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# An Integrated Engineering Model for Advising

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# An Integrated Engineering Model for Advising


## Abstract

This evidence-based practice paper describes the theoretical foundations of the supportive advising practices used by the Integrated Engineering Department (IE) at Minnesota State University, Mankato. The driving motivation for the advising model is to support the development of student engineers as whole people. Generally in academia, faculty in traditional professor roles serve as formal advisors, mentors, facilitators, evaluators, and coaches and are joined by full-time staff that serve in roles to support student development. Integrated Engineers at Minnesota State University, Mankato are supported to become the engineer they want to be. This paper describes the unique model employed by IE of mentoring and advising that incorporates not just faculty but staff, industry mentors or facilitators, and peers that bring different perspectives to student support. Evidence of effectiveness includes high graduation rates, career placement rates of students, and student perceptions of preparation for meeting our program educational objectives. Perspectives from faculty new to the program and current and former students illustrate the personal impact of the model.


## Introduction

The Department of Integrated Engineering (IE) at Minnesota State University, Mankato houses upper-division project-based and co-op-based programs at two different off-campus locations. Student engineers in the programs are primarily transfer students from two-year colleges and spend at least two years in our programs to complete their BS in Engineering, thus creating a 2+2 learning experience. The curriculum includes technical knowledge required of engineers but equally emphasizes engineering design and complementary professional skills. In order to teach and develop professional skills, addressing the whole student is crucial. The department has a history of collectively learning about advising practices in order to support student engineers in their learning and in their academic and career decisions. IE is comprised of PhD-level, tenure-track faculty, program directors, technical and administrative support staff, and engineers who serve as “facilitators,” or learning coaches, who support students in their professional skill development, career pathway, and use of engineering design processes in industry-sponsored co-ops. There are about the same number of people serving in facilitator roles as faculty roles, which allows for strong relationships between students and people invested in their development and there are additional volunteers of project mentors (frequently long-time volunteers or program alums) who work with student project teams. Departmental interventions for faculty, staff, and facilitators have included workshops on appreciative advising, student mental health, and Title IX issues as well as regular program-level conversations to discuss supporting students who are struggling, whether academically, personally, or in their career pathway. This paper describes the unique model employed by IE of mentoring and advising that incorporates not just faculty but staff, industry mentors or facilitators, and peers that bring different perspectives to student support. Supporting theory is also presented. Evidence of effectiveness includes the graduation rate, the career placement rate of students, and student perceptions of preparation for meeting our program educational objectives.

## Theoretical Framework

Theoretical foundations for this model include the Whole Student Model [1] for student support on best practices for both advising and mentoring; Future Time Perspectives, or how students' perceptions of the future influence present decisions and behaviors; with support from contingent goal path theory and future possible selves to better understand the connections between the present and their future career goals; and Schlossberg's transition theory because our students are advised in their early transition into their careers. These theoretical foundations will be discussed in the next sections.

### *Whole Student Model*

In IE, everything is designed with the whole student in mind, which includes the "Trilogy of Student Success" as defined by Jolly et al. [1] as Engagement, Capacity, and Continuity. The focus on the whole student arises from understanding that improvements to simply improve standards, curriculum, and teaching practices are not going to be sufficient in recruiting, retaining, and developing a diverse population of engineers [1]. The Institute for Broadening Participation [2] emphasizes the need for intentional design in various aspects of education to help students participate and succeed in engineering. Within IE, the specific aspects we have focused on are to provide authentic science engagement, active learning, and culturally relevant pedagogy and science relevancy while encouraging resiliency and self-efficacy through modeling, mentoring, and providing an overall atypical campus and classroom culture [2]. The whole student model and Trilogy of Student Success are kept in mind while designing these aforementioned aspects.

Within the whole student model, engagement is what encourages or invites a student to learn about a given topic, yet there are many avenues of engaging that must be considered, such as behavioral engagement (i.e., involvement in classroom and extracurricular activities), emotional engagement (i.e., positive emotional reactions to situations, people, classes, etc.), cognitive engagement (i.e., dedication to learning difficult topics), or vocational engagement (i.e., positive views of field of study and potential future career) [1]. Belonging and engagement are associated with one another, working hand in hand to improve student retention by helping students feel interpersonally connected and supported by other students, faculty, and staff [3]. This comes by having available formal and informal interaction between all of these parties.

Capacity is the possession of the necessary skills and knowledge needed to succeed in a given field, as well as the recognition that continuous learning and improvement is necessary [1]. Within IE, curriculum is developed on the basis of a "three-legged stool" with the legs representing domains of learning being design, professional, and technical [4,5]. This allows for students to come out with a well-rounded capacity to succeed in all aspects of their career. This model of the three-legged stool acknowledges and embraces fully the breadth of student outcomes in ABET accreditation criteria [6] while also allowing students to gain skills in emotional intelligence [7], growth mindset [8], and lifelong learning [9].

Lastly, continuity is giving students the necessary resources that they can continually advance [1]. This means giving *every student* access to the courses, instructors, advising, material,

encouragement, support, etc. they need to succeed in their education and career, which includes activities both inside and outside the classroom [1].

*Future-Oriented Motivation*

Advising, by nature, is future oriented, and considering students' hopes and dreams for the future is critical for successful advising. These goals and beliefs about the future and how those perceptions connect to the future is an individual's Future Time Perspective (FTP) [10]. Research has demonstrated that undergraduate engineering students' choices and behaviors are dependent on their goals for the future and the students' goals are, in turn, dictated by the present decisions and experiences [11]. Experiences such as projects and co-ops can help students identify desired or avoided future possible careers [12]. To actively work towards these future possible careers, students take steps, or make sub-goals, to reach their distant future goal [13]; this path is known in the literature as a contingent goal path [14].

When visualizing these hopes and dreams of the future, students are creating their future possible selves [15]. When thinking specifically of who they want to become in their careers, undergraduate engineering students are considering their future possible careers (FPC) [12]. Students may think about who they can become (realistic FPC), who they want to become (ideal FPC), and who they do not want to become (avoided FPC) in terms of their careers [12, 15].

*Scholssberg's Transition Theory*

Since a core focus of the IE programs is to prepare students to transition to industry careers, the relevant part of Scholssberg's Transition Theory is the idea of "taking stock", which is made up of four domains: situation, support, self, and strategies [16]. From attachment style [17] to parental influence [18], there are a number of factors that can create stress and complicate a student's eventual transition from college to career. To ease the student's transition, it is important for advisors, in whatever formal capacity they have, to recognize these factors and provide appropriate support. Faculty and staff within IE work to get to know each student well enough to support them through choice of engineering focus (if desired), help them identify career aspirations, and partner with them each step of the way from full-time student to working engineer.

Research conducted by Goodwin et al. [19] examined whether coaching students on the Situation/Task, Actions, Result (STAR) format would improve students' abilities to communicate their skills to potential employers. The results indicated that students who were taught the STAR format were better able to communicate their skills, and that capability was independent of how far along a student was in college and whether or not they were in a cooperative education program [19]. It appeared that the 5 students who were taught the STAR format had higher levels of confidence as well, but this study did not explicitly study student confidence [19]. If the STAR format does indeed boost student confidence, this would also fall under the self domain of Schlossberg's Transition Theory [16] as well, as it would enhance self-efficacy. This transition theory strongly informs how students are coached and advised to prepare for industry actions in IE. Students generally enter the program with work experience from areas outside of engineering, and often find it challenging to identify how their skills translate to the

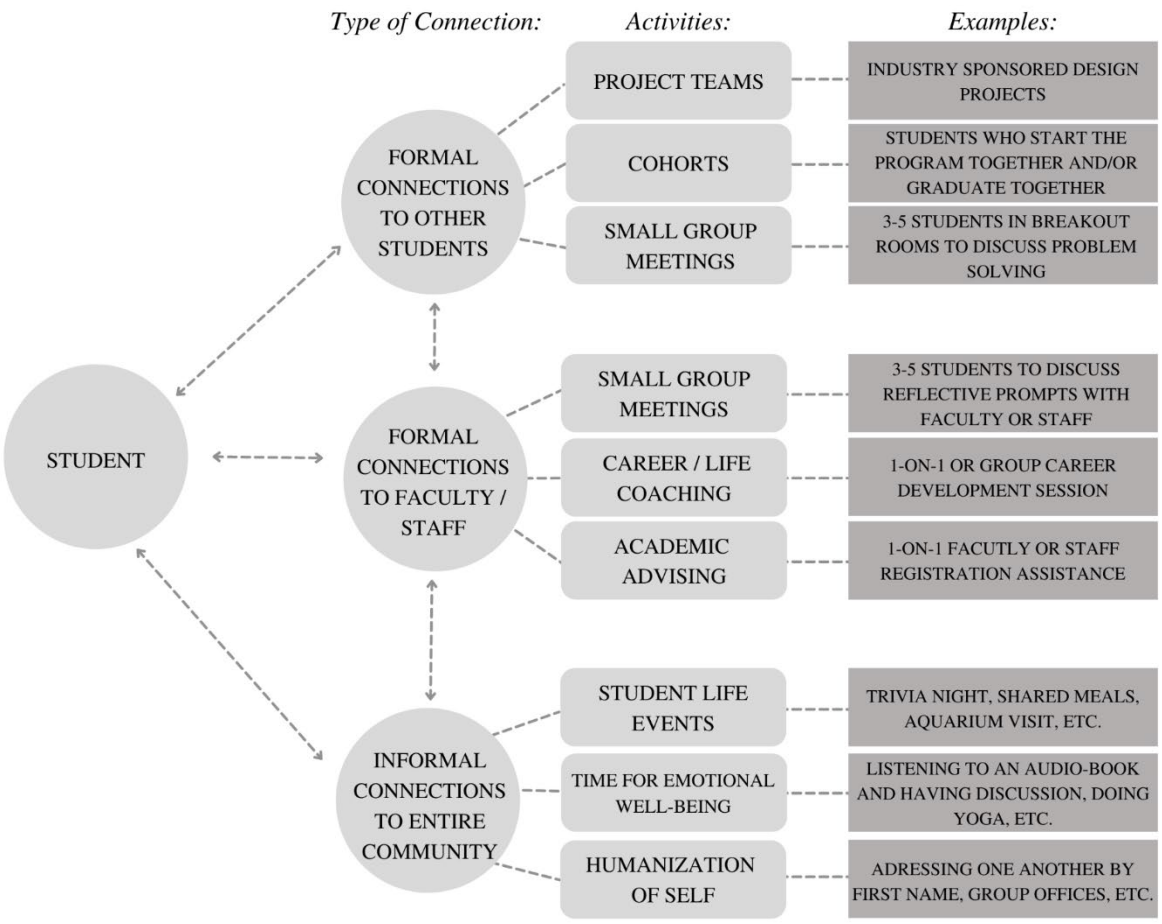


**Figure 1: Integrated Engineering Advising Model**

needs of an engineering employer. IE faculty and staff work with each student to identify transferable skills and craft a resume that captures these skills. Then, IE students are taught the STAR format and given multiple opportunities to practice this format in mock interview sessions with faculty, staff, and peers.

## Our Model

In IE, students are central to the advising model (Figure 1). This model includes the types of connections that the student establishes in each program. All the connections made are available throughout their tenure, allowing for accessible support and advising in all facets of their education. Students are connected in a breadth of formal and informal ways to other students, faculty, and staff. Staff in our department can include learning coaches and facilitators, within both academic and industrial realms. It is important to note that the faculty and staff are highly involved in facilitating the student's formal connections to other students as well as informal opportunities, thus allowing a fully integrated and bi-directional approach to advising. In the model (Figure 1), branching from those connections are sample activities that may happen between those connections. Simple examples of each activity are also given to further illustrate what these connections may look like, with two more unique, program realms explained in the

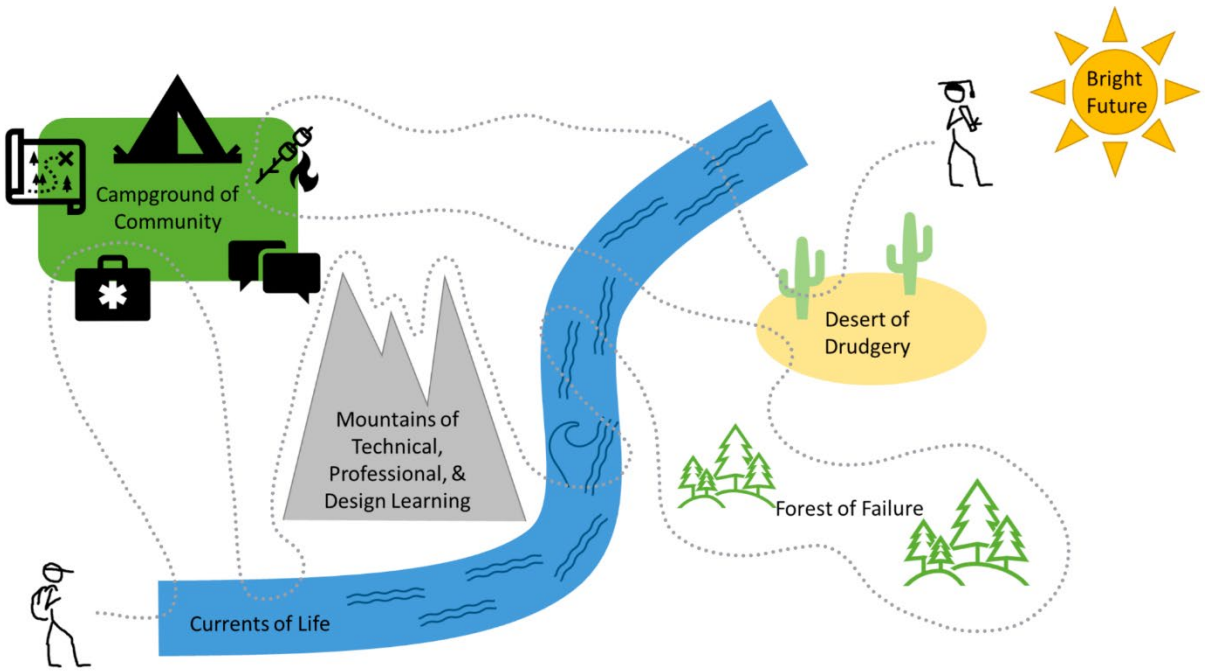


**Figure 2: Allegorical View of the IE Advising Model**

following paragraphs. The activities and examples are by no means fully representative of the extensive advising and mentoring that happens, but give a general overview.

For example, students are connected formally to students in the same academic year through "cohorts," or a group of students who started the program together. Cohorts attend weekly seminars with active learning and opportunities for interactions on professionalism topics. Students have formal opportunities for interacting across cohorts through project teams. The inter-cohort collaboration offers opportunities for professional and technical development in the context of working on industry projects.

The small group meetings referenced on Figure 1 are formal opportunities for students to connect with other students and with facilitators and are used in the co-op based program. Students meet in small groups of 3-5 students to discuss a variety of topics. All students in the department are regularly asked to complete reflective prompts; the small group discussion can be focused on those reflective prompts, such as "Why is it important to set goals?" Small group discussions may also focus around career development goals (e.g., updating and receiving feedback on resumes). Further descriptions of interventions for formal and informal advising are described in the "Implemented Practice" section.

*Implemented Practice*

Although the core tenants remain consistent, practical implementations of this advising model look different across the three programs within this department because of contextual variability. An allegorical picture of the student experience, with the student seen as a whole person facing choices and decisions, is shown in Figure 2. While students will inevitably face the mountains,

deserts, and forests, some with more frequency than others, they always have a campground of community to come back to for support. Within this “campground,” each program offers regular workshops connected to various aspects of the whole student engineer. Other formal supports include one-on-one advising and coaching as well as small group advising and coaching. Importantly, the student engineers in each program value the positive culture associated with their program and support one another in ways to sustain that culture. Additionally, staff and faculty in the different programs actively refer students to resources available locally when appropriate. Finally, the cultures place an emphasis on care taking through informal engagement. Despite key differences between the three programs in this study, the common advising model in the department effectively meets student engineers' needs where they are on their path.

Workshops provide students in our learning communities the tools to manage challenges that impact their performance as engineers. By engaging new student engineers in active workshops as part of an intentional onboarding process, we introduce them to many of the supports available. Each program also has workshops throughout the semester which connect to various professional aspects of engineering including but not limited to inclusivity, community connection, and work-life balance. For example, students attend a workshop titled “Acting Ethically.” Through framing the session with the example of the 2007 I-35W MN Bridge Collapse, students are able to use a “real-life” example of a local catastrophe to learn the principles of ethics. Group discussions are used when presenting ethics topics and case study breakout groups allow students to explore the ethical issues and present solutions. These strategies allow students to actively engage with the topic at hand. The timing and content of each workshop is carefully considered to maximize relevance by relating to the engineering experiences students are navigating. Importantly, workshop participants regularly deploy learned strategies as they move forward as engineers.

Staff and faculty also develop and maintain connections to small groups and individuals. Small group coaching sessions, whether driven by student request, cadenced check in, or observed floundering, work to address the specific needs of a smaller team. When necessary, students are given individual coaching to support their unique development. This coaching is distinct from, but related to, advising which connects to the academic needs of student engineers. Across many contexts, the staff and faculty of all three programs connect to the student, the engineer, and the whole person.

The programs are also designed to provide spaces for student engineers to support one another. Some of these connections are driven through engineering project teams. By ensuring teams cut across cohorts to include both juniors and seniors, the programs create a space for peer mentoring. Other groups, such as coaching groups, also cut across cohorts so multiple levels of perspective are represented (described in “Our Model”). At times, however, there is value in providing space for student engineers with similar experience levels such as onboarding orientation where new student engineers connect to a smaller group of others facing the same situation to ease some of the challenge. Together, these program features help establish a powerful culture of students supporting one another.

The care taking culture extends to less formal aspects of the programs. Student life events ranging from program-sponsored meals to student organization meetings regularly connect to

care taking. There is also a constant emphasis and awareness that time needs to be taken for self-care. For example, staff and faculty watch for people who might be struggling and check in with them about not only the area of struggle but also the underlying causes. The staff and faculty also recognize they may inadvertently intimidate students and work to humanize themselves by disclosing some of their vulnerabilities, failures, and struggles. By intentionally cultivating a caring culture these programs establish strong informal networks of student support.

Finally, the staff and faculty of these programs stay aware of available resources when the support they are able to provide is not sufficient. Such resources may connect to physical resources such as food or emotional resources such as mental health counseling. At times these resources may connect the main campus. At other times, these resources are associated with the local community. Regardless of the need, the extended campus programs must be positioned to effectively support students across multiple facets of their lives.

*Faculty and Staff Support*

The model of advising presented in this paper does call for faculty, staff, and facilitators to be highly integrated and informed, which can be demanding on top of other expectations. Because of this, IE makes an intentional effort to provide workshops and training on supporting students in advising, mental health, Title IX issues. Regular discussions are also held to support one another in how to best help struggling students, whether that be academic, personal, or career struggles. Regular meeting times give an opportunity for frequent check-ins on faculty, staff, and facilitator well-being with delegation and adjusting demands occurring as needed.

## Assessing the Experience

*First-Year Faculty Narrative*

The following is a narrative of the perception of a first-year faculty member who entered into the established program and became part of the implementation team.

*After being under a "traditional" model of education for 20 years (kindergarten to Ph.D.), the model employed by integrated engineering was really just something atypical for me to step into. I believe foundationally it is what most programs theoretically would like to do because we all want a strong network of mentors and advisors built into education who can support learning both in the classroom and in life. But, being able to break the status quo of engineering education norms isn't easy. It's understandable that things have largely remained the same, especially on a large, university scale. The fact that this department is taking the opportunity to make a change and put in the work is what ultimately drew me to become a faculty member here. The personal connection I have felt with my colleagues and students is unlike anything I've heard of existing in traditional academia.*

*It definitely takes getting used to, being so hands-on in every aspect of student growth. Where my professors or advisors during my undergraduate and graduate education may have been primarily involved just in my technical learning or just in my design learning, I need to focus on all legs of the three-legged stool for my students. Even though I am duty-bound as a professor to*

*make sure my students get their technical knowledge in my courses, I make sure they are also developing their design skills through things such as being a reviewer for their projects or their professional skills through having a conversation about fundamental fluid mechanics principles in verbal exams. It takes a lot of intention, empathy, and care. I can't simply just prepare a lecture, deliver it, and hope for the best. I actively serve as an advisor to students in deciding the best pathway in their education and beyond. I am evaluating their self-directed learning courses where they dive into topics they're passionate about. I may attend a student-life event where we visit a local historical site and have dinner together or I may lead a student-life event where I'm teaching students over Zoom how to make chocolate chip cookies. I provide workshops in time management, academic honesty, and email etiquette. I appear on a podcast and share insight about getting enough rest. The opportunities really are diverse and far from just focusing on technical education.*

*As far as I have found, the approach the department has truly is integrated. We are capitalizing on all members of the community's strengths and rely on one another to fill gaps that may arise when attempting to advise but also take care of ourselves. We don't get siloed into one area of expertise or one specific "correct" way to advise. It is adaptive and flexible, allowing for impromptu advising opportunities through every facet of our programs.*

This first-year faculty narrative highlights the draw of an integrated approach to advising and is perceived as a positive direction for the engineering community. This narrative also emphasizes the strain of shifting from an advising model experienced as an undergraduate and graduate student, focused on technical advising, to a focus on holistic advising model. Providing faculty and staff with training and support to approach advising, as described in the implementation section, is intentionally done to help with these shifts. The narrative also further describes examples of formal and informal student connections presented in Figure 1.

*Student Narratives*

The following narratives show student experiences with advising. Because of the 2+2 nature of our programs, the narratives illustrate differences in experiences between a traditional advising experience and the IE model. The students were asked to consider contributing a couple of paragraphs about their experiences. The prompts were that the paragraphs do not have to be perfect but should describe a bit of their experience:

> You may have received advising (or just advice) on many aspects of your experience. You may have received it from faculty, staff, mentors, clients or other students. What did you see that worked? What did you see that could be improved?

Student 1: *I spent my first two years on a traditional college campus before entering the integrated engineering program for my final two years. As a non-traditional student, going back to school was difficult and I made it a point to meet with most of my instructors during their office hours weekly, if possible. Occasionally the meetings revolved around concepts I did not understand, but most often I was seeking advice on how to be a better student in general. The topics were strictly student-related like note taking strategies and study habits. Because I was seeking advice early and often I was well received and had good conversations with the*

*instructors. That was not the case for all students, however. I would seek out quiet work spaces between classes, sometimes outside of faculty offices, and would overhear conversations with students. In some instances, the instructors would give harsh criticisms or ultimatums. The advice might help the student pass a class, but it was just as likely to destroy their confidence and cause them to withdraw from the program altogether. I experienced minimal support from other students while on campus. There were peers I was friendly with, but it was very much a competition and working together outside of small groups was nonexistent.*

*When I entered the Integrated Engineering program at Twin Cities Engineering for my final four semesters, I experienced a completely different environment. I got to know the professors on a personal level and felt comfortable talking to them about problems in my personal life as well as in the classroom. They were always supportive and willing to provide guidance whether it was an assignment or stressors outside of school. I witnessed students struggling to decide if project-based learning or engineering was the right path for them. Instructors would ask them guiding questions to help them discover what was best for their future without encouraging a specific direction. The student interactions were very different as well. The ideas and encouragement flowed throughout the entire student body, not just small groups. Study collaboration was the norm and students not currently taking a specific course would offer ideas and advice that had worked for them. Alumni still involved with the program by acting as project mentors would offer recommendations for job searching and learning skills applicable to industry.*

This narrative from Student 1 underscores the positive impacts of instructors supporting students as individuals. Additionally, the benefits of having a "campground of community" as illustrated in Figure 2 are apparent in this narrative. This student felt supported as a whole student, and they felt they were truly guided by their peers and faculty. Similar to the faculty perspective, this student saw a positive shift from "traditional" approaches to mentoring and advising to the IE model of mutual support and appreciation.

Student 2: *I have relied on so many sources of advising, council, support, and encouragement during my time in the Integrated Engineering program working towards my bachelor's degree. I could fill several pages droning on and on about each individual who has helped me get here and through this notoriously difficult and stressful time of life, but I'll focus more on the general types and sources of assistance. Aside from the teachers and staff at Twin Cities Engineering (TCE), the clients, mentors, and other students were of great help and impact to me. Additionally, my network of support extends beyond Minnesota State Mankato and my community college. Without these helping hands, shoulders to lean on, and creative brainstormers in my corner, I feel that I wouldn't have made it this far or have been successful in my classes at TCE.*

*Primarily, the teachers can develop strong emotional connections with each of their students because of the small size of the program. This was one of the main factors that led me to choosing to apply for the Integrated Engineering program. Each one of my professors cares deeply about my and my peers' successes, enjoyment, and compatibility with topics presented in their classes. These teachers are amazingly flexible and creative at finding projects and real-world experiences for their students to engage with the material to foster deeper understanding. Each of my instructors has been willing to meet with me individually to check in on my emotional*

*state and understanding of the topics presented during classes. If school was free and I didn't need money to survive, I would choose to continue taking classes forever so I could remain in their day-to-day lives.*

*Secondly, the "clients" of our design projects have been incredibly open and available for questions and guidance, as well as scouting for potential job opportunities. I'm impressed with how involved and creative my own client representatives have been with ideas to overcome problems and obstacles in our projects. I feel that this hands-on experiential learning is invaluable in teaching us students what it might be like when we get into industry by giving us skills to navigate unpredictable environments and situations.*

*Thirdly, the mentorship program allows TCE alumni to come and help the project teams throughout the semester. Since they have been through the program already, the alumni can offer advice on homework, experiments, reports, and deep learning activities assigned by the professors. Their experience in industry has also been incredibly useful in learning how to negotiate contracts, scope projects, and manage workflow. I appreciate this form of support so much that I'm considering being a mentor for some time after I graduate from TCE too. Aside from the support offered directly through the Integrated Engineering program at Minnesota State Mankato, I've found that my own network of advisors made up of past instructors, friends, and therapists have contributed to my personal feelings of ongoing success and hope for the future. Without these people, I wouldn't have had the self-confidence to choose a STEM career path, much less maintain it through a stressful pandemic and unstable socioeconomic climate.*

*To sum this up, my experience with advising and mentorship throughout college and TCE has been THE main contributing factor to my ongoing success and enrollment. I know that I'll go on to have a successful career and give back to my local communities and the greater society as a whole because of the care and support I have received. I look forward to being in a position when I may pay the favor forwards to others.*

Student 2's narrative also highlights the benefits of having a "campground of community" and specifically describes the community as including faculty, staff, clients from industry projects, alumni mentors, and peers. Additionally, this student included an awareness that they are also a contributor to the "campground of community" for other students. Through these thoughts, the student emphasized receiving support in all parts of their whole self: personal, technical, and professional.

While these students were asked for feedback, their experiences are not atypical for students in the Integrated Engineering programs. Along with the narratives presented here, we see high graduation rates of students that remain in the program; students for whom there is a better fit are advised into programs (in engineering or otherwise) better suited to their own goals and learning. Graduation rates for students starting the upper-division programs are in the 90s (across the three programs) with rates for career placement within six months of graduation in the high 90s. We also see that graduates make a point of contributing back to the program in as many ways as they are able. A survey of recent graduates showed that they feel well prepared to meet program educational objectives, particularly in their disciplinary fields, and that they feel uniformly

prepared for further formal and informal learning, applying metacognition, gaining professional licensure, managing projects, and making ethical decisions.

## Brief Summary & Future Work

The IE programs support student well-being and development into their future possible careers in multiple ways. Along with a model that explicitly builds on strong theoretical foundations, the faculty and staff of the programs collectively create and attend professional development sessions to improve their own ability to support student learning. Some of this work is translated into workshops for student engineers. For example, students are guided through reflective processes to consider their ideal, realistic, and avoided future possible careers [15], and steps to achieve their long-term goals [13]. Workshops are also used to keep faculty and staff up to date with current models of advising, such as the appreciative advising model [20]. Addressing the programmatic value of continuous learning, the IE faculty and staff will continue to develop their advising skills, building on theory and best practices shown throughout the engineering education community.

Implications of this work and the model presented are that the "campground of community" makes a difference for students. This could be implemented in multiple ways, depending on local context. The intentional connections with the whole student, instead of just on their technical learning, is a positive experience for students and faculty. Shifting to a model like this may be difficult because of academic norms, particularly in engineering, but the authors' experience is that it is worthwhile. Future work for assessing and improving our implementation of this model include examining additional reflections about the advising experience from a broader range of students as well as comparing them within and across programs and over time.

## Acknowledgements

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