Multidisciplinary Engineering Programs: Does Combining Engineering Focus Areas with Courses outside of Traditional Engineering Add Value to Students' Degree and Career Pathway?

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Key words: multidisciplinary engineering, retention, recruiting, undergraduate engineering, pathways through engineering

Abstract

As engineering strives to solve increasing global and complex challenges, universities find themselves uniquely positioned to create opportunities for their engineering students to develop more diverse skill sets through multidisciplinary degree programs. These programs focus on combining a traditional engineering discipline (e.g. mechanical, aerospace, electrical, etc.) with an outside area of study (e.g. business, philosophy, linguistics, etc.). Many possible advantages can arise from these programs, but the current published literature concerning these types of programs is lacking [1]. This study analyzes the Integrated Design Engineering (IDE) program at the University of Colorado Boulder, one such multidisciplinary program. Quantitative survey data and qualitative focus group data from the students in IDE are obtained and analyzed to determine the value of these programs, as well as improvements that can be made. The results of the surveys and focus groups show that multidisciplinary engineering programs are in fact valuable in recruiting and retaining engineering students. These programs attract students who are well-rounded, have many interests, are collaborative, and are looking for versatility in future careers. The program is able to provide hands-on, real-world learning; a combination of technical and professional skills; and opportunities for new experiences and coursework. Improvements can be made in community building, access to possible career information, better marketing to employers, and more mentoring opportunities.

Introduction

The demand for engineers and other STEM related occupations is increasing [1], yet the recruitment and retention of students to their engineering programs continue to be a source of pressure for universities [2, 3]. Currently there is limited research concerning how and why students choose certain engineering degrees, which becomes an issue as universities compete to draw in more students through innovative engineering programs. More recently, there has been an emergence of new engineering majors which incorporate additional science and liberal arts education in combination with traditional engineering curricula. These programs often leverage existing courses in the traditional majors while offering additional content to cover student areas of interest, such as linguistics, philosophy, business, education, and humanitarian studies, making these programs multidisciplinary. Combining two or more distinct multiple academic fields can provide a more well-rounded understanding of problems that need to be solved. New multidisciplinary engineering degrees have the potential to increase the number of students that

enter into the engineering field and stay in their selected major, offering students greater autonomy and choice as they navigate their futures in STEM. Despite the possible benefit of increased recruitment and retention, published literature is extremely minimal regarding the success of these engineering majors. Studying multidisciplinary engineering students' rationales as to why they choose certain areas of study alongside engineering will give insight into what collegiate engineering programs can adjust to better serve the intentions and expectations of their students.

This research paper uses a mixed-methods approach to examine why students combine traditional engineering fields with other certain areas of study (e.g. science, economics, linguistics, etc.). Factors that will be examined include the student's interest in their engineering field and outside area of study, past experiences, relationships (e.g. family, mentors, peers), and desired future careers. Additionally, this paper addresses how well multidisciplinary engineering programs are meeting the needs of their students by querying how their engineering field and outside area of study will help them in their future career goals. The students are asked to consider whether or not they feel prepared as engineers by incorporating the additional field of study. Analysis helps reveal important patterns about prioritizing the study of engineering in conjunction with other fields, which can then be used to support engineering colleges in growing their multidisciplinary offerings and increasing retention of talented students.

Background

In current society, the demand for engineers and other STEM related occupations is only increasing [1], yet universities are having difficulties recruiting and retaining students in their engineering programs to keep up with this demand. 41% of engineering students left their majors between 2003 and 2009 [2], and ASEE reports that there has only been a 0.7 percentage points increase in engineering bachelor's degrees awarded to U.S. students since 2007 despite wide recognition that engineering degrees lead to strong career prospects [3]. Engineering retention remains at the forefront of most university discussions, though there exists limited research concerning how and why students choose specific engineering degrees [1], which is a large issue since universities will only be able to draw in more students when they know why students decide to enroll in which engineering programs.

Another concern is the severe underrepresentation of women in the engineering field. In the US, 20% of engineering professions are held by females, and engineering is one of the few remaining male-dominated fields [4]. This trend continues despite the national push in engineering and sciences to retain a workforce representative of its population; women constitute/account for nearly half the US workforce but only a third of the STEM workforce [4]. Studies in Europe found that more women engineers would gravitate towards multidisciplinary and co-curricular studies, while additional research shows that multidisciplinary curriculum involving two or more

subject areas not only increases students' competence in complex problem solving and thus competitiveness in the workforce, but also increases interest in future coursework for women [5, 6, 7, 8]. The inclusion of engineering majors that support multidisciplinary pathways could help recruit and retain more engineers into the workforce, as well as help balance the ratio of men to women engineers practicing the profession.

Recently at several universities (such as University of Colorado Boulder, Boise State, Oregon State, Texas A&M, Purdue, and University of Southern California), there has been an emergence of new engineering majors which incorporate outside disciplines into engineering studies, allowing for more choice and flexibility in an engineering degree pathway. Based on the research that supports student autonomy in undergraduate courses, these new types of engineering degrees are capable of increasing the number of students that enter into the engineering field and stay in their selected major, among other possible benefits [9].

The biggest factor that students consider when choosing their major is their interest in that field [10], but people's interests typically diversify across fields. Multidisciplinary engineering programs allow for students to pursue engineering along with other interests. Humanities and social sciences courses can help engineers with their critical thinking and adaptability [11], important features of a good engineer. Understanding economics and business are helpful in any engineering workplace since engineers constantly have to determine the costs of what they are making. The ability to communicate effectively with people across disciplines is integral in today's workforce. These are only a few of the long list of benefits that could arise from introducing these kinds of engineering majors.

Despite all the possible upside to academically integrated pathways, few universities currently offer formalized versions of these kinds of programs, and there has been little published literature concerning the outcomes of engineering majors that combine engineering studies with other separate disciplines outside of engineering. This paper will dive into one such program and its students' attitudes around their course selection and program effectiveness.

Research Objectives

The overarching goal of this research project is to improve engineering pathways for modern students and retain more students traditionally underrepresented in the engineering workforce.

The primary objective of the research is to examine why students combine certain emphases (engineering focus areas) with certain concentrations (courses outside of traditional engineering). Learning about students' rationales as to why they pick their emphasis-concentration combinations will give insight into what a multidisciplinary engineering program can adjust to better serve the intentions and expectations of the students. Certain factors that were examined

concerning why students choose their specific emphasis and concentration include (1) the student's interest in their engineering emphasis and concentration, (2) supports and barriers to their decisions, and (3) how the student's projected future outcomes influenced their decision. Examining the data from each of these factors independently can create various different methods for improving non-traditional engineering programs. Thinking about these factors holistically can then uncover other patterns into why students choose traditional engineering majors with additional concentrations.

The secondary objective of this research is to examine whether or not the emphases and concentrations that students are studying add value to their degree and career pathway, and how effectively the program is fulfilling the students' reasons for choosing their emphases and concentrations. In this regard, students will be asked how their emphases and concentrations will help them in their future courses and careers, as well as how much value they gained from their emphases and concentrations. The students will also be asked to consider whether or not they feel prepared as engineers to enter the professional workforce, as well as what the program can do to improve their undergraduate experience.

Methodology

To investigate students' experiences and choices in a large research university, all students in the Integrated Design Engineering program were invited to participate (n=124). Student participants vary in experience and demographics, from first-year students in engineering projects courses to third-, fourth-, and fifth-year students enrolled in the program's core engineering courses (statics, circuits, materials) or senior capstone design. Classes range from engineering projects courses to core engineering courses (statics, circuits, materials) to senior capstone design.

Setting

Launched in 2014, the University of Colorado Boulder's ABET-accredited Integrated Design Engineering program allows undergraduate engineering students to select from among one of six engineering areas of study (aerospace, architectural, civil, electrical, environmental, mechanical; called an emphasis) and combine that with an additional area of study outside of engineering (called a concentration). In the engineering area of study, students take a number of courses (including capstone design) taught in those disciplines. The appropriate streamlined engineering course requirements were negotiated with faculty experts in each of those disciplines. The catalog of concentrations includes business, economics, and STEM teacher courses as well as other concentrations that are often versions of existing minors and certificates. Additional components to the program include required engineering design courses and an emphasis on active learning (e.g. team projects in most courses). As a result, the degree offers over one hundred different pathways, each leading to a unique engineering undergraduate experience.

Research Questions

The primary research questions addressed in this study are the following:

1. Why do engineering students choose to study an additional discipline alongside their engineering emphasis?
2. How well are multidisciplinary engineering programs meeting the needs of their students?

Data Collection

This study has a mixed method design employing two data collection techniques: aggregating online attitudinal survey data and analyzing follow-up data from focus groups. Each of these methods is described below. Surveys and focus groups from students were conducted with approval from CU Boulder's Institutional Review Board (IRB). Students have been given pseudonyms to conceal their identities.

Quantitative - A survey for the student participants was used to investigate the participants' choice of emphasis and concentration, as well as probe their current and past experiences that influenced their emphasis and concentration decision. This survey included 25 multiple choice and short answer questions querying student opinion of their engineering pathway and their interest in additional areas of study. This survey was used to evaluate trends in the student participants' opinions around the research questions.

Qualitative - Focus groups were convened to probe qualitatively for common threads among the experiences of students in the IDE program. These focus groups allowed for additional qualitative context to the collected survey data. The focus groups asked students for their ideas and suggestions on better methods of assisting students with their decisions on emphasis and concentration.

Data Analysis

Quantitative data was collected using online surveys distributed to all current students in the program. 52 students responded to the survey representing 42% of the students in the program. For Likert-style questions, data was aggregated and analyzed for comparison purposes. Percentages and number of respondents are used to illustrate student attitudes. These surveys were distributed through Qualtrics online platform, and the data focused on aligning the data sets into a usable format and analyzing the aggregate results. A complete list of survey questions is provided in APPENDIX A.

Qualitative data from the written responses and focus groups were analyzed to find trends in attitudes, interests, and choices of the students. Within the focus groups, we asked the students about their thoughts on completing a major that combines an engineering focus area with courses outside of traditional engineering and how such programs can help prepare them for the future jobs or careers that they desire. A complete list of focus group questions is provided in APPENDIX B.

Students enrolled during the 2022-23 academic year were solicited to participate in 45-60 minute focus groups. The first focus group convened in December 2022 with four participants and two facilitators. The second focus group convened in March 2023 with four more students and two facilitators. Both focus groups were audio and video recorded to allow for future analysis. The audio was subsequently transcribed to text and personal identifiers were removed prior to analysis by the full research team.

The first focus group's participants and their areas of study:

- Liz (she/hers): senior, mechanical engineering, combined with engineering management and entrepreneurship
- Jo (she/hers): junior, mechanical engineering, combined with developing communities
- April (she/hers): senior, electrical engineering, combined with creative technology and design
- Alex (they/them): fifth-year senior, environmental engineering, combined with evolutionary biology (self-directed)

The second focus group's participants and their areas of study:

- Jenn (she/hers): junior, mechanical engineering, combined with engineering management and entrepreneurship
- George (he/his): first year, mechanical engineering, not sure about his area of concentration (undecided)
- Robert (he/his): first year, mechanical engineering, combined with German studies
- Anne (she/her): junior, environmental engineering, combined with global communities

The qualitative focus group data was compared to the quantitative survey data to better understand and corroborate student survey answers. Full audio recordings were listened to by members of the research team to partially "quantify" conversations by monitoring themes and motifs. This strategy helped the researchers identify segments of interest for transcription into text and delve further into students' agreements and disagreements.

Findings

Research Question 1: Why do engineering students choose to study an additional discipline alongside their engineering emphasis?

To assess the background of why some engineering undergraduate students are drawn to study more than just a traditional engineering discipline, we surveyed students who deliberately chose to combine academic study areas through the IDE program. Survey questions analyzed covered (1) the student's interest in areas of study combinations, (2) environmental supports and barriers to their decisions, and (3) how the student's intended future outcomes influenced their decision. Results from these survey questions are provided below.

Student interest

The aggregation of engineering emphases for student survey responders are found in Table 1. The survey responders' top secondary areas of study is in Table 2. Most students combine business with engineering, followed by computer science, engineering management, economics, and world languages. Many students also combine more than one additional area of study (such as both business and management).

Table 1. Engineering area of study (n=48)

Engineering Area of Study	% IDE Program overall	% student responders
Mechanical	59%	64.58%
Environmental	8%	14.58%
Architectural	6%	8.33%
Electrical	8%	8.33%
Aerospace	10%	2.08%
Civil	8%	2.08%

Table 2. Second area of study combined with engineering major (n=48)

Second area of Study (outside engineering)	% student responders
Business	28.26%
Computer Science	13.04%
Undecided	13.04%
Engineering Mgt	10.87%
Econ	10.87%
Language, Literature & Culture	6.52%
Self-Directed	6.52%

Both multiple choice and open-ended questions probed/examined student rationale for choosing a multidisciplinary program. Students indicate that their main reasons for choosing their major include personal interests, preference for hands-on learning, a smaller community, working in

teams, frustration around adding minors to their pathway, and perceived value for their future desired careers. Specifically, the following survey comments capture similarities across several student responses.

> "IDE gave a more well-rounded degree. I was able to incorporate engineering and business together while being able to do a lot more hands-on classes."
>
> "I have too many interests, so this major was a perfect way for me to combine a couple of them."
>
> "I started in (another department) and was disappointed by the lack of hands-on and individualized learning opportunities within the department. The teaching style and environment didn't match with my way of learning or what I value and believe. Once hearing about this program and its structure I realized it was what I had been envisioning and wanting the whole time so I switched. I wish I had learned about it - in an equal emphasis kind of way to the other engineering options - when applying."

Focus group students discussed why they entered or transferred into the IDE program, their individual goals and plans, and how their pathways felt different than the traditional engineering majors in the college. Their responses mirrored the survey attitudes about added skills and having a well-rounded experience. The responses also provided a little more insight into similarities and differences they feel between their major and more traditional majors. A theme of this discussion was that the students felt like the integrated program valued their differences over their similarities; they had "found a little pot of gold" [Jo] in the IDE program. One student described the difference in interactions with students inside and outside the program in terms of collaboration. Students outside the program were confused and sometimes disdainful about combining interests, while students in the same program were excited to share ideas. "Everyone who I've gotten to work with in [the program] is very passionate about like multidisciplinary studies… they're like, "oh, that's so cool! Have you thought of this and this, and everyone's really excited to help each other like brainstorm, and seek new things out, which I think is a very positive environment." [April]

Supports and barriers

We also asked students about the various prior supports for and barriers to their college experience in both the survey (Figure 1) and focus groups.

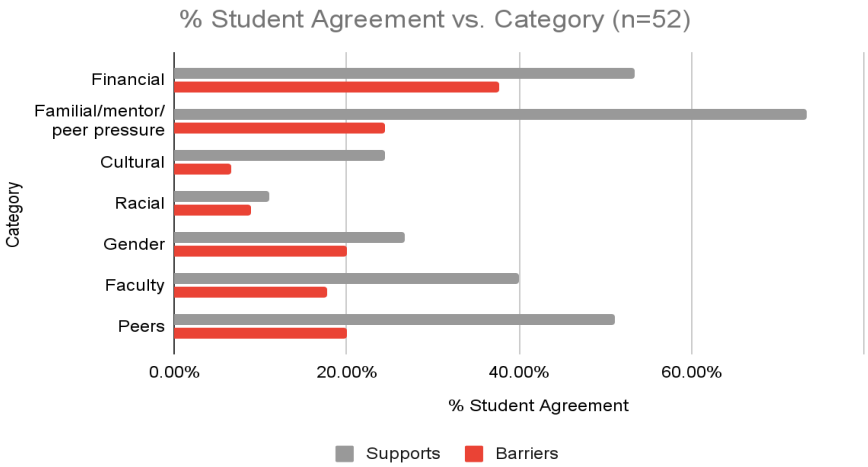

Figure 1. Survey participants' self-reported supports and barriers to engineering. (n=52)

Finances top the categories in both a support and a barrier to the students' college experience. Families and mentors also provide both support and barriers. Overall, the students feel more support than barriers in their college experience, though this does not fully capture the extent of the specific barriers to their success.

The focus groups provided a little more insight into the support the students experience. When asked how their families and peers reacted to their choice of major, they expressed mostly positive sentiments about family support for finding a path that really fit their goals.

- " My parents really like it because I've always kind of expressed that desire to have something multidisciplinary, and when I was even deciding to do engineering in the first place, I was like, I want kind of like engineering, and so I was already thinking about doing a minor so they really like it." [Jo]

- "My parents like, they were super on board with it like right off the bat, and they like really wanted me to do it. And I was also like sold on it. I was like so like really excited about it, and like my siblings like they also went to college. None of them were engineers, though, but they were just… they're like, 'Wow, that sounds so cool.'" [George]

- "My parents were very skeptical of me transferring out of aerospace to anything. And then, obviously, once I explained it, they were like, 'oh, it's like really cool. That's like perfect.'" [Robert]

As for their peers, the students describe mixed reviews depending on the major and level of the students. Conversations with senior undergraduate students were more often tolerant of multidisciplinary pathways as evidenced by the comments here:

- “As a senior, everyone that I talk to is like, ‘oh my God! I should have done that.’ Like all the seniors that are like at their end are like, ‘Why did I put myself through this instead of doing that?’” [Liz]
- “Part of it too, I think it’s really interesting is like, once you get the job, then your major doesn't matter. Like… different colleges have different curriculums for their engineering doesn't mean that one is a big one and one of the real ones, right?” [Alex]

Intended future outcomes

Additionally, students were asked an open ended survey question to offer insights on how they think this program will influence their intended future career prospects. Responses were mostly positive and pointed to unique skill sets, increased confidence in solving problems, better communication skills, hands-on learning, expanded portfolios, and finding a job they enjoy. However, some hesitation remained around explaining a multidisciplinary engineering degree to future employers. The breadth of responses from survey participants are demonstrated below.

> “I hope that the portfolio of projects I will have after this program will be a unique way to share my skills with employers.”
>
> “It will give me the qualifications to have a good career while also giving me the experience to pursue what I love.”
>
> “The fact that I have a minor in something else proves that I am multifaceted and can apply the skills that I learn in engineering classes to my other academic pursuits.”
>
> “I will need to sell my degree more than somebody with a traditional mechanical degree. There will be jobs I apply for that will discount me because they are looking to fill a very specific, rigid role and need me to check a box. I don't think those jobs would have been right for me anyway. But employers looking for someone more dynamic and self motivated will probably jump at the chance to work with someone working outside the usual box, which will most likely fit me much better. I see large companies overlooking me and small or innovative companies having their interest piqued.”

Research Question 2: How well are multidisciplinary engineering programs meeting the needs of their students?

The initial survey sent to students did not ask about how *well* the program meets their needs, though some open-ended responses indicated that the program was helping them prepare for internships and careers. Instead, the focus groups were structured to better answer this second research question. During the focus groups, students were asked (1) about advantages and

disadvantages of a multidisciplinary program when compared to traditional engineering majors and (2) what the program can do to help better prepare them for their future goals.

Advantages and disadvantages of a multidisciplinary program

Building on the positive comments above about how a multidisciplinary and integrated program will help them in their future career aspirations, focus group students were excited about the possibilities of combining their interests into one plan of study but were also wary about whether a nontraditional degree would prevent them from being considered for some traditional jobs by being "sorted out of these big algorithms." [Jo]

A summary of students' perceived advantages and disadvantages of a multidisciplinary path of study is below:

Advantages mentioned by focus group students	
Combination of technical and professional skills	"I feel like IDE has given me the space to kind of build into… like, learn all the theory behind, like, development work, while also getting all the technical understanding behind development work and put it into a really hyper specific category, and really do cool things with it." [Anne] "With the entrepreneurship and business side, it also helps me be able to manage teams, which I think is key." [Jenn] "I feel like it's gonna be a great combination of skills that would be a great major." [George]
Flexibility to try new experiences/courses	"I want to study abroad. And obviously IDE allows me to do that, whereas aerospace does not. That is a really huge thing for me. That was one thing in high school I didn't get to do, so I definitely want to do in college." [George] "I'm hoping that IDE is going to help me figure that out… just the freedom to take the other classes. I feel like I can really like dive into it." [Robert]

No additional time to degree	"You get to basically have a minor, and you don't have to sacrifice any more school time, which is huge. I know lots of normal chemicals that are adding on a semester or a whole other year because they want to do a minor, so they're paying this much more to do a minor that they could have built in to their major." [Liz]
Disadvantages mentioned by focus group students	
Different coursework than traditional engineering might not match with career plans	"I was really worried about missing the couple core classes for electrical. Like we don't take thermo, statics, and mat sci and those are now things that I now have to take." [April] "It takes away some of the perhaps core classes in a regular environment." [Liz] "I have to take the fundamentals of engineering exam at the end, and that's a requirement. It's not required for (traditional) electrical." [April]
Graduate schools and potential employers are not informed about non-traditional engineering majors	"But also just like grad school in general, people are like, 'I don't know how this will look to grad school applications that are outside of this university.'" [April] "And they ask me, 'How are you going to get a job with a degree that no one knows?'" [Jenn]

Program improvements

The students offered many ideas for program improvements that would help clarify the major for incoming students and potential employers. Their main ideas are summarized here:

Main idea	**Student insights**
Help with navigating their undergraduate courses across two areas of study	"I love the flow chart. Everyone should have a flow chart… I've seen other, other majors have just like a basic excel sheet. I love the flow chart." [Liz]

Building more community with their peers on similar pathways in order to share experiences and provide mentoring	"It would be nice to be able to get connected to people who share the same emphasis with you slash concentration, but the concentrations are like more all over the place. But I think I've finally met one other IDE program electrical, and it's been really nice to just like bounce back ideas, say like, 'what's your experience with internships, like looking for with this major, how is that going?' Like, I think that's super useful is to have someone looking for a similar career path, even though you have differences still and be able to talk about it." [April] "I think that'd be really cool for some incoming IDE students who may not have an idea of what they want to do for a concentration or what they want to do for an emphasis. Kind of have an overview of things that you could combine." [Anne]
Access to online information on how different combinations of emphases and concentrations could be applied in future careers as a way to address the ambiguity around non-traditional engineering pathways	"I feel like, to like, truly find the information like online for, like, what you could do with this degree, and maybe like that, like when you first I talked to your or talk to the you know, IDE program advisor that you can like, maybe there's like some kind of packet or some kind of information that is more in depth that… says like, 'Okay. I know you chose this, probably, but like also here, like, here's what you could do with that.'" [Alex] "(Learning about) potential jobs you can get as an IDE student. Like if you were to do this concentration and this emphasis, you can reach this point of capacity. Or or like a way of helping students determine which path is a match for their goals and and like expertise." [Jenn]
A better way to explain the multidisciplinary pathway/benefits to employers and grad schools	"I don't know how this will look to grad school applications that are outside of IDE." [April] "Reaching out to like businesses or like forming those connections like with IDE program with specific companies, and like really like selling them. Like, 'this is what the students in IDE are doing. Like, this is why they're really valuable.'" [Robert]

More connection with alumni of the programs and discussion of possible futures post-graduation	“Maybe hear from alumni, or a panel about what people are doing. Because that was super cool, the panel that we had last winter.” [Jo] “I feel like real life stories, it's pretty cool, or having speakers like alumni come to speak.” [Jenn]
Overall, better marketing and awareness of the program from the university	“I had no idea what IDE was. Like, I only found out because I was searching for other majors that would give me more flexibility. So I don't know what the solution is to that, but maybe just more visibility by IDE in the college of engineering in general. Especially to like, maybe advertising to the incoming class would be good, yeah.” [Robert]

Study Limitations

The findings of these analyses must be considered within the limitations of the study. First, the data presented in this study is self-reported by students, and therefore inherently subject to bias. Additionally, the study is focused on students who are currently enrolled in a program at a singular large research university, which is openly known for its innovative teaching approach. As such, students within the program may have some degree of positive feelings toward nontraditional programs, which may lead to some bias inconsistent with a more general population’s perception of similar environments. Therefore, the conclusions found in this study may not be easily applied to more traditional engineering programs. Though pleased with the participant survey response rate from our program, we acknowledge that these are relatively small sample sizes and recognize additional research is needed.

Key Findings

We investigated two main questions throughout the research process. The conclusions to each of those questions are summarized below.

Why do engineering students choose to study an additional discipline alongside their engineering emphasis?

- Well-rounded
- Many interests
- Support from family
- Collaborative
- Versatility in future career paths

How well are multidisciplinary engineering programs meeting the needs of their students?

- Love the community
- Hands-on and real-world learning
- Combination of technical and professional skills
- Opportunities for new experiences and coursework
- Unsure about limitations to opportunities if companies/grad schools are looking for traditional majors over skill sets
- Suggestions include (student facing): clarity of course pathways, peer mentoring, community building, information about possible careers
- Suggestions include (employer facing): help explaining multidisciplinary pathways to prospective employers and grad schools, connections to alumni, mentoring, overall better marketing/awareness

Discussion and Recommendations for Future Work

Results from the analyses presented in this paper support the need for and value of nontraditional undergraduate engineering pathways and other faculty negotiating multidisciplinary pathways in engineering settings. Student voices are an important contribution of departments and colleges as they develop strategic statements and learning outcomes for the next generation of engineers, especially if they desire the populations of engineers to reflect the populations of their communities.

The most popular emphasis in the Integrated Design Engineering program is mechanical. The survey and focus group responses suggest that this emphasis is well liked among students due to it being viewed as extremely versatile. Some of the students stated their belief that the mechanical discipline would be applicable in a wide variety of careers. This corroborates with the expected mindset of the IDE program students since they are frequently looking for more variety in their degree, which can then help in future career paths.

The students in this study offered many ideas for program improvements that could extend to any nontraditional program working towards better implementation. Most strikingly was the need for better communication of the value of the different types of engineering programs available to prospective employers and graduate schools. Faculty and students are aware that experiences outside of narrow engineering pathways allow students to broaden their understanding of global perspectives and that combining interests (academics and personal) can lead to more adaptability and innovation in the workplace. Emphasis should be placed on capturing the success stories of students in integrated engineering and sharing those widely.

Future analyses could and should include the voices from alumni of multidisciplinary engineering programs to better map the breadth of options available to students post-graduation, advice for navigating job interviews, and value of combining engineering with outside interests in satisfaction of life/work opportunities. Conducting related studies at other universities with

similar multidisciplinary engineering programs should also be considered to see if trends persist across larger and more diverse populations.

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(APPENDIX A) **Survey Questions**

Name:
What is your IDE emphasis area?
What is your IDE concentration (if known)?
What are your biggest reasons for choosing the IDE major (pick 2)?

- Interest/Passion
- Value in future career
- Important part of your identity
- Family/mentor/peer influence
- Future financial benefits
- Employee prospects
- Difficulty
- Personal values/moral beliefs
- Aptitude to the major
- Hands-on/ active learning courses
- Other: _____

Which of the following criteria were you looking for when deciding on your major (check all that apply)?

- Interest/Passion
- Value for future career
- Important part of your identity
- Agrees with family/mentor/peer beliefs
- Future financial benefits
- Employment prospects
- Difficulty
- Personal values/moral beliefs
- Aptitude to the major
- -Other:_____

What specific experiences led you to choose IDE?

- _____

Why did you choose your specific emphasis and concentration?

- _____

Did your family/teachers/counselors/peers influence your decision to choose IDE, your emphasis, and your concentration? If so, how?

- Yes
- No
- _____

Which (if any) of the following collective identity categories have influenced your decision to pursue the IDE program?

- Gender identity
- Ethnic identity
- Cultural identity
- Other:_____
- None of the above

Are there other aspects of your identity that have influenced your decisions?

- _____

How have any of your identities influenced your decision to choose your specific emphasis and/or concentration?

- _____

Did you begin in the IDE program, or did you transfer into the program?

- Began in IDE
- Transfer from another engineering major
- Transfer from outside of engineering

If you transferred from another major into IDE, why did you decide to transition?

- _____

If you began in IDE, why are you still continuing in this program?

- _____

How interested are you in your emphasis?

- 1(Not interested) 2 3(A little bit interested) 4 5(Fairly interested) 6 7(Very interested) 8 9(Extremely interested)

How interested are you in your concentration?

- 1(Not interested) 2 3(A little bit interested) 4 5(Fairly interested) 6 7(Very interested) 8 9(Extremely interested)

What environmental supports have you had *prior* to your college experience?

- Financial
- Familial/mentor/peer pressure
- Cultural
- Racial
- Gender
- Faculty
- Peers
- Other:_____

What environmental barriers have you had *during* your college experience?

- Financial
- Familial/mentor/peer pressure
- Cultural
- Racial
- Gender
- Faculty
- Peers
- Other:_____

How would you rate your academic performance?

- Extremely bad, very bad, bad, slightly bad, slightly good, good, very good, extremely good

How would you rate your time management?

- Extremely bad, very bad, bad, slightly bad, slightly good, good, very good, extremely good

How would you rate your work/life balance?

- Extremely bad, very bad, bad, slightly bad, slightly good, good, very good, extremely good

What kind of extracurricular activities do you participate in?

- Athletics
- Club athletics
- Academic clubs
- Volunteer/community engagement clubs/organizations
- Cultural clubs
- Other:_____

Have your extracurriculars affected your major, emphasis, and/or concentration? If yes, how?

- _____

How do you think that IDE will influence your future career prospects?

- _____

If comfortable, would you be willing to speak about your financial aid situation?

- Yes.
- No.

Would you be willing to participate in a 45 minute focus group with other IDE students? Food will be provided.

- Yes.
- No.

(APPENDIX B) **Focus Group Questions**

1. What are your thoughts about the other traditional engineering majors?
2. Consider other students that you know. What similarities and differences do you have between them?
3. How have others (e.g. family, peers, etc.) reacted to your major?
4. What are your future goals and plans, and how does this program help your progress towards these goals?
5. What do you intend to use your concentration (second area of study) for in your future?
6. What reasons do you have for combining your specific engineering emphasis with your specific concentration? What advantages and disadvantages does your specific emphasis-concentration combination have?
7. What qualities do you think good engineers have? Do you think you will be a capable engineer after completing your major?
8. What can the program do to better help you be prepared for your future goals? What do you think is missing from the program?