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RESEARCH ARTICLE

Perceptions of future careers for middle year engineering students

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Abstract

Background: One facet of motivation relevant to students' learning is their perceptions of the future, including future career goals and how those perceptions influence their present actions; this is collectively referred to as their future time perspective (FTP).

Purpose/Hypothesis: This study describes the different FTPs of engineering students. We aim to help researchers and practitioners leverage students' motivations to improve learning experiences and inform future studies by providing a model of engineering students' FTP.

Design/Method: A phenomenographic approach was used to determine students' different characteristic FTPs within the context of their engineering courses. Interviews with engineering students ($n = 18$) at a southeastern US research-intensive university were analyzed for differences and similarities in their descriptions of their FTPs.

Results: Three groups emerged from the data that were visualized as different shapes within the outcome space. Cone, a long narrow shape, represents students who narrowed down their future careers deep into the future. Cup, a wider truncated cone, represents students who have conflicting desired and realistic future careers. Bowl, a short and wide shape, represents students who have broad perceptions of their future careers and do not describe how their future goals affect their present actions.

Conclusions: Using a phenomenographic approach to examine engineering students' FTPs revealed three characteristic groups and allowed us to document how different FTPs affect students' perceptions of tasks in their engineering courses. Our findings can help educators foster students' interest in and value of learning engineering concepts and their positive perceptions of their future careers.

KEYWORDS
future career goals, future time perspective, motivation, phenomenography, undergraduate

1 | INTRODUCTION

Engineering students' motivation toward their future influences many of their academic decisions, such as major choice (Godwin & Kirn, 2020), persistence in their major (Jones et al., 2010), course enrollment (Lichtenstein et al., 2009), and effort given to their courses (Nelson et al., 2015). Engineering students' motivations and the influence those motivations have on academic decisions vary (Hilpert et al., 2012); however, limited data exist exploring the differences in the future-oriented motivations of engineering students in their middle years. Understanding engineering students' time-oriented motivations can help educators understand students' reactions and attention to different types of problems and projects and also helps explain varying reactions and approaches to planning for the future.

The objective of this study is to identify the different ways middle year engineering (MYE) students perceive their future careers and how those perceptions influence their current academic decisions and prioritizations. In this study, we focused on MYE students because the middle years (between the third and fifth semester) are when students are most likely to leave engineering (Min et al., 2011). Additionally, MYE courses tend to have higher enrollments than senior-level technical courses, making it more difficult for instructors to get to know their students (Lodish et al., 2004). By characterizing students' motivations, educators could more effectively design instructional, advising, and mentoring activities that consider attributes of MYE students that influence learning and goal attainment.

In this study, we explored the different ways future goals are perceived by MYE students, building on research in future-oriented motivation, specifically future time perspectives (FTPs), future possible selves, and contingent goal paths (de Bilde et al., 2011; Kirn & Benson, 2018). The research question we addressed in this study is "What are the different ways MYE students perceive their future careers in the context of their present engineering coursework?" Addressing this question provides insights into the varying aspects of students' motivations that can influence important academic outcomes and a model for educational researchers exploring engineering student motivation at the individual level.

1.1 | Positionality statement

To help the reader understand the construction of this study, we provide a positionality statement of the research team. Our positionalities as researchers shape the theories we engage with, methods we use, our mechanisms for communicating within our team, and how we present our research findings (Secules et al., 2021).

The research team is composed of three white researchers, two of whom identify as cisgender women and one as a gay cisgender man. As a team, we sought to explore how students' motivations shaped their practices in the engineering classroom. Driven by our theoretical perspectives of motivation, we found in previous work that student conceptualizations of the future emerged as a key construct in students' approaches to problem-solving (Benson et al., 2013). Working from this initial finding, we have shown that students' perceptions of the future shape and are shaped by their experiences in engineering (Kirn & Benson, 2018). In this work, we expand these findings to highlight potential differences in how students perceive the future to help educators understand how they can leverage the range of motivations in their classrooms. The research presented here was started by Author 2, including initial models of visualizing students' motivations for the future, and was continued and refined by Author 1, resulting in the final representations of our findings. Authors 2 and 3 facilitated and guided this transfer of research responsibilities (Walther et al., 2017), requiring negotiation of positionalities and interpretive lenses consistently throughout the project to ensure a shared research voice and focus.

2 | LITERATURE REVIEW

2.1 | Future-oriented motivation

Individuals, including engineering students, are goal-driven, and part of our role as educators is to help students find their motivation for achieving goals through the framing, monitoring, and evaluation of those goals (Miller & Brickman, 2004). Goals are inherently future-oriented, ranging in how far into the future they reach. Future-oriented motivation theories capture this idea of being motivated by the future and specific goals in the future (Miller & Brickman, 2004). FTP is a theory capturing how future goals, or perceptions of the future, are integrated into an individual's present and affect their present actions (Husman & Lens, 1999). An individual's perceptions of the future are also captured in the theory of Future Possible Selves; their future possible self is the vision of themselves in the future, capturing their hopes, dreams, and fears (Markus & Nurius, 1986). Students who are actively working toward their future possible selves take steps in the present to reach those goals. The series of steps, or subgoals, create a path to reach their distant future goal (Miller et al., 1999) related to their future possible careers; this path is known in the literature as a contingent goal path (Oettingen & Mayer, 2002). Together these theories describe an individual's future-oriented motivation and form the theoretical framework for this research.

2.1.1 | FTPs framework

FTP is the relationship between a person's future goals and their actions in the present (Daltry & Langer, 1984; Hilpert et al., 2012; Husman & Shell, 2008). Research in FTP has demonstrated a connection between students' perceptions of the future and their approaches to problem-solving and learning in engineering (Kirn & Benson, 2018; Nelson et al., 2015). However, little research examines the different ways aspects of students' FTPs combine to influence their perceptions of current academic tasks.

Building on existing work, constructs from the FTP framework relevant to our work include extension and perceived instrumentality. Extension, or valuing of distant future goals, has been associated with improved academic performance (Volder & Lens, 1982). Further, the longer one's extension, the more value one will place on distant future goals (Husman & Lens, 1999). Through one's extension, a person can anticipate the future and recognize its influence on the present.

The cognitive connections made between future goals and present tasks are what make those tasks useful to an individual and serve to motivate the individual to complete those tasks and achieve goals. Perceived instrumentality is the connection of a present task to one's future goals and is a task-specific, cognitive construct (Husman & Lens, 1999; Husman & Shell, 2008; Lens et al., 2012). Engineering student-perceived instrumentality has been likened to a mastery orientation (Puruhito, 2017) and correlated to the use of adaptive learning behaviors, with high perceived instrumentality predicting the use of self-regulation and knowledge-building strategies (Nelson et al., 2015).

2.1.2 | Future possible selves

Perceptions of the future are also characterized in terms of cognitive manifestations of oneself in the future, which are described as future possible selves (Markus & Nurius, 1986). These include who one can become (realistic possible self), who one wants to become (ideal possible self), and who one does not want to become in the future (avoided possible self; Markus & Nurius, 1986). Students who possess realistic or ideal possible selves have something to strive for and display high levels of persistence toward achieving future goals (Markus & Nurius, 1986; Pizzolato, 2006, 2007).

For this work, we contextualize future possible selves with respect to one's future possible careers. Future possible careers describe students' cognitive manifestations of who they feel they can become, want to become, and do not want to become in terms of their careers (McGough et al., 2018). These future possible careers often come with contingent goal paths (Miller et al., 1999; Oettingen & Mayer, 2002), which are the set of dependent goals needed to reach distant future goals (Raynor, 1969). For example, an engineering student may have a distal future goal of working for an automotive company and a subgoal of graduating with a mechanical engineering (ME) degree. That student may define several more subgoals, for example passing required core courses or completing a co-op in the automotive sector, creating a series of steps that are dependent on each other to reach the distal goals (i.e., creating a contingent goal path). Tasks related to a student's contingent path often have more perceived instrumentality than tasks unrelated to a contingent path (Miller et al., 1999).

Although future-oriented motivation is a well-established theoretical framework, there is a gap in the literature in terms of how theoretical constructs within this framework manifest at the individual student level. The literature to date has examined generalizable trends related to students' future-oriented motivation with little consideration of the patterns of variation that exist within those trends. A phenomenographic approach will allow us to focus on student experiences and provide meaningful context to existing literature.

2.2 | Phenomenography

In this study, we draw from phenomenography with some pragmatic variation to address our research purpose. Phenomenography is a qualitative methodology focused on individuals' experiences of a phenomenon and the variety of ways a phenomenon is experienced (Marton, 1981, 1986). The purpose of phenomenography is not to capture reality but rather the experience of reality. The ontology of phenomenography is based on the stance that reality and the experience of reality cannot be separated (Barnard et al., 1999; Marton & Booth, 1997). When discussing students' future possible selves and FTPs, we must consider the context of reality in which students are thinking about these aspects of their future.

The tenets of phenomenography argue that there is only one reality that is experienced in a finite number of ways (Barnard et al., 1999; Dall'Alba & Hasselgren, 1996; Marton, 1981). These experiences or perceptions are referred to as ways of thinking (Marton, 1986). Identifying ways of thinking has been an approach in engineering education research for describing students' experiences in team-based ill-structured problem solving (Dringenberg & Purzer, 2018) and the different ways engineering students understand chemistry concepts in a chemical engineering context (Ebenezer & Fraser, 2001). In this study, the phenomenon is MYE students' ways of thinking about future careers, and the context for the phenomenon is MYE coursework.

3 | METHOD

We addressed our research question using a phenomenographic-informed approach to map the different ways that MYE students perceive their future possible careers (Marton, 1981, 1986) in the context of their present engineering coursework. Phenomenography allows us to identify and describe the variation of participants' perceived experience of a phenomenon, in this case, the experience of thinking about their future careers (Sandberg, 1996).

Informed by phenomenography, the outcomes of this study consist of a set of categories that describe different ways of experiencing the phenomenon. We defined categories that are generalized enough to be transferable and still capture the full range of individuals' experiences so that each group conveys a distinctive experience of the phenomenon (Åkerlind, 2012). These categories are described in an outcome space comprising the structural relationships between the different categories (Marton, 1988) and representing a logical relationship between the categories (Dringenberg et al., 2015). Through this approach, we address our research objective of identifying the different ways MYE students perceive their future careers and provide a framework for conceptualizing engineering student motivation for future research.

3.1 | Participant selection

The target population of this study was MYE students, and the sample group of participants was biomedical (BME) and mechanical (ME) undergraduate engineering sophomore and junior (middle year) students at a southeastern US research-intensive land grant institution. The participants ($n = 18$) primarily consisted of sophomore students interviewed at the end of their second year; the four students who were juniors were interviewed at the beginning of their third year. The number of participants was influenced by balancing the need for adequate data to identify variations within it, the goal of reaching saturation (a point at which no further insights or perceptions about the phenomenon are revealed), and the practical constraints of working with a manageable amount of data (Yates et al., 2012).

For the purpose of understanding the variety of students' perceptions of their future career, MYE students are ideal since they have started their discipline-specific courses and their futures beyond graduation are not yet solidified, as they may be for senior students. Researchers and funding agencies have identified a gap in research around the middle years (sophomore and junior years) of engineering education (Lord et al., 2017; Lord & Chen, 2014). In a study of engineering education publications, a predominance of work focused on first-year engineering students was identified, with significantly fewer studies focused on sophomore engineering students (Borrego, 2007). Considering the lack of research and the importance of these middle years for engineering students, particularly in terms of how they are experiencing the perceptions of their future possible careers, we believe this population is the most likely to benefit from better understanding their perceptions of the future.

The purposive sampling of students within two similar majors at a single institution was appropriate for a phenomenography, which seeks to reveal variations in experiencing the same phenomenon (Ashworth & Lucas, 2000; Dringenberg et al., 2015). Having two engineering majors provides a variety of possible future careers and potentially a variety of ways of thinking about those future careers. ME and BME students experienced the phenomenon in a similar context in terms of engineering coursework, as many of the core courses that mid-year students take are similar in BME and ME programs (Kirn et al., 2014).

Mid-year BME and ME students were sent a survey on motivations and attitudes in engineering as part of a separate study (Benson et al., 2016). The survey included a question asking if the student was willing to participate in a follow-up interview and informed them of a $20 gift card incentive for participating. Students were selected for interviews based on their positive response to this question; any student who was willing to be interviewed was sent a link to schedule an interview. Participants were recruited over three semesters until the researchers identified no new major themes within the memos they wrote after each interview, indicating saturation was being met (Marton, 1988).

3.2 | Data collection

A key aspect of phenomenography is identifying and describing the participants' perceptions of their experience of the phenomenon in a specific context (Sandberg, 1996). With this in mind, we conducted semi-structured interviews that prompted participants to describe their experiences of the phenomenon (thinking about their future careers) in the context of their current engineering coursework. Our interview protocol had three parts: long-term goals (perceptions of their future careers), short-term goals (academic behaviors and decisions), and interactions between long-term and short-term goals (relevance of their education to their future careers). The interviewer prompted the participant to explicitly reflect on their experience of the phenomenon of interest (Åkerlind, 2012; Dall'Alba & Hasselgren, 1996; Marton, 1986). The interviews started with the question related to long-term goals: "What are your goals for the future?" The interviewer then guided the students through different aspects of their future goals (career, ideal, avoided, relevant skills) with a range of follow-up questions. The full interview protocol can be found in the Supporting Information, and information on the protocol development can be found in Kirn & Benson, 2018. Use of a purposefully developed and tested protocol ensured procedural validity through consistent prompting of participants (Walther et al., 2017).

Interview length ranged from 39 to 95 min and was audio recorded. Data collection occurred over the course of three consecutive semesters. Collecting data over multiple points in time does not follow the phenomenographic tradition but was necessary to compile sufficient numbers of interviews to reach the levels of saturation required by phenomenography (Marton, 1988). However, the context across the three semesters was consistent and did not pose a challenge to the objectives of phenomenography to identify student perceptions in a particular context. The use of commonly accepted phenomenographic data collection procedures, such as not interrupting or cutting off participants, allowed participants to fully describe their experience (Sandberg, 1996; Walther et al., 2017). To allow the interview experience over the course of multiple semesters to be consistent for all participants, we used the same semi-structured interview protocol and data analysis methods throughout the study, with no feedback from the initial data analysis (completed by the second author) affecting the data collection process (completed by the first author).

A concern with phenomenography is how an individual's explicit reflections on their experiences are formed during an interview; there is a possibility that the study is only capturing experiences as formed by the interviewer and interviewee at that moment (Dall'Alba & Hasselgren, 1996). The extent to which theories and concepts were compatible with the empirical reality, or pragmatic validation (Walther et al., 2017) was addressed during the interviews by using carefully worded prompts, using follow-up questions to check that the interviewer fully understood the descriptions provided by the participant, and establishing a balance of power between the participant and interviewers. For example, the interviewers, both of whom were graduate students, wore casual clothing, sat side by side with the participant, and established rapport with the participant.

3.3 | Data analysis

The interviews were professionally transcribed, and at least one researcher per interview listened to audio recordings of the interviews while simultaneously reading the transcripts to check for accuracy and for immersion into the experiences of the participants. A full description of our approach to the coding process can be found in Kirn and Benson (2018). In brief, coding was conducted line by line within each interview. The analysis consisted of iteratively reading the interview transcripts and identifying descriptions related to the phenomenon (Barnard et al., 1999; Marton, 1988) bounded by our theoretical framework, previous work (Kirn et al., 2014). Units of coding were short phrases or sentences. We created an initial codebook with broad themes after the initial analysis of the first nine interviews (Kirn, 2014) and the codebook was used to code the remaining nine interviews. Analysis continued iteratively as we identified emerging themes that allowed us to distinguish similarities and differences between the participants' experiences of the phenomenon (Åkerlind, 2012).

As our analysis continued, we refined the initial codebook into a more detailed codebook, reflecting a thematic inductive approach to coding (Hsieh & Shannon, 2005). We used Qualitative Data Analysis in R (RQDA), a qualitative coding tool, to mark text in the interview transcripts that fit within a code (R Core Team, 2016). We marked and re-examined participants' descriptions that did not fit within existing codes or needed refinement to distinguish between codes and created new codes as needed. In the finalized codebook, we broke the major themes into differentiated codes with definitions and example quotes for each code. The final codebook is included in the Supporting Information.

We then created a summary page for each participant in which key aspects of their experiences of the phenomenon were described based on the codes. Initially, hypothesized groups were developed based on similarities and differences in these summaries. The researchers then examined the proposed groups and discussed ways that participants fit into groups. We used the entire corpus of codes from the interviews to determine student classification into a specific group. Memoing of these discussions throughout the handling of the data ensured that the theory being generated reflected the social reality or theoretical validation (Walther et al., 2017). Specifically, the researchers discussed and created memos on potential biases, such as gendered stereotypes, and discussed alternative interpretations of the data. If questions about participants' meaning emerged, participants were contacted via email for clarification. During these discussions and memoing, no new groups emerged, indicating saturation, and within-group variations were clarified.

The final result of this analysis was a set of groups that are described in a consistent outcome space, focused around the final themes (Barnard et al., 1999). The descriptions and definitions of these groups were reviewed by experts in the field of FTP, authors of cited and supporting literature, and the descriptions were abbreviated to highlight delineating constructs for each group. By handling the data in the ways described above, we have ensured theoretical validation and that the final groups resulting from the analysis authentically represent the range of participant experiences (Åkerlind, 2012).

3.4 | Constructing the outcome space

As part of the process of identifying distinct groups, or ways of thinking, the groups were compared to one another for how they are distinct. Characteristics that distinguished each group from the other were identified and described in terms of existing literature. Those characteristics were visualized together as the outcome space in which the different ways of thinking exist.

Each group or way of thinking was visualized based on the holistic description of the groups; those visualizations were further refined based on existing literature. These visualizations are represented as different shapes. The shapes were then placed in the outcome space in a way that qualitatively helped distinguish between the groups. The shapes representing the individual groups all placed together create the outcome space of this phenomenographic study.

4 | RESULTS

4.1 | Outcome space

Our phenomenographic analysis revealed three distinct ways students conceptualized their FTPs, which were represented as differently shaped cones and frustum in the outcome space. The outcome space captures the interplay between participants' perceptions of their future careers and their behavior in the present, represented on two axes:

- Extension axis: how far into the future students are conceptualizing their future careers, ranging from near future to distant future.

- Alignment of ideal and realistic future possible careers axis: how aligned students perceive their ideal and realistic future possible careers to be, ranging from less aligned to more aligned.

The key themes that distinguish the three groups within the outcome space are shown in Figure 1. The length of the shape was determined by how far into the future participants perceived their possible careers. The radius of the shape, from the present to the future, was based on how well-defined the participants' descriptions of the future were (narrower indicated more detail about a fewer number of future possible careers). To communicate our results to a broad audience, we assigned the names of recognizable shapes to the FTP groups: Cone, Bowl, and Cup.

What follows are descriptions of the participants, including their FTP group, definitions of the three shapes representing FTP groups, and the relative positions of the three groups within the outcome space. The groups are described in order of their extension into the future, which allows us to describe the way of thinking that is most well-defined first without being redundant in our descriptions. We do not wish to imply any type of hierarchy or indicate a preference for Cone because we are describing the Cone first in each section.

4.2 | Description of participants

As shown in Table 1, 10 of the participants were BME majors, and 8 participants were ME majors. Sixteen of the 18 students identified as white, one student identified as African American, one student identified as being of African descent, and two students were international. Seven of the 18 students identified as female, and 11 identified as male. Racial and ethnic status is not attached to specific students to protect the anonymity of participants. Although students who identify as white make up a majority (63.7%) of undergraduate engineering students nationwide (Yoder, 2016), 16 out of 18 (88.9%) students identifying as white in this study over-represents the national average, which is a limitation of this study. The racial and ethnic demographics are representative for the Primarily White University (PWI) at which this study was conducted (83.2% white). In terms of gender, women are over-represented in this study population. Women constitute 13.8% of ME undergraduates nationally and 37.5% for this study; women make up 41.4% of BME undergraduates nationally and 40% for this study (Yoder, 2016). Table 1 includes pseudonyms assigned to participants and also presents the different ways students were grouped based on their FTPs as a result of this study. The evidence for these characteristic groups of different ways of thinking about their future possible careers is described in the results section.

4.3 | Representations of different ways of thinking about future possible careers

4.3.1 | Cone: Narrow and well-defined deep into the future

Students in the Cone group, visually represented as a narrow and long shape, as shown in Figure 2, believe they can attain their ideal future career and have established a narrow range of present tasks having perceived instrumentality

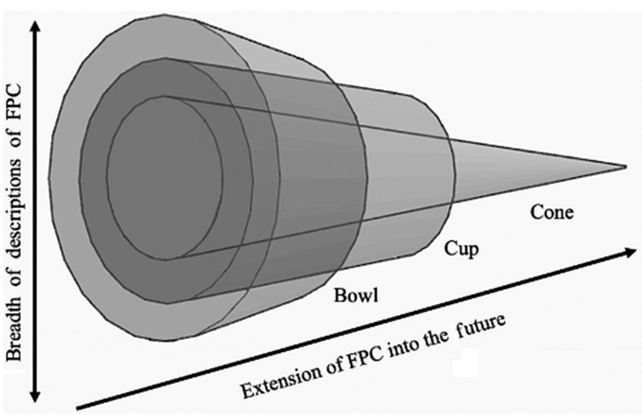

FIGURE 1 Three distinct ways of thinking about the future are represented as different shapes (Cone, Cup, and Bowl). Extension of future possible careers (FPC) is shown as length of the shape and the definition of participants' FPCs represented by the radius of the shape, with narrower indicating a more well-defined FPC

TABLE 1 Description of participants, their majors, academic year, and the phenomenographic future time perspective (FTP) group they were assigned to during analysis

Participant	Major	Year	Group
Katerina	BME	Sophomore	Cone
Katherine	BME	Sophomore	Cone
Bonnie	BME	Junior	Cone
Jeremy	BME	Junior	Cone
Matt	BME	Junior	Cone
Silas	BME	Junior	Cone
Chris	ME	Sophomore	Cone
David	BME	Sophomore	Cone
Emily	ME	Sophomore	Cone
Logan	BME	Sophomore	Cone
Will	BME	Sophomore	Cone
Stefan	ME	Sophomore	Cup
Jacob	ME	Sophomore	Cup
Caroline	ME	Sophomore	Bowl
Damon	ME	Sophomore	Bowl
Anna	BME	Sophomore	Bowl
Mary	ME	Sophomore	Bowl
Noah	ME	Sophomore	Bowl

Abbreviations: BME, biomedical engineering; ME, mechanical engineering.

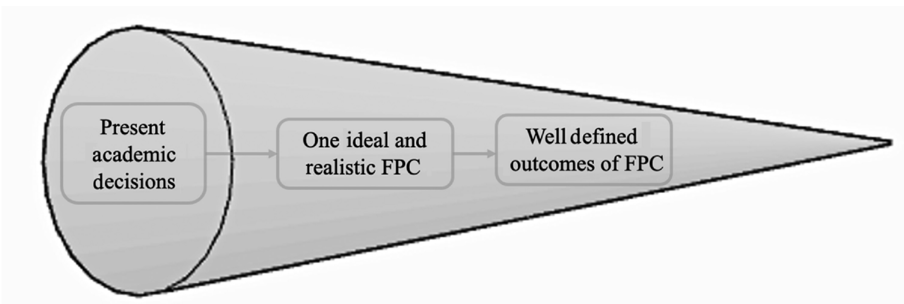

FIGURE 2 Participants describing a cone-shaped future time perspective (FTP) describe one well-defined future possible career (FPC, represented with the narrowing of the cone) deep into the future (represented by the length of the cone)

based on their specific ideal future possible career goals. They defined their FTPs with a high level of clarity extending deep into the future (well beyond graduation, and in many cases, up until retirement). They describe one ideal possible career that is well-defined and attainable, as well as the tasks most important in helping them attain it.

When asked to describe her future self in 10 years, one participant responded in detail:

> I really see myself in the [BME] field doing R&D for a company, orthopedics, possibly implants, whatever they have to offer and I could get excited about. (Emily, Cone group)

Another distinguishing feature of the Cone group was a matching ideal and realistic future possible career; their ideal career was also attainable. For example, one participant in this group, Katherine, established in her interview that being a radiologist working with a specific nonprofit medical organization was both her ideal and attainable career. Students in the Cone group also described outcomes of their distal future goals, such as being successful (Logan) or helping others (Will).

4.3.2 | Cup: Narrowed and defined up to the first job after graduation

Students in the Cup group described future careers that were well-defined, but when asked to describe where they see themselves in 10 years, they did not express future goals beyond their first job after graduation. This was represented by a truncated cone in the shape of a cup, as shown in Figure 3. These students did not believe their ideal future possible career was attainable but could describe both ideal and realistic future possible careers in detail. They determined their perceived instrumentality for tasks based on both their ideal and realistic possible careers.

One participant described his ideal career to be with [major aerospace company], but believed he could realistically attain a position at [major automotive firm], which matches his later description of his avoided future possible career:

> [I don't want to be] in a place that's really corporate like [major automotive firm]. Like, you can move up and it's a great job obviously right out of college, but I can only move up so much. And so that's one thing that I don't want to do forever and just being in a really corporate business. (Stefan, Cup group)

4.3.3 | Bowl: Open and broad perceptions of the future up to graduation

Students in the Bowl group described their future careers in ambiguous terms and often did not have a defined future possible career, even for their first job after graduation. For example:

> I don't really know what my future goals are yet, so kind of whatever experiences I can get now will hopefully help me in the future. (Caroline, Bowl group)

The breadth in their descriptions and short extension is represented as a broad and truncated shape, as shown in Figure 4. The students in this group believed they would be able to achieve their ideal future career once they defined it and used their present academic experiences to begin defining their future possible careers.

Because of their broad perceptions of the future, the Bowl group found most tasks to be useful for their future. For example, when asked what parts of her education she saw as relevant, one participant in this group (Caroline) responded, "All of it."

4.4 | Distinguishing between groups

After defining each of the groups identified in this study, we introduce a comparison across the groups, first in Table 2, then in text descriptions with supporting quotes.

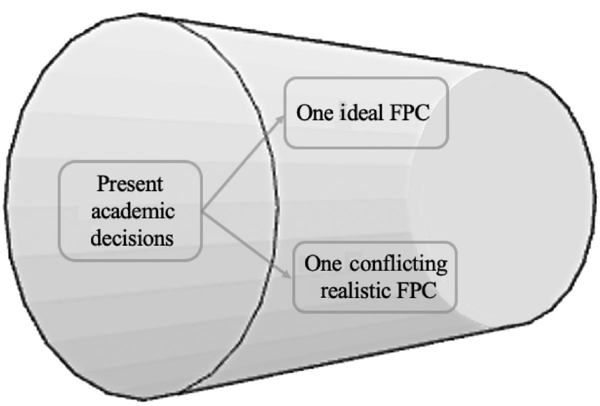

FIGURE 3 Participants describing a cup-shaped future time perspective (FTP) describe conflicting future possible careers (FPCs, represented with the slightly broader width of the shape) in their first career after graduation (represented by the truncated length of the shape)

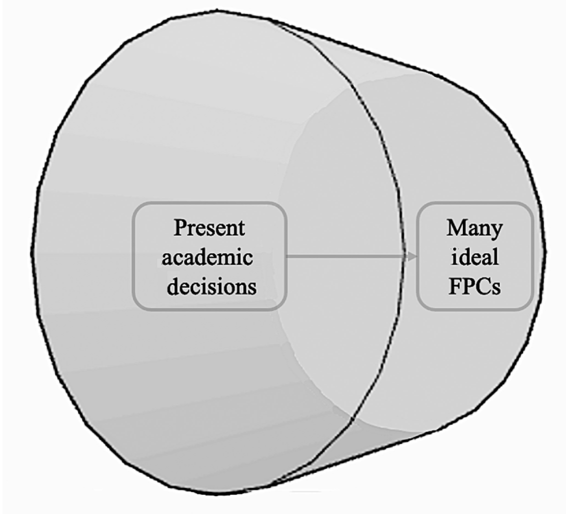

FIGURE 4 Students describing a bowl-shaped future time perspective (FTP) have broad, ill-defined descriptions of their many possible future possible careers (FPC, represented as a large radius of the shape) with limited descriptions of their future after graduation (represented with the short length of the shape)

TABLE 2 Description of the key features, representation in the outcome space, and definition for each grouping

	Representation in outcome space	Cone	Cup	Bowl
Extension of future career goals	Length of shape	More depth (i.e., up to retirement)	Some depth (i.e., first job after graduation)	Less depth (i.e., up to graduation)
Definition of future career goals	Width (diameter) of shape	More definition	Some definition	Broadly defined career goals
Alignment of future possible careers (FPC)	Descriptions within definition of FPC	Attainable ideal FPC and avoided FPC distinct yet in the same field	Conflicting ideal and realistic FPC. Realistic FPC is also avoided	Ideal FPC is possibly attainable. Avoided FPC is in an unrelated field
Relationship between future and present	Descriptions within extension of the future	Narrow	Some breadth	Broad

4.4.1 | Definition and extension of future career goals

Students varied in how far into the future they described their possible careers and career goals and how well-defined their descriptions of those careers and career goals were. The amount of detail aligned with the level of extension in students' descriptions of their future career goals. Despite these characteristics being represented in two different ways on the shapes (defined as the width of the tip and extension as length), they are best described together, as this is how they appeared in the data.

Students in the Cone group described their future possible careers with more definition than students in other groups.

> I'd like to work on creating more organic implants for like, like bad breaks and such, um, I don't really know the title or what, how you'd classify that but, um, right now if I could choose I really want to do work in that field where, because right now you put metals and all sorts of stuff in people's bodies, but after 20 years they break down, it doesn't work, you've got to go back in and that's all sorts of trauma to the tissue and just, I feel like there's a better way for that. (Matt, Cone group)

Students in the Cup group described their future possible careers with some detail, but with a focus on their first job after graduation and their employers:

> I'd really like to work for [major aerospace company]. Especially because I live in [nearby city] right now, and they have a plant, factory, whatever. They're expanding like crazy so they've got all sorts of stuff down there. I'd love to work there and help them build airplanes and stuff. (Jacob, Cup group)

Students in the Bowl group defined their future in terms of careers they did not want to do and desired characteristics of future careers. When asked, "What are your goals for the future?" these students often responded with uncertainty, with statements like "I'm not sure …" or "I don't know…." Noah responded to this question as follows:

> I don't really have a set career goal. I definitely want to move up but I don't want to be in a position to where there's not a separation between work and life. I'm open to working overtime and different things like that but I don't want it to be where I'm constantly having calls and things like that while I'm at home. I'd like to move up and I'd like to be successful in my career but money's not the most important thing. I think engineers make good salaries but if I wanted a bunch of money I would've become a doctor or something like that. (Noah, Bowl group)

Unlike the Bowl and Cup groups, the Cone group described their future well beyond their first job after graduation, as demonstrated by the quote from Jeremy, as well as outcomes from their future possible career as shown in Will's quote below:

> Um, I'm going to stick with the undergraduate BME program, pursue a master's and then, um, my goal is to ultimately work for a medical device company in research and design so, yeah, that'll be the ultimate goal. Probably Ph.D. also after I start working, too, so. (Jeremy, Cone Group)

> [My ideal medical practice would be] a really family friendly environment, just serving other people. That's what I really want to do. And I like to help people, see people feel better and succeed. So that would be my ultimate goal is to help people. (Will, Cone group)

4.4.2 | Alignment of future possible careers

Further distinguishing these three groups is the way they differentiated between their ideal, realistic, and avoided future possible careers. Cone and Bowl groups perceived their ideal future possible careers as being attainable. For example, David (Cone group) described his ideal future career as "a project manager working on the innovation of prosthetic limbs, like being able to fully integrate them with nerve cells, and making them lighter," which he believed was attainable because "there is always more to do, more ways to improve medicine and prosthetic limbs." However, students in the Cup group had conflicting ideal and realistic future possible careers:

> [Ideally, I see myself] like, working in a factory, [but realistically] I'm not expecting that to happen. (Jacob, Cup group)

Students in the Cup group indicated that they may achieve their ideal future possible career in the distant future; however, their perceptions of the future did not extend beyond the first job after college.

> Um, I, right now if you asked me what would probably happen, I would probably end up taking the position at [major automotive firm] …. I guess I can't really speak for what I'll feel like in 10 years. (Stefan, Cup group)

The way students described future possible careers differed based on how aligned their realistic and avoided future possible careers were. For the Cup group, as demonstrated in the quotes above about ideal and realistic future goals, these two were aligned within the same field, but the Bowl group identified avoided careers as being in unrelated fields. Students in the Cone group split the difference between the two groups as their realistic and avoided future possible careers were similar yet clearly distinct. For example, Will (Cone) described his ideal and realistic future possible career as being a cardiothoracic surgeon with his own practice, while his avoided future possible career was being in general medical practice. Silas (Cone) echoed this theme:

> Ideally, I think the anesthesiologist assistant or any sort of person in, you know, a hospital setting would be a goal. I've never really wanted to be like a surgeon or a doctor. (Silas, Cone group)

In contrast, Damon (Bowl group) described an avoided career unrelated to his ME degree:

> I don't want to be a garbage man or sort of a standard factory worker. I don't want to necessarily just work at a desk all day. (Damon, Bowl group)

Unlike Cone and Cup groups, the Bowl group defined desired characteristics of their future careers when discussing the specific jobs they wished to avoid in the future:

> I wouldn't want to be stuck doing just one tiny part. I'm a big picture person so it would be really fun to be involved in all aspects of something. (Caroline, Bowl group)

4.4.3 | Relationship between future and present

As the participants' perceptions of the future narrowed, so did their perceived instrumentality or aspects of their present tasks that would be useful for their future (widest point on the shape). Students in the Cone group described specific coursework or skills that would or would not be useful in attaining their future career goals and how they prioritized that coursework.

> I'm definitely going to be inventing things. I need to have their weights balanced out properly. I'll have to have enough force going into whatever pieces I need. With Statics and Dynamics, of course, that's all it is. With that, I'll be able to properly configure my machines, my inventions so that they work as I want them to, and without Statics and Dynamics, I would not be able to even come close to that. (Chris, Cone group)

> I definitely do judge things based on if I think this will apply later on in life. Do I need to actually understand it? Or is it just something I need to get done, in which case I just get it done and not put as much time into trying to understand it if it does not click right away. So probably just like, how much effort and focus into understanding the current problem I put into and depending on if I see it applicable later on in life. (Katerina, Cone group)

Students in the Cup group also described skills that could be useful in their ideal or attainable careers, but with more breadth than those in the Cone group:

> Definitely classes like Statics and Dynamics [are relevant to my future] … and those kinds of classes. Those definitely have a lot of real-world applications to it. Other math classes like [Ordinary Differential Equations] and stuff, not so much. But any level courses, like … [Mechanical Engineering Laboratory] those definitely seemed like they had a lot of relevance to a real-world job. (Jacob, Cup group)

The Bowl group did not describe their future as influencing their present behaviors; however, these students did describe a broad range of tasks with perceived instrumentality to fit their broad definitions of their future possible careers:

> I think pretty much all of it [my education] is [relevant] because even when going down to the level of dealing with a professor, it relates to dealing with a boss. You can have a good professor or bad professor, a good boss or a bad boss. You have one that has reasonable requirements or one that has unreasonable

> requirements. I've had both and so that teaches you that. Learning the technical skills that we'll be using in the actual job to solve real-life problems. (Noah, Bowl group)

Students in the Bowl group focused on opportunities in the present that provided them with a breadth of opportunities in the future:

> I'm not trying to force a future for myself at this point. More so, be out there looking and embrace what opportunities are given to me. I used to be dead set on like what I wanted to do but I realize that's not necessarily going to make me happy where I want to be. (Mary, Bowl group)

Unlike the Bowl group, students in Cup and Cone groups described a feedback loop between the present and the future, where the future informs the present, and the present informs the future. Anna (Cone group) described her first job after graduation as being hands-on and eventually working up to a management position because "that is the logical progression." When describing their future goals, students in the Cone group described one or more contingent goal paths that lead to those possible selves:

> I'm going to stick with the undergraduate [BME] program, pursue a master's, and then my goal is to ultimately work for a medical device company in research and design. So, yeah, that'll be the ultimate goal. Probably a Ph.D. after I start working, too. (Jeremy, Cone group)

Students in the Cup group also describe how their future goals were influencing their current actions, such as applying to internships or graduate school.

> I'm trying to figure out two paths that I want to go, possibly. I'm an ME, so I could possibly just do summer internships and go straight into the industry when I'm done with my undergrad and hopefully get a master's through the company that I join, or I could go the other route. I'm doing [BME] research, and I really enjoy it, so I may choose to go straight into my PhD in [BME], in which case, I'll need to look for a graduate program after school. (Emily, Cup group)

In both of Emily's contingent goal paths, she described a series of goals that are dependent on each other to achieve her ideal future possible career. She described actively striving toward both paths and described both paths with some level of clarity.

4.4.4 | Summary of distinctions between groups

As highlighted in Table 2 and throughout our description, students in the Cone group displayed future goals that project deep into the future (~30+ years) that defined a narrow band of tasks that they viewed as relevant in the present. In contrast, the Cup group had less depth into the future (~10 years), had conflicting future ideals and realistic future goals, and saw a range of present tasks as relevant to their future goals. The Bowl group did not establish future-oriented goals beyond graduation and viewed all present tasks as potentially relevant to their future.

5 | DISCUSSION

First, we provide evidence of the different ways MYE students engage with their future careers and selves. Second, through reflection on their future possible selves, MYE students created different perceptions of their future careers that may or may not be aligned. Finally, we identify how students' different ways of thinking about the future impact commitment to short-term and long-term tasks in courses. These main contributions are captured in the description of three distinct FTP groups in our phenomenographic outcome space. In alignment with the philosophical underpinnings of phenomenography, we tie distinguishing aspects of these groups to the literature on students' time-oriented motivation, with the understanding that populations in some of these prior studies differ from our study.

5.1 | Perceptions of future career and future possible selves

Our findings illustrate the different ways students construct their futures. Students in the Cone group expressed a high level of detail and depth in defining their future possible careers, defined specific desired outcomes of their careers, and created contingent goal paths. The increased depth and specificity of the Cone group's FTPs, while narrowing their perceptions of their future goals and what present tasks are relevant to achieving those goals, could lead to their increased valuing of future goals (Husman & Shell, 2008).

Students in the Bowl group had shorter FTPs, and they defined general rather than specific traits of their future possible careers. The Bowl group made connections between a wide variety of present activities and their potential future selves and leveraged the intrinsic enjoyment of learning during present tasks. This conceptualization of the future by the Bowl group may allow them to develop the broad range of skills required of engineers (Litzinger et al., 2011) if their engineering courses can leverage their intrinsic motivation for learning (Nelson et al., 2015). If not appropriately leveraged, it is possible that this shorter depth into the future can lead college students to adopt practices not conducive to learning (Fryer et al., 2016) and may lead to decreased motivation for present tasks (Husman & Lens, 1999; Raynor, 1969).

Students in the Cup group fell between those in Cone and Bowl groups in terms of depth and clarity of future career goals, for example only describing a future career beyond 10 years after graduation. Like the Cone group, the Cup group valued future goals, but like students in the Bowl group they did not express desired outcomes for their future careers that could foster their future-oriented motivations.

The discussion of future career goals or attempts to establish career goals by students in all three groups mirrors previous work showing that engineering students prioritize career-related goals when discussing their futures (Hilpert et al., 2012). Previous research has shown that engineering students discuss their careers through the lens of future possible selves (Kirn & Benson, 2018). Specifically, students discussed ideal selves; realistic or attainable selves; and avoided undesired selves. This reflected findings from research in education and psychology (Oyserman et al., 2004; Pizzolato, 2006).

5.2 | Alignment of future possible careers

We extend previous FTP research by highlighting variations in the ways engineering students operationalized their future career goals. We found that students in the Cone group did not distinguish between ideal and realistic future possible careers, which served to create a focal point (a single career goal) for their FTP. However, their highly developed perceptions of the future allowed them to distinguish between ideal and avoided careers in fine detail and to balance these possible selves. Balanced work-related possible selves have also been correlated to stronger intentions to pursue careers in engineering (Koul, 2018).

Students in the Cup group did not have closely related ideal and avoided future possible selves; their ideal, attainable, and avoided selves were distinct from each other. This broader range of future possible selves created multiple focal points or career options in Cup FTPs. Multiple distal goals have been found to limit the extent to which undergraduate students project into the future (Fryer et al., 2016). While students in the Cone and Cup groups established future possible selves, students in the Bowl group did not establish future selves that extended beyond graduation. Although there are correlations reported between low future-oriented motivation and reduced levels of deep approaches to learning (Fryer et al., 2016), in our study students in the Bowl group indicated that they see everything in their courses as potentially relevant to their future, which could allow for deep approaches to learning (e.g., trying to understand how different concepts are related) and an openness for emerging opportunities that students had not been aware of.

5.3 | Interactions between perceptions of future career goals and present tasks

Students with detailed FTPs may be more likely to determine which present tasks are useful for their future goals (perceived instrumentality) and fall within their contingent paths (Husman & Lens, 1999; Raynor, 1969) and which ones just need to get done without being explored deeply (Husman et al., 2004; Husman & Lens, 1999). Perceived instrumentality manifested itself differently in the three groups, so the same task could be perceived differently for students in different groups. Students in the Cone group had a narrowly defined set of tasks they viewed as relevant for their well-defined futures. In contrast, students in the Bowl group viewed all tasks as being relevant to their relatively undefined futures, and students in the Cup group determined the relevance of present tasks in terms of readying themselves for a range of ideal, realistic, and avoided future possible careers. A task perceived as relevant to a student in the Bowl or Cup group will likely be met with increased task persistence (Kirn & Benson, 2018), but the same task may be perceived by a student in the Cone group as being less relevant for their future, who would complete it as expediently as possible (Kirn & Benson, 2018).

In making judgments about what is useful for achieving future goals, students in the Cone group are likely to consider the present tasks that must be completed to reach their near future goals, which, in turn, enable them to obtain their more distant—but very specific—future goal. This relatively narrow contingent goal path (one task depending on another to reach a goal) would result in these students perceiving a limited number of tasks as having perceived instrumentality; there are only so many tasks that are needed to achieve their specific future goal. However, students in the Cone group also created feedback loops wherein they refined their perceptions of their future careers; as they accomplished tasks in the present, they generated more well-defined perceived future careers, which, in turn, determined the instrumentality of present tasks. Similarly, students in the Cup group established connections between the future and the present that were directed by judgments about the perceived instrumentality of present tasks. Students in both the Cone and Cup groups worked to limit which tasks they viewed as having little relevance to their futures.

6 | IMPLICATIONS FOR PRACTICE

Insights into the connections between engineering students' time-oriented motivations and their perceptions of present tasks in their engineering courses can help educators understand students' varied reactions to certain types of course activities (e.g., students may or may not perceive activities as relevant to their future goals) and can help educators make informed choices about what to present and how to present it. We focus here on how educators could leverage our findings about engineering students' FTPs to help students foster interest in and value of learning engineering concepts, develop positive perceptions of their future careers, and use effective learning strategies.

6.1 | Fostering interest in and value of learning engineering concepts

Educators can leverage existing disciplinary seminars and speakers, which most academic departments host, to incorporate discussions about students' potential future paths. Seminar speakers could be invited to visit MYE classrooms, or MYE students could attend seminars in which speakers have been asked to discuss possible career paths in engineering and related fields. These explicit discussions can help students envision themselves in their future possible careers and find relevance in their coursework to those possible careers. Some affinity groups, such as discipline-specific professional organizations and student clubs, may also provide opportunities for guest speakers from industry, medicine, government, or nonprofit organizations to discuss future career paths.

Our findings, however, show that not all students will respond the same way to these discussions of their future in engineering. Understanding students' valuing of a task and the subsequent approaches they take to complete the task sheds light on why students with similar levels of academic preparation and performance may reach different levels of understanding in the same course (Husman et al., 2007; Malka & Covington, 2005). Students in both the Cone and Cup groups expressed how they approach tasks differently based on the value they place on those tasks.

Our findings related to students valuing tasks that are relevant to their lives support the use of interventions prompting students to reflect on how course content is related to experiences in their own lives. This type of intervention was developed as part of an online engineering course by Heddy et al. (2016), which resulted in increased value that students placed on course content. Motivational interventions have been used to enhance engineering student performance and foster interest in engineering by increasing their perceived instrumentality for the content they are learning. For example, Puruhito et al. (2011) observed increased first year engineering students' perceived usefulness of their course after they watched videos of experienced engineering students describing the importance of that course.

Helping students find value for present tasks in terms of reaching their future goals can help them further refine their future goals, and vice versa, regardless of their current FTPs (Husman et al., 2016). Our findings show that for some students, expected outcomes of future careers are very specific, but for others, these outcomes are broadly defined, for example "to help people, see people feel better and succeed" (Will, Cone group). Instructors can leverage these motivations and expected outcomes to identify ways that course activities connect to broad goals like improving people's lives.

6.2 | Positive perceptions of the future

As practitioners, we need to be aware that our students likely have a way of thinking about the future that is different from our own. As such, we need to guide students to connect tasks to their own perceptions of their future. For example, when describing their career aspirations, students in the Cone group distinguished between aspects of professional fields at a level of detail that educators might find surprising. These students noted that perceiving certain tasks as relevant to their future gave them reasons to work harder, focus more, and strive for learning over memorization.

MYE students have access to opportunities such as co-ops, internships, and study abroad that can influence their perceptions of their future possible careers. When opportunities arise, we should ask them to reflect on these experiences. Prompts such as, "How has your experience affected your perception of the future," could provide opportunities for students to envision themselves in the future. It is also important to present students with a range of options for applying their engineering skills and knowledge, for example exploring careers in related professions such as medicine and law, and in positions that do not involve the term "engineering" in the job title (Rohde et al., 2020).

6.3 | Effective learning strategies

Students are more likely to use strategies that are adaptive for learning if they view that task with perceived instrumentality or as being useful (Husman & Lens, 1999). Adaptive approaches to learning could lead to students being more self-regulated learners (Pintrich, 1999). In related work about students' FTPs and self-regulated learning (SRL), a connection between students' SRL strategies and the extension of their future goals was found; students with distal future goals prioritized SRL strategies for tasks they deemed as relevant to those goals (Chasmar, 2013).

Although it may be more challenging to motivate students in the Cone group to use knowledge-building strategies on tasks for which they have low perceived instrumentality (Peteranetz et al., 2016), it is possible for educators to design tasks that leverage the contingent nature of these students' goals, or their focus on pathways leading toward their future goals (Husman & Lens, 1999; Raynor & Entin, 1983). With the understanding that students would view tasks that are not part of their contingent path as being valuable only to the extent that they achieve a specific outcome (Raynor, 1969; Tabachnick et al., 2008), educators could introduce tasks as being relevant to near future goals, for example explicitly identifying how certain material is a prerequisite for a follow-on course or providing examples of how an activity will prepare students for success in an internship that is critical to successfully gaining employment in their field.

7 | IMPLICATIONS FOR RESEARCH

This study adds to existing motivation literature in the engineering education community, specifically expanding FTP literature in terms of MYE students' perceptions of their future careers. The results of this study include a detailed codebook that can be used in future research as a tool for understanding time-oriented motivation theories in an engineering context. The axis system and the three characteristic FTPs constitute a framework for describing the attributes of engineering students' time-oriented motivations, which can be used to evaluate evidence-based interventions aimed at fostering and leveraging student motivations in and out of the classroom. In addition, the visualization of these characteristic FTPs as different recognizable shapes provides a rich representation of abstract concepts.

8 | LIMITATIONS

This study was conducted at a single, land grant, research-intensive university by design, as a phenomenographic approach requires a consistent context in which the phenomenon is described. We believe our findings are meaningful beyond our study setting because students' FTPs intersect with their learning environments regardless of the educational context. However, the university is a predominately white institution, and the study population was primarily white. With the understanding that "race and ethnicity are implicated in the way that students perceive and interpret the social dimensions of their school environments" (Gray et al., 2018, p. 97), our findings may not apply to students of color and other demographic groups. Career trajectories intersect with structural racism and systems of oppression that white students do not experience, and Asian, Black, Latinx and Native American students may construct different visions of career paths.

Purposive sampling was limited to the identification of our population of interest, mid-year BME and ME students. Due to a low response rate on invitations for the interviews, participants were self-selected and not purposefully selected for variation in social identities such as race and gender. Such social identities likely influence how students think about their futures in engineering and should be considered for future work. Additional contexts for understanding students' experiences could be included, such as socioeconomic status. We did not collect data from students regarding social identities such as socioeconomic status, which is a limitation of this study. For future work, it is important to note that many students' perceptions of their future possible careers will be affected by their own socioeconomic realities. Future work will include additional contexts such as social identities.

9 | FUTURE WORK

The results of this study can be expanded by exploring how these conceptualizations of FTPs extend to other populations within engineering and how these different conceptualizations serve to influence students' behavior in and out of the classroom. Future studies will include replication studies at other institutions that reflect engineering student populations not represented by our current participants, including those who are underrepresented in engineering (Pawley, 2017). Additional work is needed to understand how students' characteristic FTPs change over time. Our work represents a snapshot of MYE students but does not address how significant experiences such as design courses, internships, or employment after graduation may serve to shift students' FTPs. These expanded studies are likely to reveal more characteristic FTPs for engineering students, for example, students who lack or have negative perceptions of their future possible selves or future careers in engineering.

Additionally, work is under way to use these results to develop a survey instrument to quantify characteristics of students' FTPs. The goal of the survey is to allow instructors, particularly instructors with large class sizes who may not be able to learn about every student's perceptions of the future, to quickly understand the range of motivations that exist within their classrooms. Developing a survey instrument will also allow for increased generalizability of findings related to the different profiles of motivations that exist within engineering. Finally, we propose connections between elements of the FTPs described in this study to specific practices within the classroom based on supporting literature. Future work is needed to understand how the interactions of the elements that create each FTP type influence students' academic behaviors and learning.

10 | CONCLUSIONS

This phenomenographic study resulted in descriptions of three characteristic ways that engineering students think about the future and the ways in which those future perceptions interact with their perceptions of academic tasks and activities in the present. We describe these characteristic time-oriented motivations, or FTPs, as different shapes in an outcome space defined by elements of FTP literature: extension of future careers, attitudes toward future possible careers, and perceived instrumentality of present tasks. We have labeled these different recognizable shapes as Cone, Cup, and Bowl to help readers visualize the FTP elements and their relationships.

The Cone group has a long extension into the future for their career goals, often up to retirement. Their matching ideal and realistic future possible career goals allow them to narrow their perceptions of the future and result in a narrow definition of what present tasks they perceive as having instrumentality. The Cup group has a mid-range extension into the future for their career goals (up to the first job after graduation). Their conflicting ideal and realistic future possible careers prevent their future perceptions from extending much beyond graduation but broaden their perceptions of tasks that have perceived instrumentality to include those relevant to both their ideal and realistic future possible careers. The Bowl group has broad perceptions of the future, with the belief that keeping many options available will provide them with an ideal future career, which is not yet defined. This results in a shortened extension into the future of their career goals (up to graduation). These students perceive tasks as having perceived instrumentality in most academic pursuits because, with their ill-defined perceptions of the future, anything may be useful for their future possible careers.

Through this work, we have generated a model of the range of students' time-oriented motivations that exist within engineering education environments. This model, developed from interviews with 18 MYE students at a predominantly white institution, highlights the ways in which students incorporate ideas about engineering practices and personal priorities to create their FTPs. Our model displays a limited range of FTPs for MYE students, thus providing researchers and educators with discrete ways to understand how students' motivations may influence their academic performance and how interventions may influence students' motivations in the engineering classroom.

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