about the program launch.

At launch and to this day, Wake Forest Engineering offers one Bachelor of Science Engineering degree. In time and driven by student interest, five optional engineering concentrations (biomedical engineering, civil and environmental engineering, electrical and computer engineering, materials and chemical engineering, and mechanical engineering) were launched starting Fall 2021. The concentrations leveraged existing credits within the degree to offer students a benefit when applying for engineering jobs, but did not change the degree title.

In regards to admissions, it is important to understand that students apply to Wake Forest University specifying areas of interest in regards to major, but do not apply directly to a specific school or department. All students enroll as "undecided" in terms of academic interest. Although students do not formally declare a major until their sophomore year, typically spring semester during Major Declaration Week in February or upon having completed 40 credits, most of our engineering students begin taking engineering classes during their first year. Our engineering students originate from across the United States of America and across many countries in Europe, Asia, and South America. About 20% of the Wake Forest Engineering undergraduate student body call North Carolina their home state and about 10% are international students. These trends apply to Wake Forest Engineering too. This type of geographic diversity accompanied by the broad diversity of interests that our students have across engineering applications has guided the intentionality of building Wake Forest Engineering and the intentionality of many of the strategies that will be presented in this paper. Founding WFU Engineering Chair (Pierrakos) invited students to be partners in the creation of the curriculum, advising, learning, pedagogical insights, etc. Student input, as will be seen by many of the strategies that are described herein and that were deployed, laid a foundation to innovating in the space of curriculum, advising, learning, etc.

Because of the discovery we made early on that our engineering students join Wake Forest University with broad and diverse interests across engineering applications and beyond engineering, the Wake Forest Engineering Program Educational Objectives (Figure 4), informed by engaging the diverse program constituents, showcase a glimpse of the program vision in regards to educational objectives.

Program Education Objective 1:	Demonstrate versatility and adaptability in applying engineering fundamental knowledge, skills, and mindsets to diverse career trajectories within or beyond engineering.
Program Education Objective 2:	Integrate ethical decision making, effective communication, inclusive collaboration, and innovative thinking towards professional practice with and for diverse stakeholders.
Program Education Objective 3:	Actively engage in lifelong learning for the betterment of one's personal and professional self with the ultimate goal of serving society and human flourishing.

Figure 4: Wake Forest Engineering Program Educational Objectives

In regards to academic advising, Wake Forest Engineering being housed in a College of Arts and Sciences meant that the College advising model was initially implemented with customization to meet the needs of an externally-accredited (ABET) professional undergraduate degree. At launch (2017-2018), the WFU College model for advising involved two types of advisors - lower division advisors (LDAs) and major academic advisors (MAAs). College LDAs represented faculty from across the 30 College departments and LDAs were assigned to incoming students based in part on who was the faculty instructor of record teaching a required First Year Seminar course. The College model of advising with use of LDAs outside of a students' major of interest was intended to support students with the non-major degree requirements that all students had to meet. Upon declaring a major, typically spring of sophomore year, students would be assigned a (Major Academic Advisor) MAA. The challenges with this advising model for engineering students was that LDAs (all of which were outside of Engineering for the first four years of Wake Forest Engineering) lacked the engineering-specific curricular and professional knowledge to appropriately advice engineering students. Such challenges were made visible to Founding WFU Engineering Chair (Pierrakos) immediately upon arriving on campus. Engineering-interested students (i.e. those taking engineering courses with the intent to major in Engineering but not yet declared an Engineering major due to the minimum 40-credit completion requirement) were ineffectively being advised by LDAs and placed in the wrong math and science courses. In time, transcript analyses, a procedure Founding WFU Engineering Chair (Pierrakos) instituted in preparing the university and WFU Engineering towards ABET accreditation, revealed these gaps with the standing College LDA advising model. To address the advising shortcomings that existed with the standing College LDA advising model, Founding WFU Engineering Chair (Pierrakos) connected academic advising to the engineering curriculum. This resulted to cohort-style academic advising happening within first year and second year engineering classes. Several strategies bridging academic advising and curriculum will be described in the following sections. Founding WFU Engineering Chair (Pierrakos) also appointed 1-2 engineering faculty to oversee academic advising for engineering-interested students leading to one-on-one meetings, developing advising documentation, communicating with LDAs, etc. Part-time staff outside of Engineering were hired to support some of these elements but advising mishaps were still persisting as revealed by transcript analyses. It was not until year three of launching Wake Forest Engineering that the first teaching professor (Kenny, co-author) was hired in Engineering and Founding WFU Engineering Chair (Pierrakos)

appointed Dr. Melissa Kenny (co-author) to serve as the WFU Engineering Academic Advisor (EAA) and to continue streamlining academic advising for engineering-interested students and streamlining academic advising for engineering majors with engineering MAAs. It was not until the summer of 2020 when Founding WFU Engineering Chair (Pierrakos) oversaw a Mock ABET visit - as a means to prepare the institution for an institutional readiness report to ABET fall 2020 and the initial ABET accreditation visit (fall 2021) – that further revealed Criterion 1 student advising shortcomings that the College finally supported a variant model of academic advising for Wake Forest Engineering. Fall 2021 was the first time that the College allowed LDAs for engineering-interested students to be Engineering faculty. Since then, the College hired STEM advising staff but with a lack of engineering-specific curricular and professional knowledge, advising mishaps persisted. The saving grace continued to be having a dedicated Engineering faculty member serve as WFU Engineering Academic Advisor (EAA). Dr. Melissa Kenny (co-author) has been in this role upon her hiring in fall 2019. MAAs in engineering are assigned upon students completing a major declaration engineering survey instituted by Founding WFU Engineering Chair (Pierrakos) as a means to make informed decisions about MAA assignments based on engineering student interests across engineering disciplinary application focus areas. More is described about this practice in the next section of this paper.

As the WFU Engineering curriculum was built and evolved, academic advising had to also evolve and align with the curriculum. As pointed out in the introduction, higher education's siloed approach to curriculum and advising means that these two critical components of education are mismatched. As Wake Forest Engineering was being launched, the curriculum was changing and evolving one semester at a time. Curricular structures and learning were evolving informed by student insights, faculty insights, external experts, research in engineering education, etc. Founding WFU Engineering Chair (Pierrakos) was intentional in bringing all these diverse insights into curriculum built and ultimately advising. Previous publications have presented strategies and efforts towards whole engineer education in launching and building Wake Forest Engineering (Pierrakos, 2025; Pierrakos, 2024; Hitt, Banzaert, Pierrakos, 2023; Pierrakos et al., 2021; Brock et al., 2024). Herein, we focus on the advising elements (academic and career) that were informed by curricular decisions. As an example, it became evident to the founding WFU Engineering team within the first few weeks of the inaugural academic semester (fall 2017) that study abroad was an essential learning experience that many students came to WFU for and desired to be part of even as engineering students. An initial poll in the inaugural engineering class (fall 2017) revealed that at least 80% of students desired to participate in study abroad during an academic year of their four-year degree. The Founding WFU Engineering Chair (Pierrakos) and founding faculty team knew at that point that the WFU Engineering curriculum had to be different from the typical engineering curriculum that is rigid, linear, packed, and inflexible. Engineering student feedback, in this example, motivated us to reimagine a curricular structure that would be more flexible. Engineering education curricular structure expert Greg Heileman came on site during year one to inform the WFU Engineering team on the importance of more simplified and flexible curricular structures (Heileman et al., 2019; Heileman et al., 2018; Heileman et al., 2017). This ultimately led to pre-requisite course structuring that would support curricular flexibility for students. Advising standards and requirements would then need to be developed to make visible to students how to navigate and fit study abroad experiences within the WFU Engineering degree experience. Even in midst of a pandemic, the WFU Engineering inaugural graduating class had about 50% of engineering

students participate in study abroad experiences at locations like Chile, Australia, Italy, Denmark, Spain, Germany, England, etc. ***This is just one example of how student feedback and engineering education research informed curricular decisions and informed advising structures, practices, and policies.***

Beyond academic advising, career advising is an important aspect to Educating the Whole Engineer and Educating the Whole Student towards degree completion and professional success. When WFU Engineering launched in 2017, the WFU Office of Personal and Career Development (OPCD) was also undergoing growth and development under new leadership. The only OPCD staff that had experience with professional degree career advising for undergraduate students were in the WFU School of Business. Similar to what was observed with the standing WFU College academic advising model, shortcomings quickly were evident with the standing WFU College OPCD model to career advising that was setup as a pre-professional center to prepare students towards medical school, law school, graduate schools, and other advanced degree pathways. Inadequate staffing and resources within OPCD meant that WFU Engineering would need to think out of the box in supporting career advising for engineering students. Although from year one, OPCD staff were invited to engage with engineering-interested students, curricular and co-curricular experiences within WFU Engineering would have to lay the foundation for strong connections between engineering learning, career advising and coaching, and engineering practice.

V. ADVISING STRATEGIES DEPLOYED AT WFU ENGINEERING

In this section, we share a variety of strategies we deployed in launching Wake Forest Engineering's academic and career advising model. Many of these strategies have persisted and continued to evolve and continuously improve.

A. Entrance Surveys for Incoming Students

As an NSF-funded engineering education researcher and R&D engineer, Founding Engineering Chair (Pierrakos) knew the importance of both using evidence to make informed decisions and the importance of developing solutions that meet user's needs. As it became visible quickly in talking to the inaugural engineering students, they joined Wake Forest Engineering with many and multiple interests across engineering applications. Pierrakos quickly instituted the use of entrance surveys for all incoming students because it was important for all to understand the backgrounds and aspirations of our students within and beyond engineering. Starting with the inaugural cohort (fall 2017) and each August until 2021, incoming students who enrolled in EGR 111 (Introduction to Engineering Thinking and Practice) and/or EGR 112 (Introduction to Engineering Measurement and Analysis) – the two first year engineering courses that students could take out of sequence – were invited to complete an entrance survey. The following figures showcase this entrance survey. Beyond the instructions provided about the Entrance Survey, Figure 2, engineering students were asked about their interests to come to Wake Forest University and join Wake Forest Engineering, their interests with other majors, their aspirations during the four years at Wake Forest University and high impact learning experiences they wanted to be part of, and aspirations they had professionally for the future. Figures 6 and 7 show some of the questions that were part of this survey. In time, continuing students (sophomores,

juniors, and seniors) were sent an annual "start of the academic year" engineering survey in order to continue taking a pulse around what students desired in their journey at Wake Forest University and to understand their evolving goals and professional aspirations. Our goals with such a survey were to: (1) gain insights into students' areas of engineering interest, (2) gain insights into summer work experiences (i.e. internships, research, service experiences), (3) identify ways that the program can meet students' professional goals. All these goals towards making informed decisions about curriculum, advising, hiring, and even facility buildout. As an example, results from the first two years of the survey revealed that students were interested in: (a) biomedical engineering applications (about 30%), (b) environmental and civil engineering applications (about 15%), (c) computer and electrical engineering (including computer science) applications (about 15%), (d) mechanical and materials applications (about 15%), and (e) the remainder having interests across other engineering applications (e.g. systems engineering, aerospace engineering, neuroengineering, chemical engineering, etc.). This kind of information informed (a) curricular decisions around course offerings and course modules, (b) hiring decisions to diversify the engineering faculty body across diverse disciplinary applications, (c) advising documents to support diverse interests and pathways of students, etc.

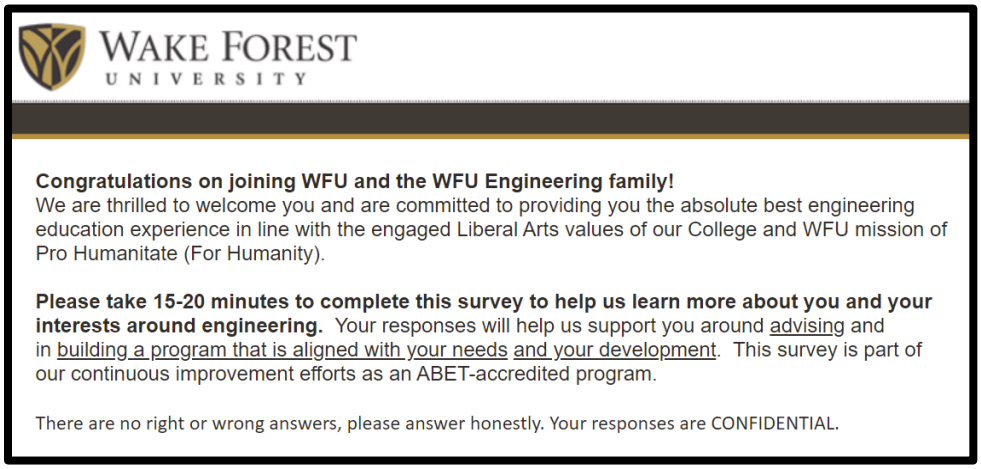


Figure 5: Instructions to the WFU Engineering Entrance Survey for incoming first year students.

Findings from the entrance survey also revealed to us that some students had clear plans around professional aspirations post-graduation but many also were trying to still figure out how they would use their WFU engineering degree. Figure 5 shows aggregate results pointing to WFU engineering students having diverse post-graduation aspirations and interests, as well as many of them still working to figure out those aspirations. Such insights meant that career advising and guidance needed to be a part of our students' WFU Engineering journey and that we had a responsibility to try to help them.

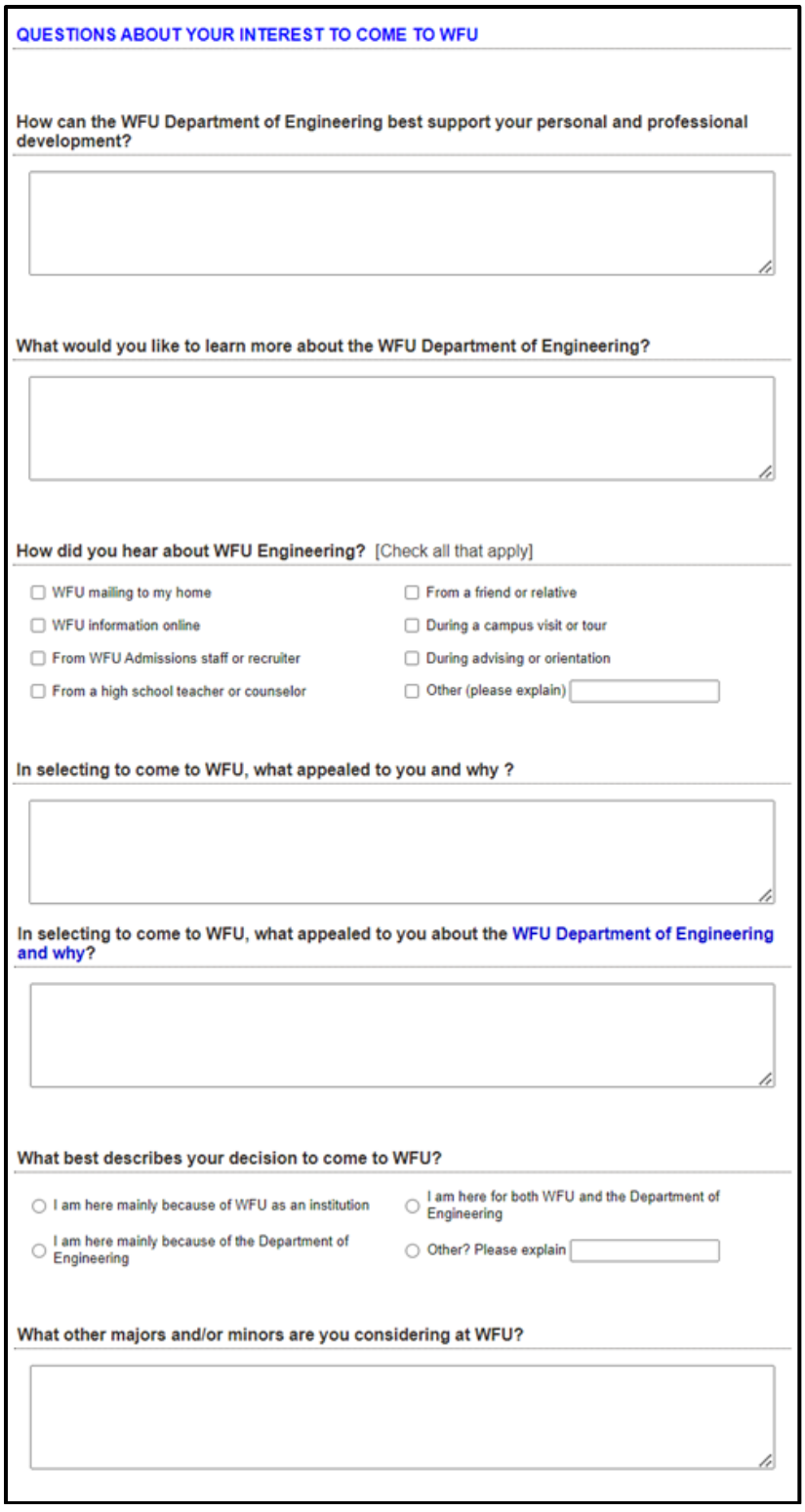


Figure 6: Entrance Survey questions targeted at understanding incoming WFU Engineering student needs and interests.

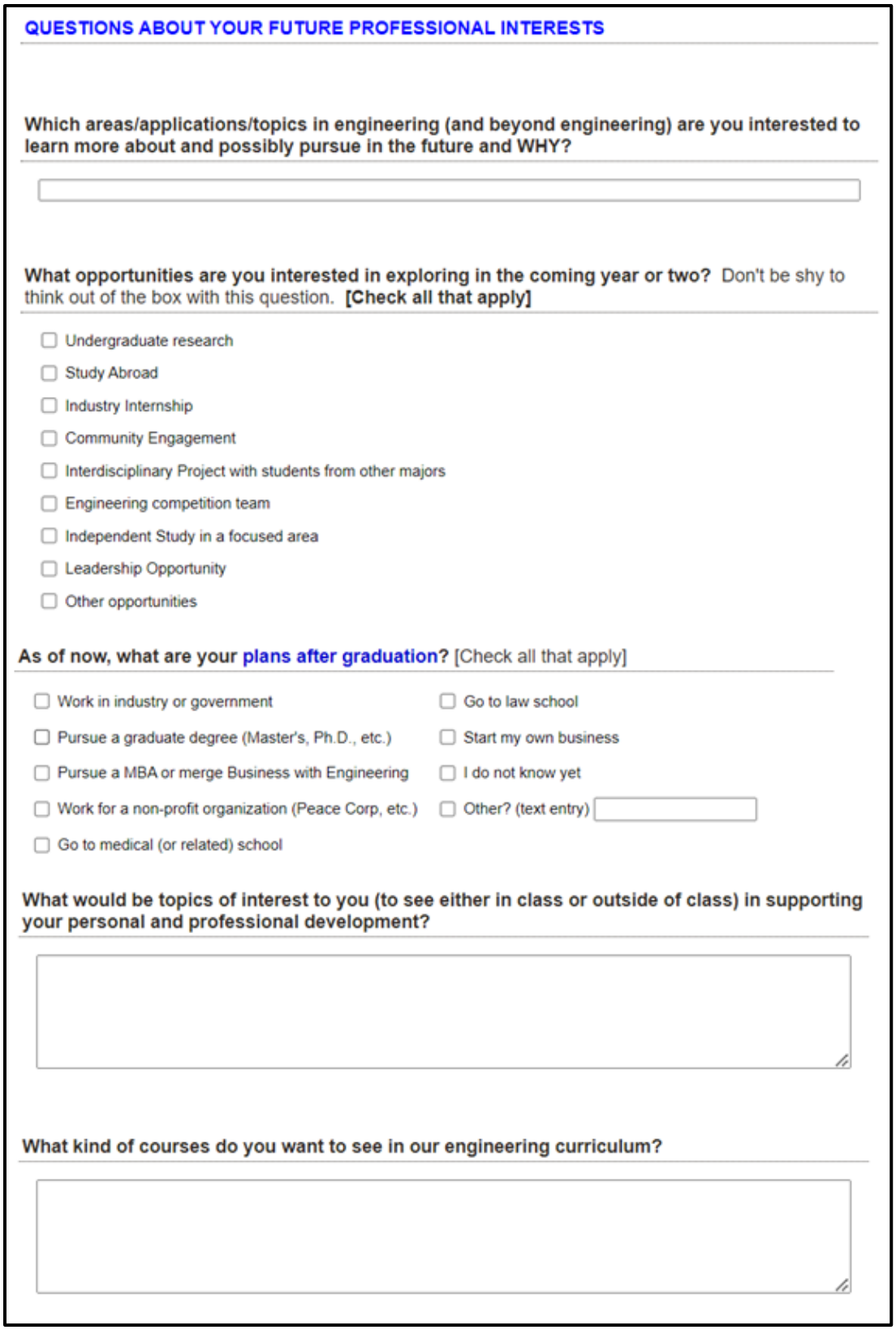


Figure 7: Entrance Survey questions targeted at understanding incoming WFU Engineering students' professional aspirations.

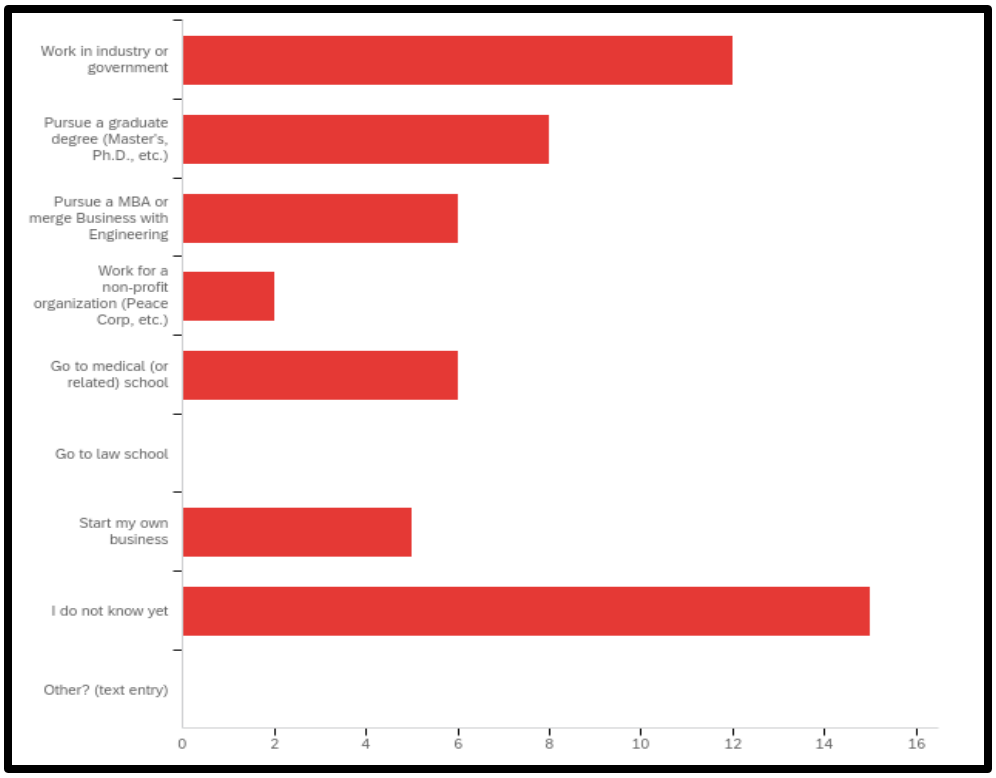


Figure 8: Entrance Survey student responses from the question "As of now, what are your plans after graduation?" The x-axis is the number of students.

B. First Year Curricular Assignments to Support Academic and Career Advising

What was learned from the Entrance Survey even in the inaugural year started to immediately inform curricular and advising practices. As pointed out previously, intentionality around building connections between academic and career advising were made within the curriculum.

Starting with the inaugural year (2017-2018), several assignments were designed and embedded within both of the first-year Engineering courses (EGR 111 and EGR 112) to support both academic advising and career advising. In EGR 111 during fall 2017, Pierrakos embedded a personal statement assignment and an Individual Development Plan (IDP) assignment to support personal and professional growth. Within, this IDP assignment, EGR 111 students reflected on their personal and professional values in the context of also laying out a personal plan to support personal and professional goals. The IDP assignment enabled academic development planning during their undergraduate years by inviting students to create a 4-year curricular map, interview both an engineering professor and a working engineering professional, and developing a plan of action towards professional aspirations and goals. The IDP assignment continued to evolve and be improved by EGR 111 instructors (i.e. Kenny and Luthy). In EGR 112, students focused more on professional development by creating a LinkedIn profile, updating their resume, writing a cover letter, and ultimately applying for an internship. OPCD staff were invited to support the EGR 112 assignments. The following figures showcase excerpts from the IDP assignment and the 4-year curricular mapping spreadsheet. Prior publications describe more details about the IDP, 4-year curricular mapping, and EGR 111 (Kenny, 2024; Kenny, Pierrakos, O'Connell, 2021).

Individual Development Plan (IDP) Assignment

Overview - An individual development plan (IDP) is a tool to assist you in personal and professional development. Its primary purpose is to help you reach short-term and long-term career goals, as well as improve current performance. It is a process that should be iterative and a process for you to consult with mentors (e.g. peer mentors, parents, friends, faculty, professional mentors, personal mentors, etc.). The more you invest in this process early, the more the rewards will pay off. Most students either never complete an IDP during their tenure as students or they tackle an IDP as seniors as a means to find a job after graduation. For us at WFU Engineering, we are committed to your personal and professional growth from semester one!

Goal(s)/objective(s)

(1) Understand the value and purpose of an independent development plan for personal and professional growth.
(2) Reflect deeply on personal and professional short-term and long-term goals accompanied by action items and evidence of achievement.
(3) Conduct a gap analysis to understand your current and desired states as a person, as a student, and as a professional.
(4) Take part in a self and professional exploration of thinking about the role of engineering in your journey.

Individual Development Plan (Template)

(1) **My Current State** - Who am I now? What are my passions and interests?

a. As a Person – My Current State

A description of who you are now as a person accompanied by your personal passions and interests.
Think about the values and beliefs you hold as a person and why these values and beliefs define you.
Think about your story, your family, your history, your community, your experiences which make you unique.
Think about your strengths as a person and the opportunities that you see for growth.

b. As a Student - My Current State

A description of who you are now as a student accompanied by your academic passions and interests.
Think about the curricular and extracurricular aspects of your journey as a student and how such experiences define you.
Think about your strengths as a student and the opportunities that you see for academic and intellectual growth.

c. As a Professional – My Current State

A description of who you are now as a professional accompanied by your career passions and interests.
Think about the professional and career passions and interests that you have as of now. Many of you are exploring these professional/career facets now, so describe this exploration and what you are doing to help yourself determine those authentic passions and interests. Describe the reasons and motivations for these professional/career interests.

Include a **current resume** here as an artifact of who you are as a professional! Use the resources shared by OPCD.

(2) **My Desired State** – Who am I in the future? Who do I want to be? What hopes and dreams do I have for the future? Why do I want to achieve that?

a. As a Person – My Desired State

A description of who you desire to be in the future as a person accompanied by your personal hopes and dreams.

b. As a Student – My Desired State

A description of who you desire to be in the future as a student accompanied by your academic hopes and dreams.

c. As a Professional – My Desired State

A description of who you desire to be in the future as a professional accompanied by your career hopes and dreams.

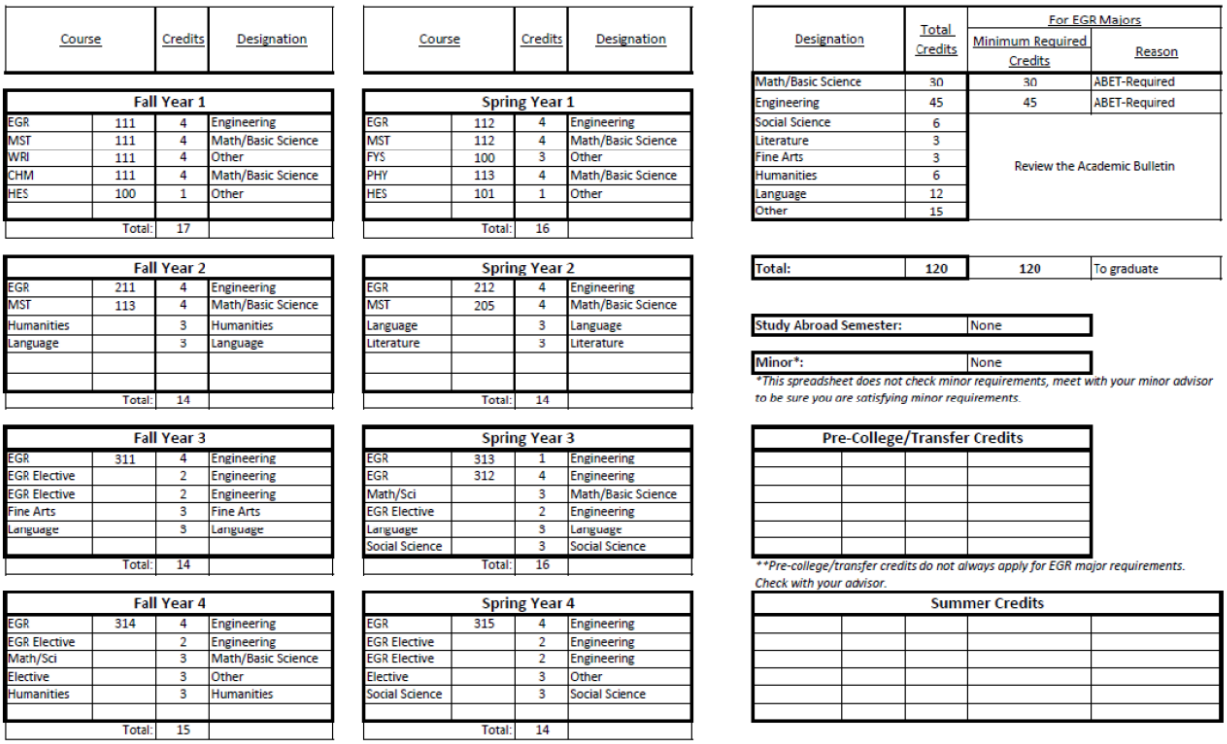
Include what you hope to add to your resume in order to achieve your future hopes and dreams.

(3) **My Plan of Action** – What are my goals and strategies to achieve my desired state? What is the timeframe? How will I evaluate my goals and strategies? How often will I iterate on this plan?

At a minimum, identify goals and strategies related to (a) a 4-year curricular plan (see Table 1 as an example format), (b) goals for internship, research, or other work/project experiences, (c) extra-curricular goals like clubs or volunteer organizations and leadership opportunities, (d) skills that you would like to develop, (e) personal growth opportunities.

Goal or Strategy	Areas of Growth	Purpose	Priority	Timeframe	Relevant Activities OR Action Items	Evidence of Accomplishment
Develop a 4 year curricular plan to complete my degree	As a person As a student	Ensure that I have meet all degree requirements	High	January 2018	(1) Understand all divisional and general education requirements (2) Make an informed and intentional decision on which general education courses to take and why you selected them (3) Consult with my lower division advisor twice per semester (4) Consult with an EGR faculty twice per semester	See below
Participate in a Study Abroad experience	As a person As a student	Personal and professional growth	High	January 2018		
Get an internship	As a person As a student As a professional	Gain non-academic and practical engineering experience	High	Summer 2018	(1) Prepare resume (2) Search via LinkedIn in a specific location (3) Prepare cover letter (4) Attend Career Fair (5) Do a Mock Interview with OPCD	(1) Professional artifacts (resume, cover letters, etc.) (2) Job offer
Read news articles twice per week	As a person As a professional	Stay informed about current events and seek new opportunities	Medium	Continuous	(1) Identify news sources (2) Set up news feeds or digests (3) Set calendar reminders	

Figure 9: Wake Forest Engineering Independent Development Plan (IDP) assignment excerpts.



Course	Credits	Designation

Fall Year 1			
EGR	111	4	Engineering
MST	111	4	Math/Basic Science
WRI	111	4	Other
CHM	111	4	Math/Basic Science
HES	100	1	Other
	Total:	17	

Fall Year 2			
EGR	211	4	Engineering
MST	113	4	Math/Basic Science
Humanities		3	Humanities
Language		3	Language
	Total:	14	

Fall Year 3			
EGR	311	4	Engineering
EGR Elective		2	Engineering
EGR Elective		2	Engineering
Fine Arts		3	Fine Arts
Language		3	Language
	Total:	14	

Fall Year 4			
EGR	314	4	Engineering
EGR Elective		2	Engineering
Math/Sci		3	Math/Basic Science
Elective		3	Other
Humanities		3	Humanities
	Total:	15	

Course	Credits	Designation

Spring Year 1			
EGR	112	4	Engineering
MST	112	4	Math/Basic Science
FYS	100	3	Other
PHY	113	4	Math/Basic Science
HES	101	1	Other
	Total:	16	

Spring Year 2			
EGR	212	4	Engineering
MST	205	4	Math/Basic Science
Language		3	Language
Literature		3	Literature
	Total:	14	

Spring Year 3			
EGR	313	1	Engineering
EGR	312	4	Engineering
Math/Sci		3	Math/Basic Science
EGR Elective		2	Engineering
Language		3	Language
Social Science		3	Social Science
	Total:	16	

Spring Year 4			
EGR	315	4	Engineering
EGR Elective		2	Engineering
EGR Elective		2	Engineering
Elective		3	Other
Social Science		3	Social Science
	Total:	14	

Designation	Total Credits	For EGR Majors: Minimum Required Credits	For EGR Majors: Reason
Math/Basic Science	30	30	ABET-Required
Engineering	45	45	ABET-Required
Social Science	6	Review the Academic Bulletin	
Literature	3		
Fine Arts	3		
Humanities	6		
Language	12		
Other	15		
Total:	120	120	To graduate

Study Abroad Semester:	None
Minor*:	None

*This spreadsheet does not check minor requirements, meet with your minor advisor to be sure you are satisfying minor requirements.

Pre-College/Transfer Credits			

**Pre-college/transfer credits do not always apply for EGR major requirements. Check with your advisor.

Summer Credits				

Figure 10: Four-year curricular mapping spreadsheet template created by Dr. Melissa Kenny to support academic planning and advising as part of the EGR 111 IDP assignment.

C. Major Declaration Questionnaire to Support More Specialized Advising and Mentoring

Considering that engineering students join Wake Forest University with diverse interests within and beyond engineering, we knew that we would need to keep our pulse on their interests annually. We described previously the use of Entrance Surveys to guide us with curricular, hiring, and advising planning, guidance, and decisions. With a similar intent and purpose, we instituted a practice that was distinct in the WFU College and essential in the continued planning and decisions in building WFU Engineering – Major Declaration Questionnaires. At Wake Forest University, undergraduates formally declare their major upon completing 40 credit hours towards their degree. While engineering undergraduates informally begin taking engineering coursework during year one, the majority declare their engineering major in the spring semester of their sophomore year, with some able to declare in the fall semester of their sophomore year due to AP/IB credits. In order to declare, students must have completed or be currently enrolled in either EGR 111 or EGR 112 and they must complete the WFU Engineering Major Declaration Questionnaire (Figure 8). Although this questionnaire was originally an editable PDF format, it is now administered as a Qualtrics survey questionnaire. The WFU Engineering Major Declaration Questionnaire guides students and us. Having completed first year engineering courses and some sophomore engineering courses, students' understanding of engineering has evolved and they are able to make more informed decisions about their next two years of academic life and hopefully more informed decisions about professional goals and aspirations. The WFU Engineering Major Declaration Questionnaire guides the department too (Chair, faculty, and staff). The insights gained from the WFU Engineering Major Declaration

Questionnaire enabled the Chair and Engineering Academic Advisor make informed assignments of faculty advisor in the major (aka Major Academic Advisor MAA), support planning for future course offerings informed by student interest, and continued departmental planning with hiring, curriculum development, and advising. The student responses to the WFU Engineering Major Declaration Questionnaire also guided and informed one-on-one meetings with Major Academic Advisors (i.e. engineering faculty advisors). Knowing the academic experiences that an engineering declared student was interested in guided us to develop supporting advising documents (e.g. study abroad procedural and approval documents), institute new co-curricular initiatives (e.g. matching engineering students with research experiences), continuously improve the curriculum (e.g. offer engineering concentrations, add new course offerings informed by identified areas of student interest), improve career advising resources and practices (e.g. offer graduate school panels, career fairs, internship forums), and inform future hiring decisions. All in all, there are so many benefits we gained by sourcing once again student insights during a critical point in their academic journey – students formally declaring engineering as their major of choice.

The WFU Engineering Major Declaration Questionnaire also enabled us to understand other academic interests of our engineering students beyond engineering. We discovered via this questionnaire second majors and minors that our students were interested in pursuing. During one-on-one meetings with their Engineering MAA, students would update and share their updated 4-year curricular map (Figure 7) to confirm that second majors and minors could be completed and all requirements could be met. Knowing these trends and interests enabled the Founding Wake Engineering Chair (Pierrakos) to assign engineering faculty to particular majors and minors so as to lay out templated and diverse pathways to connect the BS Engineering degree with other academic interests. Pierrakos could also strategically partner with other department chairs and program directors to find points of curricular alignment and synergies. Such strategies in time revealed that WFU Engineering graduates were pursuing second majors and minors. In fact, ***annually, starting with the inaugural cohort, 50% to 75% of graduates pursued minors or a second major beyond engineering.*** Second majors our engineering students have pursued include the following (in no particular order): (1) Biology, (2) Politics and International Affairs, (3) Computer Science, (4) Studio Art, (5) Music, (6) Japanese Language and Culture, (7) Physics, and (8) Economics. The most popular second majors for our engineering students are Physics and Economics. Minors our engineering students have pursued include (in no particular order nor degree of frequency): (1) Spanish, (2) Mathematics, (3) Economics, (4) Biology, (5) Russian, (6) Computer Science, (7) Chemistry, (8) Environmental Science, (9) Chinese Language & Culture, (10) Art History, (11) Statistics, (12) German, (13) Writing, (14) Psychology, (15) Entrepreneurship, (16) Theatre, (17) Anthropology, (18) Bioethics, Humanities and Medicine, (19) Latin-American and Latino Studies, (20) Global Trade and Commerce Studies, (21) Japanese Language and Culture, (22) Studio Art, (23) Art History, (24) Film and Media Studies, (25) Sociology, and (26) Dance. The most popular minors with our engineering students are Mathematics and Computer Science. This level of academic diversity bridging the BS Engineering degree with such a diverse set of minors and second majors speaks the authentic integration of Engineering with the humanities, the arts, social sciences, etc. This is liberal arts engineering education and a new model for rethinking engineering education due to the intentionality around academic and career advising practices.

D. Annual Start-of-Year Surveys for Continuing Students

Even beyond Entrance Surveys (administered to incoming students) and Major Declaration Questionnaires (administered to sophomore students), we also continued to administer annual surveys and questionnaires to third year students and rising seniors. While some questions remained the same as those in the Entrance Survey, we also used these continuing student surveys to request feedback on advising practices and curricular matters. We witnessed just-in-time students' interests change and evolve in ways that allowed us to innovate and rethink engineering education. Student responses informed not only curricular decisions but informed academic and career advising as students entered junior and senior years.

E. One-on-One Mentoring with Engineering Faculty

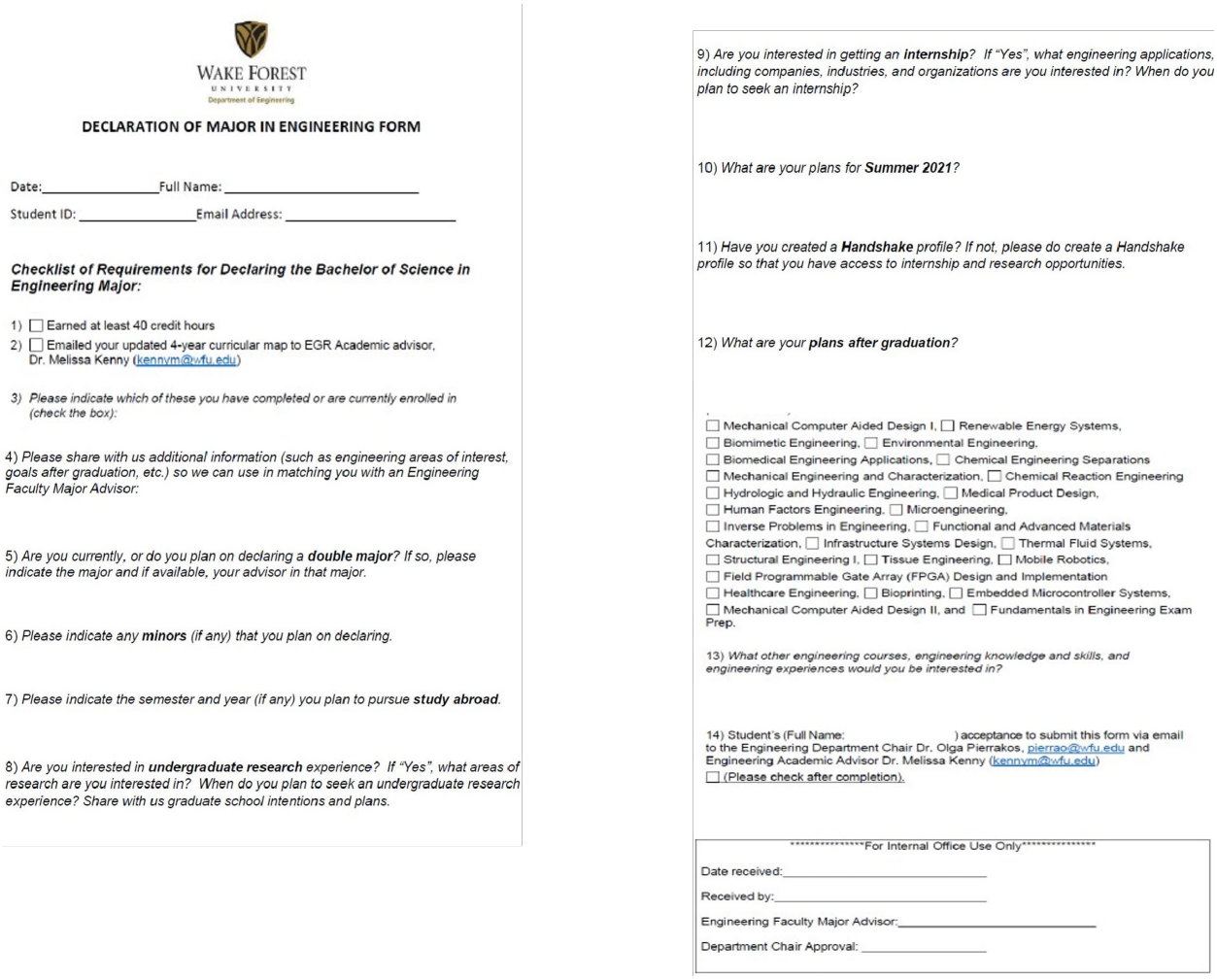
As pointed out previously, engineering students were assigned an Engineering MAA upon declaring the Engineering major during the sophomore year. At least once per semester, engineering students were and are required to meet with their Engineering MAA for academic planning (e.g. course registration for the following semester, updating and reviewing the 4-year curricular map) and career planning (e.g. summer experience planning such as internships or undergraduate research, post graduation discussions and planning, etc.).

Semester-by-semester coaching topics were provided to engineering faculty and included guiding questions to ask advisees about updated career goals and learning experiences they wanted to leverage. MAAs encouraged advisees to take part in high impact learning experiences such as internships, undergraduate research, study abroad, community service, etc. The MAAs would help students ensure that high impact learning experiences beyond the engineering classroom could still fit in their 4-year curricular map (Figure 7) and that time to graduation would remain on track.

F. Upper Curricular Assignments to Support Academic and Career Advising

Curricular assignments to support academic and career advising continued into the junior and senior years as students were continuing to refine the professional journey they wanted to pursue. We discovered that the areas of engineering applications continued to evolve from one year to the next and informed by the diverse engineering curriculum they engaged with. Whereas about 60% of the WFU Engineering curriculum represented common fundamentals that cut across engineering applications (and disciplines), 40% of the engineering curriculum can be customized to meet students' engineering interests and applications (Pierrakos 2023). We strived to enable each engineering student to take ownership of their engineering journey and take engineering elective courses that varied from mechanical engineering to biomedical engineering to electrical engineering to materials engineering to environmental engineering to civil engineering and so on. Some of the additional curricular assignments that were part of Wake Forest Engineering curriculum were designed to support both career advising and academic advising: (1) ***Self-Discovery assignments*** – aimed to guide students through a series of reflections to map self-interests and self-passions to professional practice and experiences that enabled self-flourishing. (2) ***Journey Mapping assignments*** – aimed at guide students to develop 3 to 5 different journeys that would be of interest post-graduation so as to imagine oneself through various professional

paths. (3) ***Capstone career readiness assignments*** – aimed to guide seniors during capstone through a list of career readiness activities that they would select in support of professional development and career development. Activities included interviewing an engineering working in an job of interest, seeking out a certification relevant to one's career interest, seeking out professional development opportunities online or through a professional engineering society, joining a professional engineering society and attending a local meeting of practicing engineers, etc. All in all, such assignments enabled students to reflect and determine their purpose as professionals. Sometimes these activities opened students' minds in considering new academic courses and educational opportunities while in college, while other activities positioned them to imagine career journeys and opportunities they could seek out as students to better understand future work environments, position types, and work environments. Lifelong learning strategies to help students think out of the box about their own journeys and professional careers.



WAKE FOREST UNIVERSITY
Department of Engineering

DECLARATION OF MAJOR IN ENGINEERING FORM

Date:_____Full Name: _____

Student ID: _____Email Address: _____

Checklist of Requirements for Declaring the Bachelor of Science in Engineering Major:

1) ☐ Earned at least 40 credit hours
2) ☐ Emailed your updated 4-year curricular map to EGR Academic advisor, Dr. Melissa Kenny (kennym@wfu.edu)

3) *Please indicate which of these you have completed or are currently enrolled in (check the box):*

4) *Please share with us additional information (such as engineering areas of interest, goals after graduation, etc.) so we can use in matching you with an Engineering Faculty Major Advisor:*

5) *Are you currently, or do you plan on declaring a* ***double major****? If so, please indicate the major and if available, your advisor in that major.*

6) *Please indicate any* ***minors*** *(if any) that you plan on declaring.*

7) *Please indicate the semester and year (if any) you plan to pursue* ***study abroad****.*

8) *Are you interested in* ***undergraduate research*** *experience? If "Yes", what areas of research are you interested in? When do you plan to seek an undergraduate research experience? Share with us graduate school intentions and plans.*

9) *Are you interested in getting an* ***internship****? If "Yes", what engineering applications, including companies, industries, and organizations are you interested in? When do you plan to seek an internship?*

10) *What are your plans for* ***Summer 2021****?*

11) *Have you created a* ***Handshake*** *profile? If not, please do create a Handshake profile so that you have access to internship and research opportunities.*

12) *What are your* ***plans after graduation****?*

☐ Mechanical Computer Aided Design I, ☐ Renewable Energy Systems,
☐ Biomimetic Engineering, ☐ Environmental Engineering,
☐ Biomedical Engineering Applications, ☐ Chemical Engineering Separations
☐ Mechanical Engineering and Characterization, ☐ Chemical Reaction Engineering
☐ Hydrologic and Hydraulic Engineering, ☐ Medical Product Design,
☐ Human Factors Engineering, ☐ Microengineering,
☐ Inverse Problems in Engineering, ☐ Functional and Advanced Materials Characterization, ☐ Infrastructure Systems Design, ☐ Thermal Fluid Systems,
☐ Structural Engineering I, ☐ Tissue Engineering, ☐ Mobile Robotics,
☐ Field Programmable Gate Array (FPGA) Design and Implementation
☐ Healthcare Engineering, ☐ Bioprinting, ☐ Embedded Microcontroller Systems,
☐ Mechanical Computer Aided Design II, and ☐ Fundamentals in Engineering Exam Prep.

13) *What other engineering courses, engineering knowledge and skills, and engineering experiences would you be interested in?*

14) Student's (Full Name:) acceptance to submit this form via email to the Engineering Department Chair Dr. Olga Pierrakos, pierrao@wfu.edu and Engineering Academic Advisor Dr. Melissa Kenny (kennym@wfu.edu)
☐ (Please check after completion).

**********For Internal Office Use Only**********

Date received:_____

Received by:_____

Engineering Faculty Major Advisor:_____

Department Chair Approval: _____

Figure 11: WFU Engineering Major Declaration Questionnaire.

G. Extra-Curricular and Co-Curricular Career and Academic Advising Opportunities

As was revealed from student responses in entrance surveys and major declaration questionnaires, we knew that students were interested in leveraging co-curricular and extra-curricular experiences to benefit their academic journey and to inform their career trajectory. Our students were not only interested in study abroad (as mentioned earlier in the paper), but were also interested in undergraduate research, internships, community engagement, and leadership development. While we leveraged existing institutional resources, we also innovated to support these high impact experiences for our students. Engineering faculty build partnerships within the community and Founding Chair (Pierrakos) was strategic in recruiting research labs across the campus and inviting a new Assistant Professor (Kyana Young) to develop processes to match engineering students interested in research with a diversity of research labs across campus. This initiative ultimately led to 50% of graduates having participated in undergraduate research when national norms are around 5-10%. Starting in their first year, engineering students were invited to select from a list of available research projects and connect with research faculty (in Engineering and beyond) to advance their knowledge and undergraduate experience via research.

In collaboration with the Office of Personal and Career Development (OPCD) at Wake Forest University, WFU Engineering faculty worked to support career planning and advising opportunities for engineering students. This included engineering-targeted graduate school panels, internship forums, mini career fairs, alumni panels, etc. WFU Engineering also hosted Alumni presentations starting fall 2022 as well. All in all, curricular and extra-curricular career focused opportunities were made possible by engaging with external engineering professionals.

H. Senior Exit Surveys and Alumni Surveys

As a final opportunity for WFU Engineering to source insights from soon-to-be graduates, a senior exit survey was designed and administered in the senior capstone course spring senior year. This survey co-developed by Pierrakos and Koehler (ABET Fellow at the time) was intended to capture students' insights across program educational objectives, student learning outcomes, general feedback about curricular experiences and capstone design, general feedback about co-curricular experiences, general feedback about academic and career advising, etc. Most insightful to us were the student responses to open-ended questions. Senior exit survey results would be shared with the Wake Forest Engineering faculty and staff to identify areas of continuous improvement.

I. Formation of the Engineering Student Advisory Council (SAC)

Within a few years of launching WFU Engineering, Founding Chair (Pierrakos) established a WFU Engineering Student Advisory Council (SAC) to be comprised of at least three students from each academic level and to collectively represent a breadth of diversity of career interests within and beyond engineering and to also represent diversity across gender, race, ethnicity, and areas of engineering concentration. This commitment would be in line with the Program Educational Objectives (PEOs) mentioned previously. Meetings between members of the SAC and the Founding Chair (Pierrakos), ABET Fellow (Jessica Koehler), members of the faculty/staff team (as appropriate to the topics of discussion) would take place 3-4 times per

semester. These meetings with the students served to make visible what was working well and what could be improved across all aspects of the engineering student experience. The anonymized feedback by the SAC was shared with the full engineering faculty/staff body to enable committees and working groups to support the work of the program for the betterment of our students. A sample of SAC feedback focused on career advising is made visible below (**Figure 12**). As one of the newest department's on campus and the only externally-accredited professional degree within a College of 30 departments and 26 programs, many of these students' insights are of no surprise. The opportunities to enhance career advising were many and the students were asking for it.

During these SAC meetings, students would also provide insights and feedback on the engineering curriculum, the general education portion of their degree, academic advising, capstone project experiences, etc. Students' insights truly enabled us to reimagine and rethink the WFU Engineering curriculum and advising practices. SAC members advocated for curricular changes that were discussed at faculty meetings and addressed with curricular decisions, provided feedback on pedagogical experiences that were effective and those that were not, offered specific examples and experiences to point to improvements with academic and career advising, and offered insights to who Engineering could and should partner with across campus and in the community to continue supporting the Education of the Whole Engineer. When appropriate, Founding Chair (Pierrakos) would consult with faculty one-on-one or with a committee chair one-on-one or with the full faculty/staff body to discuss important topics and move on some actions to continuously improve all aspects of the department.

SAC 2021-2022 Summary of Feedback Related to Career Advising

1. *Create a LinkedIn group of Engineering alumni and other alumni that are now in engineering professions.*
2. *Create a central resource/spreadsheet of alumni, the subfield of engineering, and their contact information.*
3. *Organize a virtual career fair (through OPCD).*
4. *Ask the External Advisory Council about how other Engineering schools/programs support career planning.*
5. *Create Zoom/video series of Engineering alumni about what jobs they are doing now and the path they took while at to get there.*
6. *In the Engineering Insider - organize job listings by engineering concentration.*

SAC 2020-2021 Summary of Feedback Related to Career Advising

Career Readiness/Advising/Networking – This was a rich topic of conversation that comes up in every SAC meeting. A number of ideas emerged:

1. *Engineering should have similar resources to the School of Business (SoB). A mini OPCD should exist at Wake Downtown like one exists in the SoB.*
2. *Engineering specific resources should exist on OPCD website.*
3. *Start earlier by assigning students formal career readiness assignments in EGR313 or even Fall junior year and weave into EGR312 in lieu of a few of the journal reflections. Some required and some optional assignments should be part of the core curriculum.*
4. *Build a networking spreadsheet database of alumni and other relevant contacts. Leverage LinkedIn and build out our Engineering network.*
5. *Students who have successfully networked and landed jobs are encouraged to document their process and provide mentorship to other students.*
6. *Create an Engineering group to connect students and alumni.*
7. *Offer a 1-credit career readiness course each semester for eng. students.*
8. *Create a spreadsheet or other resource showing which courses are needed depending on post-graduate plans (e.g. specific fields of graduate school, professional engineering, and other trajectories).*

Figure 12: WFU Engineering Student Advisory Council (SAC) feedback on career advising.

V. DISCUSSION

This paper highlights **theory-informed strategies of academic and career advising** to Educate the Whole Engineer and to support the **broad participation** of a diverse student body and retain a diverse student body. Wake Forest Engineering's model not only integrates multiple theoretical frameworks to support holistic student development, but it also builds connections between academic and career advising to support a holistic and innovative approach to student development. **Table 1** depicts a summary of the strategies mentioned in a manner that maps them to the theoretical frameworks. The strategies are developmentally sequenced, aligning with various theories about student growth and transition. The strategies deployed emphasize (1) individual development (cognitive, psychosocial), (2) environmental factors (support systems, resources), and (3) identity development (personal, professional). Three key themes are evident in this paper: (1) Theoretical Informed Integration to Develop and Deploy Advising Strategies, (2) Developmental Progression of Student-Centered Support, and (3) Integration of Assessment Strategies to Support Continuous Improvement. **Theoretical integration** enabled (a) multiple theories informing each strategy, (b) theories complementing each other, (c) development across domains, and (d) holistic student support. **Developmental progression** enabled (a) the first-year experience being an exploration, (b) the sophomore year being one where important decision-making took place, (c) the junior year being focused on refinement, and (d) the senior year being focused on supporting student to professional transitioning. Assessment integration enabled (a) regular feedback loops to capture the student experience, (b) multiple data points informing advising practices, (c) a culture of continuous improvement to support student-centered development, and (d) evidence-based decision making that led to outstanding outcomes for the students.

This paper also showcases the importance of building connections between academic and career advising. Curriculum planning with career preparation goals enables course selection aligned with career prerequisites, major/minor combinations that enhance employability, integration of experiential learning opportunities, and strategic planning of electives to build relevant skills. Skill development alignment enables academic projects developing workplace competencies, communication and critical thinking skills valued by employers, research and analytical abilities transferable to careers, and leadership development through academic activities. Timeline integration enables major exploration and career awareness (first year), specialization choices and internship preparation (second year), advanced coursework and professional experience (third year), and capstone projects and job search/graduate school preparation (fourth year). The benefits of academic and career advising integration positively impacts students and institutions. For students, benefits include clearer connection between studies and career goals, more efficient educational planning, better preparation for post-graduation transitions, and enhanced motivation through career contexts. For Institutions, the benefits include improved retention and graduation rates, stronger employment outcomes, more effective resource utilization, and enhanced student satisfaction.

This paper makes visible that the interdisciplinary Wake Forest University Bachelor of Science Engineering degree is ideally positioned and aligned to uniquely combine the exploratory nature of liberal arts education with the career focused nature of professional education (i.e. engineering education). The value of this paper is to showcase strategic and intentional strategies that supported the Education of a Whole Engineer on matters of academic and career advising. Key themes being (a) intentional connections being made across curriculum and advising (academic and career) that transcend the traditional and siloed models that exist at many universities, (b) intentional engagement with students in diverse ways to ensure the evolving interests and aspirations of students are being met, (c) strategic partnerships and collaborations with colleagues across campus (e.g. academic units, student affairs, support service offices, etc.). We believe that the strategies presented herein are applicable to established and new engineering programs. Our academic advising and career advising models were not only bridged within the curriculum and across co-curricular and extra-curricular experiences, but our model was developmental and customizable to meet student aspirations and goals. Certainly, the curriculum we build supported this agility, but the academic advising model and career advising model has to continue to be adapted to the experiences of our students. The strategies put in place and described in this paper point to the intentionality of holistic, integrated, and adaptive advising models to support the interests, needs, and aspirations of our students. Innovation is also evident in the strategies and this is reflective of not only the intentionality to understand our students but also the diversity of the faculty/staff team.

This entire experience of launching WFU Engineering was filled with both joy and challenge. Establishing effective academic advising models and career advising models was not an easy feet within an institution and college that is traditional and not easy to change. While wins were visible to many, a resistance to change was also visible to some. While many of the strategies described herein still remain, the hope is that theory-informed, student-centered practices should continue to guide and drive programmatic and institutional continuous improvement s.

As inspiration to the successes of the strategies described herein and deployed at Wake Forest Engineering, below are some facts about our inaugural Class of 2021 WFU Engineers that showcase the intentionality of academic and career advising towards Educating the Whole Engineer:

- About 50% of our inaugural graduates (Class of 2021) pursued a minor and/or second major (alongside the Bachelor of Science Engineering degree). This percentage was 75% for the Class of 2022.
- About 50% of our inaugural graduates (Class of 2021) participated in undergraduate research. This percentage has remained steady for all graduating classes.
- About 50% of our inaugural graduates (Class of 2021) participated in study abroad experiences. This percentage decreased for the Class of 2022 due to the pandemic and is rising again.
- About 70% of our inaugural graduates participated in internships. This percentage decreased for the Class of 2022 due to the pandemic and is back up at 70+%.

Table 1: Summary of mapping theory-informed practices at Wake Forest Engineering to support student identity, motivation, and career preparation. These strategies map to those discussed in the previous section. Not an exhaustive list but a solid representation.

Strategy	Identity Theory	Self Determination Theory	Social Cognitive Career Theory
Entrance Surveys for Incoming Students	- Students reflect on motivations and academic interests	- Messages autonomy towards degree completion in alignment with interests - Encourages exploration of options	- Students identify interests and career aspirations (if known) - Assesses support needs
First Year Curricular Assignments to Support Advising	- Personal statement reflection aids identity development - Values (personal and professional) assessments strengths identity (personal and professional)	- Supports development of competence - 4-year curricular mapping and planning develops autonomy - Interviews with practicing engineers builds relatedness	- Professional development action plan builds purpose - Career planning enhances decision making
Major Declaration Questionnaire to Support Mentoring and Advising	- Reflection enables decision-making capacity	- Identifies needed resources and support systems in place to guide program development	- Encourages evidence-based academic choice to support career goals
Start-of-Year Surveys for Continuing Students	- Tracks identity development - Monitors changing interests - Supports diverse pathways	- Supports autonomy towards academic interests - Encourages exploration of options - Identifies needed resources and support systems in place to guide program development	- Builds connections between internship experiences and interests with future career aspirations - Promotes reflection to identify academic experience and career goal links
One-on-one mentoring with engineering faculty each semester	- Supports holistic development to strengthen personal and professional identities - Provides specialized and structures guidance	- Builds relatedness through collaborative advisor/advisee relationship - Supports autonomy through choice - Enhances motivation and competence through guidance	- Builds connections between academic interests and career interests - Matching faculty/student career aspirations enhances self-efficacy towards career goals
Upper Curriculum Assignments to Support Advising	- Deepens self- discovery and self-knowledge - Supports and strengthens professional identity	- Promotes autonomy with building connections between academic and career planning.	- Strengthens career self-efficacy - Clarifies outcome expectations - Refines personal goals and professional aspirations

	- Supports authentic choices to support harmony being self and professional identity	- Promotes competence matching competencies to academic and career goals - Promotes relatedness by connecting university resources to advising	- Targets and addresses barriers to career goals - Enables self-regulation of career planning and resource alignment
Experiential Learning beyond Curriculum	- Creates rich environments for identity development - Supports engagement in learning that strengthens self-efficacy and belonging - Enables personal and professional identity development and reflection	- Promotes autonomy through choice of high impact co-curricular and extra-curricular learning experiences - Promotes competence through practical and concrete learning experiences to build knowledge, competencies, and skills - Promotes relatedness through social learning environments	- Enables opportunities to experience and reflect on academic and career connections and planning - Builds self-efficacy in bridging academic learning and professional practice - Supports reflection to determine informed professional aspirations for the future
Senior Exit Surveys & Alumni Surveys	- Enables an assessment of curricular and programmatic strengths and weaknesses to support identity development efforts for the future and represents an opportunity for continuous programmatic improvements	- Identifies effective resources and practices that supported or hindered autonomy, competence, and relatedness as opportunities for continuous programmatic improvements	- Assesses readiness post-graduation and can inform program improvements related to academic and career advising, as well as represents an opportunity for continuous institutional and programmatic improvements
Formation of Student Advisory Council	- Empowers the student voice and perspective through shared governance towards program improvement - Strengths leadership identity in students and promotes self-efficacy - Promotes broad representation of diverse student identities to support program improvements	- Invites autonomy to position diverse and lived student experiences as an opportunity to improve student experiences - Promotes competence by strengthening leadership development - Promotes relatedness through ambassadorship of student voices	- Enables an assessment of effective and non-effective career support practices and services - Invites outcomes to be assessed to support continuous improvements - Promotes self-efficacy in bringing leadership competencies towards future professional practice

We do not believe it to be a coincidence that 40-42% of our students and graduates are women nor that WFU Engineering became one of the most diverse academic programs on campus with 20-25% racial and ethnic minorities. After all, Admissions was expecting 15% women in the inaugural cohorts. Retention was high and our desire for student success was visible to the students from day one. We are so proud of these successes and believe that innovation in the curriculum, academic advising, career advising, hiring, co-curriculum, extra-curricular, strategic partnerships, departmental organization, culture, etc. played a critical role for our students to feel and know that they could thrive.

In regards to post-graduation plans, about 70% of graduates entered industry across diverse sectors of engineering and technical jobs (including infrastructure, energy, healthcare, manufacturing, data analytics), 20% entered graduate school across diverse programs (environmental engineering, biomedical engineering, data science, building and architectural engineering, etc.), and 10% advanced to other professional schools (medicine, law, and business). For the Class of 2021 and Class of 2022, the following table showcase some statistics.

Table 2: Wake Forest Engineering stats for the Class of 2021 (inaugural) and Class of 2022.

WFU Graduates Stats	Class of 2021 N = 43	Class of 2022 N = 45
% Pursued minor(s) and/or a second major	50%	75%
% Pursued internships	70%	60%
% Pursued undergraduate research	50%	50%
% Pursued study abroad	50%	10%
% Female Students	40%	44%
% Students of Color (ethnic/race)	26%	24%
Number of US states represented	18	15
Number of countries beyond the US	3	2
Post-Graduation Plans		
% Industry	70%	72% ¥
% Graduate School	20%	22%
% Business School	6%	15%*
% Law School	2%	2%
% Medical School	0%	2%
% Other (military, peace corps, etc.)	2%	2%
Average Salary	$75,000	TBD

¥ 15% of graduates going to industry accepted jobs bridging engineering and business (e.g. Business Technology Solutions Analyst at Deloitte, Technology Architecture Delivery Analyst at Accenture, Investment Banking Analyst at Morgan Stanley, Technology Analyst at Accenture, Quantitative Analytics at PNC Bank, etc.) * A number of students applied to MBA programs in Schools of Business on a deferred status.

VI. CONCLUSION

Higher education, including engineering education, faces increasing scrutiny. Criticisms range from exorbitant costs and outdated curricula to ineffective advising and unwelcoming learning environments. To address these challenges, transformative approaches are essential. The focus of this paper is on innovative and theory-informed strategies to integrate academic and career advising to **support the whole student** and **educate the whole engineer**. This papers serves as a case study to point to the ways that Wake Forest Engineering has implemented a comprehensive academic and career advising model that is grounded in theory and designed to support students' holistic development. By integrating multiple theoretical frameworks, the model addresses cognitive, psychosocial, and identity development. It emphasizes a developmental approach, aligning advising strategies with student growth stages. The model also fosters a strong connection between academic and career advising, ensuring that students' coursework aligns with their career goals. The integration of experiential learning opportunities, such as research, internships, and study abroad, further enriches the student experience. By prioritizing student-centered practices, including regular feedback loops and continuous improvement, Wake Forest Engineering aims to provide a supportive and transformative educational experience.

Wake Forest Engineering provides a compelling case study of how a student-centered approach can revolutionize higher education. By prioritizing student needs and aspirations, the program has fostered a dynamic and innovative learning experience. This paper delved into the strategies and tools employed to understand and respond to student interests from an academic advising and career advising perspective. Entrance surveys, annual questionnaires, and curricular assignments were used to gain insights into students' evolving goals. These insights informed not only curricular decisions but also personalized academic and career advising. By embracing a holistic approach, Wake Forest Engineering empowered students to pursue diverse academic and extracurricular opportunities. This includes minors, second majors, study abroad experiences, undergraduate research, and internships. The theoretical underpinnings of this student-centered approach included self-determination theory, identity theory, and social cognitive career theory. Additionally, the collaborative efforts between students, faculty, and academic advisors made this transformation possible. The implications of these strategies and tools extend beyond engineering programs, offering valuable lessons for higher education institutions seeking to improve student outcomes and address the challenges of the 21st century.

WFU Engineering was built on the mission to Educate the Whole Engineer with a vision towards human flourishing and bettering humanity. Having the opportunity to build a new engineering department from scratch with a founding team arriving on site just six weeks before the arrival of the inaugural engineering students, we knew we needed to leverage engineering education research and whole student development in the building of every aspect of WFU Engineering. We strived to be a leader in undergraduate education with motivations being innovation in the

curriculum, effective learning methods, an authentic liberal arts education educating the whole person, and featuring a project-based curriculum that emphasizes creative design and community partnerships. Our vision for our engineering students is to be (a) leaders and agents of change embodying the university motto of Pro Humanitate (for humanity), (b) active seekers and creators of knowledge, (c) empowered with the engineering fundamentals but also strengthened with the breadth of an exceptional liberal arts education, (d) adaptive experts that recognize the strengths and limits of his/her knowledge and her/his team, (e) innovators by embracing inclusion, diversity, and equity, and (f) fearless in the face of complex problems.

Our mission to Educate the Whole Engineer could not be achieved without an innovative curriculum and an innovative academic advising and career advising model. What this paper serves to showcase is the intentionality around academic advising, career advising, curriculum design, and departmental organization to support our students. For both academic and career advising, a developmental, holistic, and appreciative approach to supporting our students was undertaken. Leveraging psychological theories to understand student development, we developed, piloted, and instituted practices that truly transformed the experience of the students in ways that challenged the traditional practices and allowed innovation, inclusion, autonomy, connectedness, thriving, competence, and salience of one's professional identity.

The WFU Engineering model offers valuable insights for other institutions seeking to reform their advising practices and enhance student success. A holistic approach that integrates advising with the curriculum and leverages student feedback is crucial for preparing graduates for the evolving workforce. Institutions should consider incorporating theory-informed practices and strategies to promote student motivation and engagement in their advising approaches. We continue to advocate for deeper analysis of specific advising strategies and their impact on student outcomes. A deeper exploration of long-term benefits of WFU Engineering's advising model on alumni career trajectories is future work for us and is the scalability of the model for larger institutions and diverse student populations.

"I truly do not have the words to express my gratitude to both the program & faculty. Looking back on my journey at Wake Forest, I always planned to graduate, but I never expected to evolve into the person I am today. I end this chapter with tremendous thank for the things I've learned, but even more so for the people I've met, and who I've become."
– WFU Engineering Graduate (Class of 2022)

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