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An Analysis of Career Motivations and Aspirations of Canadian Undergraduate Engineering Students by Engineering Major

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Introduction

Engineering students, broadly speaking, attend post-secondary education with varied interests and motivations, bringing generic assumptions about what engineering is and what engineers do. They often select engineering majors (also referred to as "disciplines" or "programs") based on these assumptions [1]. According to Sheppard et al., a problem lies in the fact that "academic programs are often designed based on a projected image of engineering practice. However, this image may be outdated or misaligned with today's actual professional work" (p. 1) [2]. To exacerbate this situation, engineering career paths are expanding and becoming increasingly complex, further challenging students with conceptualizing and navigating their education and career trajectories [3]. Moreover, there may be misalignment between academic programs and the needs of industry.

Engineering identity, which is described as "the process of identifying with engineering, developing an engineer identity, and becoming an engineer" [4] can also influence career paths in different ways. One way is through retention, while another (due to its influence on persistence in the field) is employment preference in terms of roles and company fit. A national survey of 6,722 engineering students across the US has shown that student goals, values, and self-perceptions differ by engineering major [5].

The purpose of this paper is to explore how motivations, self-identity and aspirations vary by major in undergraduate engineering programs. It uses findings from a pan-Canadian survey on career motivations and aspirations of undergraduate engineering students conducted in 2023.

Background and Literature Review

Students struggle with career decisions throughout their undergraduate years, often contemplating options with no direct relationship to their undergraduate major [6]. Studies have also found that declaring an engineering major is unrelated to plans to persist in engineering post-graduation, and satisfaction with an engineering major does not necessarily translate to a student pursuing an engineering career [7] [8]. On the other hand, Masi et al. found that "although a student's major is not always directly linked to his or her career choices, it is often an accurate predictor of his or her career pathways" (p. 8) [9]. Brunhaver et al. found that when studying the careers of engineering graduates four years after graduation, certain engineering majors (i.e. mechanical, chemical) were more likely to be employed in engineering-related jobs than industrial engineering majors, for example [10]. Additional studies suggest that the nature and culture of specific engineering majors may result in tighter coupling with engineering career pathways (e.g. civil engineering majors reported the highest rates of working in the same field as their major two years after college); but postulate that personal aspects of students' individual predispositions in the major might explain this coupling [8] [11].

In 2025, in a US study of ABET-accredited institutions, Kim & Katz used survey data from a national survey of final year engineering students to understand factors associated with engineering students' likelihood of pursuing careers in the non-profit/NGO and public policy/government sectors [12]. Results revealed different predictive factors for careers in the non-profit/NGO and public policy/government sectors. While factors in students' career satisfaction predicted careers in the non-profit/NGO sector, interest in working on certain topics predicted careers in the public policy/government sector. Certain disciplines such as aerospace, environmental, and civil engineering were associated with students' interest in working in the public policy/government sector.

In terms of developing an engineering identity as a student, Tonso has claimed that engineering education matters because "as students moved through engineering education, they participated in complex sociocultural productions underpinning engineering identity" (p. 276) [13]. For example, the work of Seymour and Hewitt found that a lack of identification with engineering could cause students to migrate out of engineering and into other majors [14]. This is especially true for minority and under-represented students [15]. Lichtenstein et al. said that "some have argued that undergraduates might have undeveloped (or under-developed) professional identities related to the careers associated with their college major. Consequently, students might not believe that their undergraduate degree binds them to a related career" (p. 228) [6]. Finally, different studies highlight how the relationship between engineering identity and career path is bidirectional. Meyers et al. argued and showed that students with future career plans to continue in an engineering related field post-graduation are more likely to self-identify as an engineer [16]. Godwin et al. found that students who developed a strong engineering identity were more likely to pursue a career path in engineering [17].

A clear picture of how these motivations and aspirations may be similar between institutions but may differ by engineering program (i.e. major) can potentially assist in enhancing retention in, and diversification of, the engineering profession. In Canada, an initial effort took place in 2015 using student surveys at one engineering school in Western Canada [18], and a more comprehensive second effort involving six engineering schools across Canada was initiated in 2023, resulting in some promising findings from preliminary analyses. Differences in employment preferences were found by gender, year of study, and institution [1], and this work builds on that study.

Research Questions

We explore three core research questions in this paper, concentrating on the relationship between engineering majors and career preferences, self-identity as an engineer-in-training, and motivations for pursuing studies in engineering:

1. Do preferences for employment in different types of organizations and in doing different types of activities in professional practice vary between engineering majors?
2. Do motivations for going into engineering studies and self-identity as an engineer-in-training vary between engineering majors?
3. Do career motivations and preferences for certain "employment trajectories" vary between engineering majors?

We hypothesize that the answers to these questions are "yes" and that this study's results will help to illustrate how they differ, and how they are similar.

Methods

A survey was designed in late 2022 at the University of Saskatchewan, and minor variants were developed at five other Canadian schools: the University of British Columbia, the University of Waterloo, Queen's University, McGill University, and the University of Prince Edward Island. In Sept/Oct 2023, each of these schools sent a link to their voluntary anonymous survey to all undergraduate engineering students from their institution. Each survey contained approximately 45 questions, typically taking students 10-30 minutes to complete. Questions were primarily yes/no, multiple-choice (inc. Likert scale), multi-choice, or sliding scale, and several included an open-ended "other" response option. There were several fully open-ended questions that asked respondents why they had responded as they did, to a prior question. Surveys were approved by the human research ethics boards of all six participating institutions, and survey data was gathered using SurveyMonkey™.

The responses used in this specific study were drawn from multiple choice or multi-choice survey questions, where "other" response options were available in some cases. The specific survey questions are shown in Table A1 in the Appendix. Approximately 2500 students started the survey (a response rate of ≈10%; ranging from 4–16% across institutions) and most questions had about 1900-2000 complete responses. This response rate range is in line with those for other studies of this type [12].

For each of the three research questions investigated in this study, the relevant data was pulled from the overall survey dataset and then it was cleaned to retain only complete responses for each research question. In other words, if a respondent had failed to respond to any of the questions (or any parts of questions) in the relevant survey questions for a given research question, then all the respondent's responses were discarded. The result was 1856 "clean" response sets for the first research question, 1873 for the second, and 1742 for the third.

A total of 29 distinctly named majors were offered across the 6 participating institutions. Nine (9) of them were offered in at least three institutions: Chemical/ChemBio, Civil, Computer, Electrical, Environmental/Sustainability, Geological/Mining, Mechanical, Engineering Physics, and First Year/Undeclared (where the 4 sets of dual combinations were deemed to be sufficiently similar to be considered the same major). These were then called our "common majors".

Another 10 categories were used to cluster all 29 distinctly named majors, which included any smaller, more specialized programs. These clusters/groups were based on core topical or thematic similarities between majors and included: Bioengineering/Biochemical/Biomedical (BBB), Mechanical/Manufacturing/Materials (MMM), Chemical/Engineering Chemistry (ECE), Applied Math/Engineering Science/Engineering Physics (AMESEP), Architectural/Civil/Geological/Mining (ACGM), Electrical/Computer/Software (ECS), Environmental/Sustainability (ES), Integrated/Systems/Nano/Management (ISNM), Mechatronics/Robotics (MR), and First Year/Undeclared (FYU).

Details on the 29 distinctly named majors and the 10 clusters are shown in Table A2 in the Appendix.

Results

Responses were characterized using descriptive statistics and response pattern comparisons, with significance testing and analyses of variance.

<u>Research Question 1: Preferred Types of Organizations and Activities by Major</u>

For the survey question that probed the level of interest students had in working in different types of organizations, the Likert responses were numerically coded with –2 corresponding to "definitely do <u>not</u> want to work in this type of organization" to +2 for "definitely do want to work in this type of organization". Figure 1 shows the results for the 9 "common majors" (see Methods). Private Industry was the vastly preferred organizational type for all disciplines, with non-profits/non-governmental organizations (NPs/NGOs) being a preferred choice for students in environmental/ sustainability majors, and government being preferred by civil and environmental/sustainability majors. Academia was negatively viewed by all majors except the Engineering Physicists.

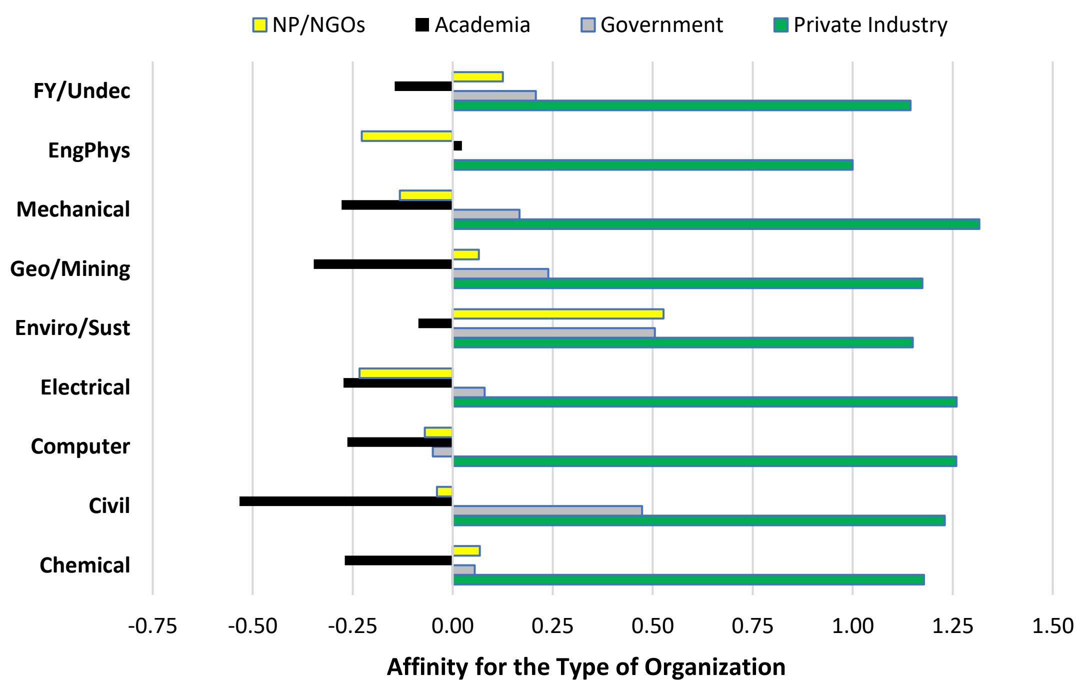

Figure 1: Preferences for employment in different types of organizations, by common major. Horizontal axis represents average affinity for the organizational type, where zero is neutral, and the possible range is -2 to +2 (n=1856).

A one-way ANOVA was conducted to determine the effect of engineering common majors on interest in working in different types of organizations (private industry, government, academia, or NPs/NGOs). Results indicate that major has a significant effect on interest in working in government ($F(8,1281) = 3.894$, $p < 0.001$) and NPs/NGOs ($F(8,1281) = 5.779$, $p < 0.001$), while no significant effect was obtained for work in private industry and academia. Post hoc analysis indicated a higher mean for interest in Government jobs for the Enviro/Sust major compared to Computer ($p = 0.001$), Electrical ($p = 0.044$) and Chemical ($p = 0.017$) majors.

Students in Civil engineering also had a higher interest for Government jobs compared to those in Computer (p = 0.003) and Chemical (p = 0.039) majors. Students in the Enviro/Sust major had a higher interest in work in NPs/NGOs compared to Civil (p = 0.002), Computer (p < 0.001), Electrical (p < 0.001), Mechanical (p < 0.001), Chemical (p = 0.035), Eng Physics (p = 0.001) and First Year/Undeclared (p = 0.014).

The question that asked students which activities they wanted to do in professional practice showed an overall preference for "designing things", "solving/analyzing problems", and "helping society". The full results across all activity choices are shown in Figure A1 in the Appendix. When disaggregated by the nine "common majors", clear preferences emerged, as shown in Table 1. "Keeping the environment safe" was a relatively preferred choice for students in the environmental/sustainability major, as was "field work" and "travel" for geological and mining.

Table 1: Eight of 19 categories describing activities that students want to be doing as practicing engineers, by common major. Percentages are of all responses by common major i.e. columns total to 100% (for all 19 activity categories). The 8 activity categories shown each had at least one difference between two majors ≥ 5%. Colour coding/shading is by row (activity). In total, n=1856 respondents and 7942 responses.

	Chem	**Civil**	**Comp**	**Electric**	**Env/Sus**	**Geo/Min**	**Mech**	**EngPhy**	**FY/Und**
design things	8.3%	10.3%	16.0%	13.1%	9.4%	5.9%	14.1%	12.6%	12.0%
field work	5.6%	7.4%	2.0%	4.7%	9.9%	14.6%	4.5%	4.0%	5.8%
travel	6.1%	8.9%	5.4%	5.6%	6.2%	11.2%	6.9%	6.3%	5.9%
solve/analyze problems	13.8%	9.8%	16.0%	11.7%	8.2%	10.2%	11.5%	14.9%	11.3%
discover new things	7.8%	4.0%	6.6%	5.4%	4.7%	4.4%	6.9%	11.5%	9.2%
lab work	6.5%	1.3%	2.0%	3.0%	3.0%	2.9%	1.8%	4.0%	3.6%
keep environ safe	8.2%	4.0%	2.4%	4.4%	15.6%	7.8%	4.1%	4.6%	5.4%
build/construct things	2.4%	12.8%	6.5%	6.3%	3.5%	6.8%	8.0%	4.6%	7.5%

Research Question 2: Self-Identity and Motivations for going into Engineering by Major

For the survey question that asked how strongly students self-identified as engineers-in-training, the Likert responses were numerically coded ranging from –3 corresponding to "strongly disagree" to +3 for "strongly agree". Figure 2, below, shows the results for the common majors.

A one-way ANOVA was conducted to determine the effect of engineering major on self-identity as an engineer-in-training. Considering the 29 distinctly named majors, (e.g. architectural, bioengineering, biomedical, etc.), the results indicate major has a significant effect on self-identity ($F(28, 1827) = 2.660$, $p < 0.001$), and results were also significant when based on the ten major clusters as well ($F(9,1846) = 5.818$, $p < 0.001$). Post Hoc tests were conducted using Tukey's HSD test by major cluster which revealed isolated statistically significant differences between the clusters: the bio (BBB) cluster was lower than the manufacturing/materials/

mechanical (MMM) cluster (p = 0.022) and the mechatronics and robotics (MR) cluster (p = 0.002), while the first year and undeclared (FYU) cluster was lower than the MMM cluster ($p <$ 0.001), the chemical/engineering chemistry (CEC) cluster (p = 0.006), the architecture/civil/geological/mining (ACGM) cluster ($p < 0.001$), the computer/electrical/software (CES) cluster ($p < 0.001$), the environmental/sustainability (ES) cluster (p = 0.017), and the MR cluster ($p <$ 0.001). Differences between other major clusters were not found to be significant. Examining the nine "common majors", results indicate that the common major has a significant effect on self-identity (F (8,1280) = 5.123, $p < 0.011$). The mean self-identity was significantly higher for Civil ($p < 0.001$), Electrical (p =0.001), Mechanical ($p < 0.001$), Chemical (p = 0.004) and Enviro/Sust, p = 0.018) compared to First Year/Undeclared.

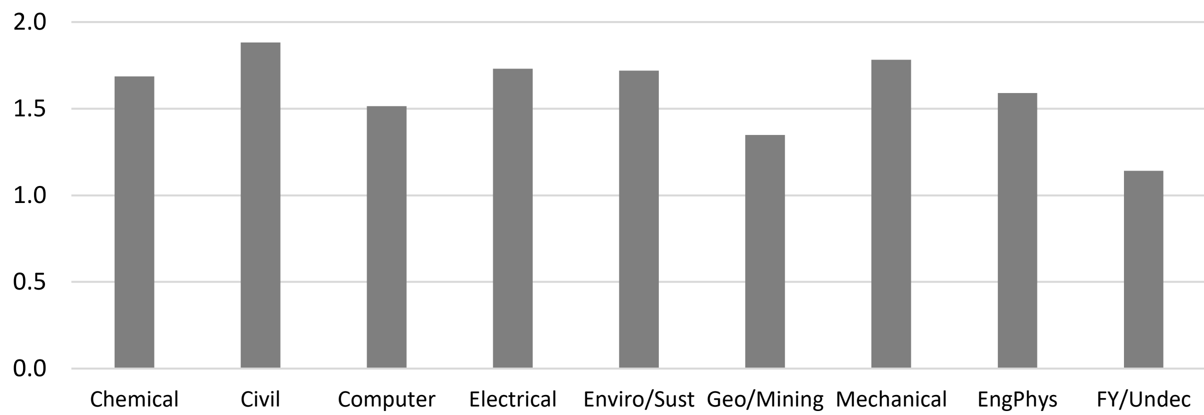

Figure 2: How strongly students self-identified as engineers-in-training, by common major. Vertical axis represents average strength of self-identification, where zero is neutral and the range is -3 to +3 (n=1873).

Students responded to the question "Why did you go into engineering?" by selecting any combination of 20 choices, along with a potential "other" response. The 20 response choices were then clustered into nine themes, as shown in Figure A2 of the Appendix. There was little variation between most majors on many of these themes, though "create/discover" did have a spread, with the more heavily science-based Engineering Physics majors reporting a larger interest compared to Geological/Mining and Civil, in particular. In terms of majors, it is evident that Geo/Mining and Eng Phys had the most distinctive motivational patterns, along with Civil to a lesser extent.

<u>Question 3: Employment Trajectories by Major</u>

Students were asked to indicate how much they would want each of 18 different types of jobs after their degree, using a Likert scale. Across all responses the three most frequently desired trajectories were *design market driven products/processes*, *solve technical problems*, and *manage technical projects*, and the least desired were *become an accountant, doctor or general lawyer*, *become an intellectual property or tech lawyer*, *technical sales support*, and *teach STEM in K-12*, as shown in Figure 3.

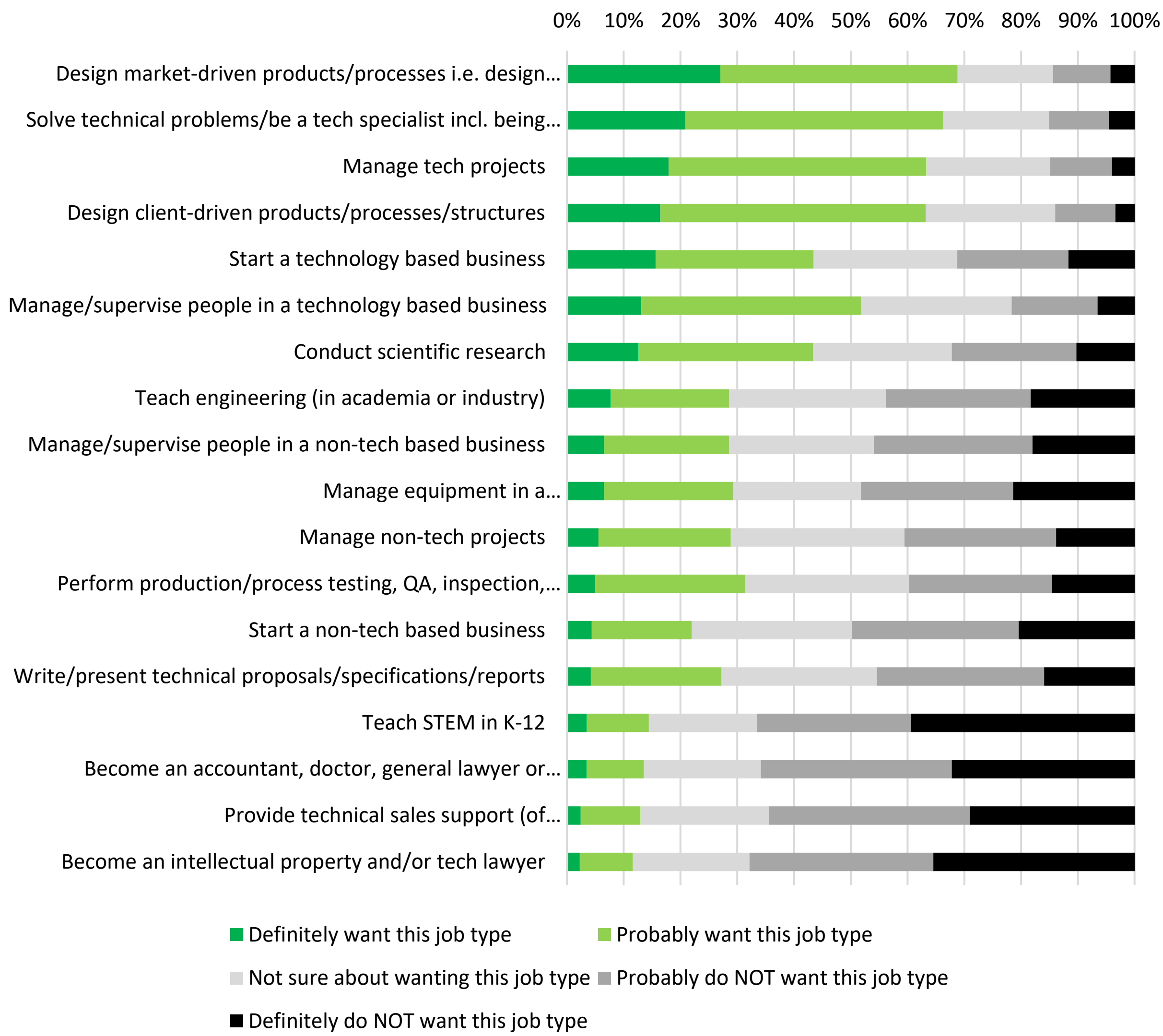

Figure 3: Percentage preferences for different employment trajectories across all respondents (n=1742).

Responses for desired employment trajectories were numerically coded with –2 corresponding to "definitely do NOT want this type of job" to +2 for "definitely do want this type of job". Averages of the affinities for each trajectory were then calculated by common major. Figure 4 shows the results for the 8 trajectories with the greatest differences between common majors. The average affinity values vary from -0.90 to +1.04 over a potential range of -2 to +2.

The results of ANOVA using the 29 distinctly named majors across the institutions indicate all trajectories are significantly ($p < 0.05$) related to the majors except three: *teach engineering*, *teach STEM in K-12*, and *become an IP/tech lawyer*, which were all among the lowest preferences across the entire sample. The results for the 9 common majors indicate that most employment trajectories have a statistically significant relationship ($p < 0.05$) with the 9 common majors except *solving technical problems*, *teaching engineering*, and *teaching STEM in K-12*.

Similar results are obtained when considering the 10 major clusters, in that all trajectories significantly depend on major cluster ($p < 0.001$) except *becoming an IP/tech lawyer* ($p < 0.05$) and *solving technical problems*, *teaching engineering*, and *teaching STEM in K-12* ($p > 0.05$).

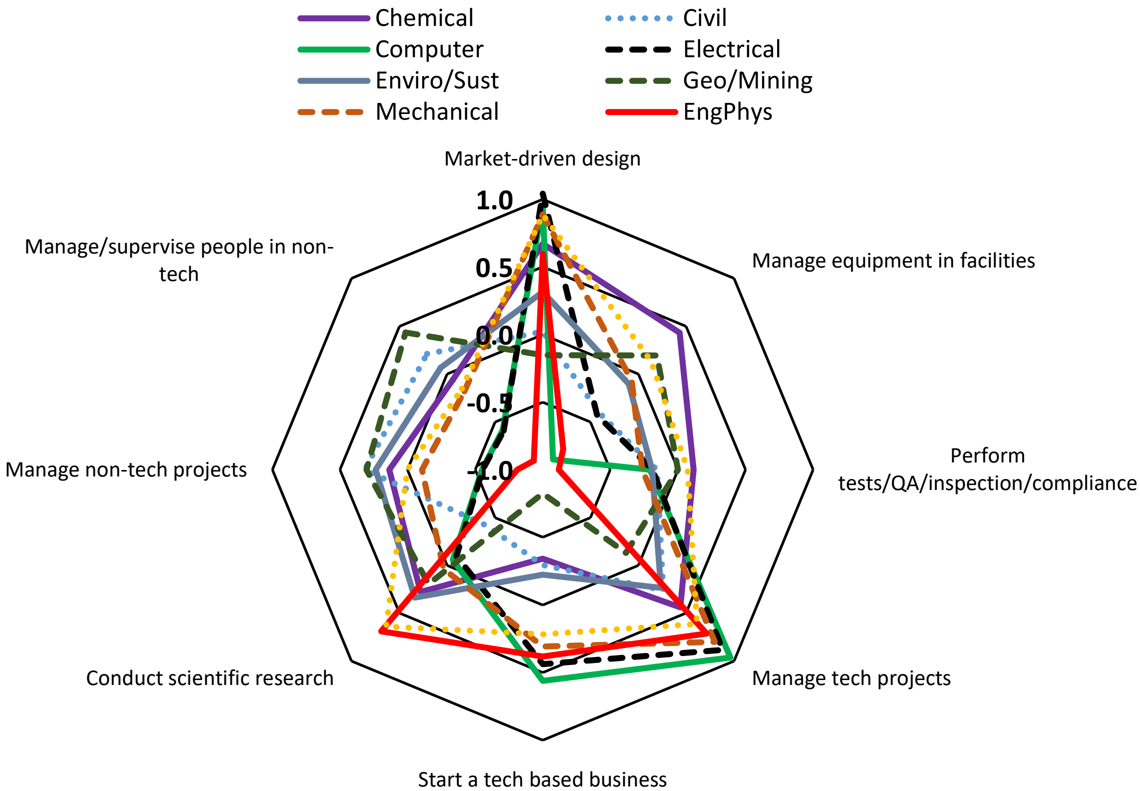

Figure 4: Average employment trajectory affinities across 9 common majors (n=1742) for the 8 trajectories with the greatest differences between common majors.

Discussion and Limitations

One of the primary motivations for undertaking this study was to see what motivations, beliefs and intentions all Canadian engineering students have in common, and to see how they might differ by major, similar to what was achieved by Potvin et al in the US [5]. The results presented here show some clear commonalities across many engineering majors. These include why they went into engineering, and a consistently low intention for teaching engineering, teaching STEM in K-12, and becoming an IP/tech lawyer. They also show key differences between most of the questions examined. The activities desired by students often align well with the activities associated with their major, e.g., students in Enviro/Sust express a greater preference for doing work keeping the environment safe, as do Geo/Mining students for field work, Civil students for building/constructing things, and EngPhys students for discovering new things. Employment trajectories and employment organization preferences are also significantly related to engineering major, perhaps best exemplified by the Enviro/Sust major's preference for working in NPs/NGOs versus other majors, Enviro/Sust and Civil engineers expressing interest in government, and EngPhys students expressing some interest in academia (and not as much interest in private industry as other majors). Some of these findings are qualitatively consistent with those of others who have looked at similar factors e.g. [12]. Not surprisingly, FY/Undec is almost a perfect average of all the other results, potentially reflecting the fact that many of the FY students were in a common first year (not yet sorted into majors).

We used 3 sets of majors for analyses, including the 29 distinctively named majors, the 10 thematic clusters of majors, and the 9 "common majors". While all three sets showed similar patterns and qualities, the 29 specific majors showed the most statistically significant differences, likely due to the several smaller majors showing unique characteristics. The 10 clusters averaged some of those differences out but also had larger *n* values per group (cluster). The 9 "common majors" shared some qualities with both the 29 specific majors and the 10 clusters. Indeed, the nine common majors included some of the specific majors and a pair of the clusters. By being "common", they cut across at least half of the involved campuses and would likely be most relevant to other schools. The distinctive overall patterns of motivations, interests, self-identification, and employment intentions, by major, may characterize the "cultural fingerprints" of these disciplinary groups.

Another key point, best illustrated in Figure 3, is that while some employment trajectories are clearly less popular than others, they are nevertheless high motivators for a minority of engineering students. If engineering schools do not support those trajectories, the profession is at risk of losing these students. This is something to investigate in engineering graduates, related to the work completed by Brunhaver et al. in [10].

The reason all of this is important for educators, and for the engineering profession generally, is that engineering students are not monolithic in their motives, intentions, and aspirations. If engineering schools do not stoke the breadth of these passions and interests, attrition is likely to occur, resulting in a reduction in the diversity of the professional engineering population. "Being an engineer" clearly means many different things to different engineering students. If we do not reflect and/or foster that diversity of aspirations in our education system and/or in the workplace, it will likely lead to attrition in school or once out in professional practice (if they ever actually practice). Indeed, this may already be occurring.

The full dataset for this study also contains information on gender, school, ethnicity, age, and other demographic factors. While some of these demographic factors have already been examined with respect to some of the survey's questions regarding employment, self-identity and motivation (e.g. see [1]), more interesting work remains to be completed on the current dataset.

Insofar as the survey questions used in this specific study are concerned, there were some weaknesses identified related to some survey questions. The question "why did you go into engineering?" included 20 different potential reasons that respondents could choose, derived from past research, all of which were selected by at least some respondents. However, in retrospect, and evident through the "other" responses to that question, some key reasons were missing. These included reasons such as "I <u>like</u> math and science" (as opposed to "I was told those good at math and science go into engineering"), "I want a <u>stable</u> job" (as opposed to "I wanted to make good money"), and "<u>engineering is exciting</u>" (as opposed to "I wanted to do exciting research"). These each appeared at least a few times in the "other" responses, and while the overall "other" response rate was less than 1% of all responses, if additional options were presented, several would have no doubt been selected quite frequently.

Such was not the case with the "When you graduate with your engineering degree, what specific activities do you really want to be doing as an engineer?" question. "Other" responses were well under 1% in frequency, with few discernable patterns. Indeed, the only type of response that recurred a few times was, ironically, not practicing engineering (instead, practicing law or medicine). This question did suffer from one avoidable problem though. About 2/3rds of all respondents provided the requested "top 3 activities" that they wanted to be doing as a practicing engineer. Another 3% provided fewer answers, while the remaining 30% provided more than 3 answers. This skewed results in favour of those who provided more answers. In future, respondents should be prevented from supplying more than three answers, if three are asked for.

Another limitation to the current work is the fact that the survey only used one question to measure self-identification as an engineer (or EIT). While the notion and definition of engineering identity might appear intuitive or straightforward, how or to what degree a student identifies with engineering is less obvious. For example, Godwin measures engineering identity using 3 constructs: performance/competence, interest, and recognition [19]. An engineering major may impact one or more of these constructs (e.g. there may be less recognition by family or friends if a student is in a less traditional engineering major) and hence, may impact student's self-identification as an engineer. Our single question did not capture such nuances and may limit the interpretations of the differences in identity for different majors as well as the interpretations of preferences for specific types of engineering activities or jobs.

More broadly speaking, work remains to conduct factor analyses for each of the questions in the survey, and especially for the employment trajectories. The initial results presented here have been very encouraging at either distinguishing the interests, aspirations and expectations of different types of engineers or showing what they have in common. However, this may be possible with fewer questions and categories which further analysis could reveal.

Conclusions

Similarities and differences in student motivations, aspirations and self-identity can be discerned between engineering majors. Identifying how student motivations and aspirations differ by engineering major can potentially assist in enhancing retention and diversification in the engineering profession, especially given that increasing retention among engineering post-graduates has become a priority in engineering education research [10]. Besides revealing similarities and differences between majors, the anticipated contributions of this work include providing a more empirically informed basis for retaining students in our profession longer. The survey instrument developed for this study is also freely available and can allow other institutions to conduct similar studies in Canada and elsewhere.

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References

[1] S. Maw, P. Neufeld, L. Chen, C. Jaeger, K. Moozeh, P. Ostafichuk, B. Frank, C. MacGregor, G. McSorley, and J. Grove. "Preliminary employment trajectory findings from a pan-Canadian survey on career motivations and aspirations of undergraduate engineering students," *Canadian Engineering Education Association (CEEA) Conference*, June 15-19, 2024, Edmonton, NPAB. https://doi.org/10.24908/pceea.2024.18625

[2] S. Sheppard, H. Matusovich, C. Atman, R. Streveler, and R. Miller. "Work in progress—Engineering pathways study: The college-career transition," *IEEE Frontiers in Education Conference (FIE)*, Oct. 12-15, 2011, Rapid City, SD.

[3] H. Matusovich, R. Streveler, R. Miller, and B. Olds. "I'm graduating this year! So what is an engineer anyway?" *American Society for Engineering Education Annual Conference & Exposition*, June 14-19, 2009, Austin, TX.

[4] M. Yatchmeneff and M. E. Calhoun. "Revisiting engineering identity in a common introduction to engineering course to improve retention," *American Society for Engineering Education Annual Conference & Exposition*, June 16-19, 2019, Tampa, FL.

[5] G. Potvin, Z. Hazari, L. Klotz, A. Godwin, R. M. Lock, J. D. Cribbs, and N. Barclay. "Disciplinary differences in engineering students' aspirations and self-perceptions," *American Society for Engineering Education Annual Conference & Exposition*, June 23-26, 2013, Atlanta, GA.

[6] G. Lichtenstein, H. Loshbaugh, B. Claar, H. Chen, K. Jackson, and S. Sheppard. "An Engineering Major Does Not (Necessarily) an Engineer Make: Career Decision Making Among Undergraduate Engineering Majors," *Journal of Engineering Education*, vol. 98, no. 3, pp. 227–234, Jul. 2009.

[7] C. Amelink and E. Creamer. "Gender Differences in Elements of the Undergraduate Experience that Influence Satisfaction with the Engineering Major and the Intent to Pursue Engineering as a Career," *Journal of Engineering Education*, vol. 99, no. 1, pp. 81–92, Jan. 2010.

[8] S. Gilmartin, S. Brunhaver, H. Chen, and S. Sheppard. "Career plans of undergraduate engineering students: Characteristics and contexts," in *US Engineering in a Global Economy*, pp. 49-85. University of Chicago Press, 2017.

[9] B. Masi, E. Hosoi and S. Go. "Re-engineering engineering education: a comparison of student motivation, ability development, and career pathways in traditional and cross-disciplinary engineering degree programs," *American Society for Engineering Education Annual Conference & Exposition*, June 26-29, 2011, Vancouver, BC.

[10] S. Brunhaver, S. Gilmartin, H. Chen, H. Matusovich, and S. Sheppard. "Comparing disparate outcome measures for better understanding of engineering graduates," *American*

Society for Engineering Education Annual Conference & Exposition, June 14-17, 2015, Seattle, WA.

[11] S. Sheppard, A. Antonio, S. Brunhaver, and S. Gilmartin. “Studying the career pathways of engineers: an illustration with two data sets,” in *Cambridge handbook of engineering education research*, A. Johri & B. M. Olds, Ed. Cambridge: Cambridge University Press, 2014, pp. 283-310.

[12] D. Kim and A. Katz. “Engineering students' interests in nonprofit and public policy careers: Applying a data-driven approach to identifying contributing factors,” *Journal of Engineering Education*, vol. 114, no. 1, pe20620, Jan. 2025.

[13] K. Tonso. “Engineering Identity,” in *Cambridge handbook of engineering education research*, A. Johri & B. M. Olds, Ed. Cambridge: Cambridge University Press, 2014, pp. 267-282.

[14] E. Seymour and N.M. Hewitt. *Talking about leaving: Why undergraduates leave the sciences*. Vol. 34. Boulder, CO: Westview Press, 1997.

[15] K. D. Stoup and O. Pierrakos. “Engineering students’ self-concept differentiation: Investigation of identity, personality, and authenticity with implications for program retention,” *American Society for Engineering Education Annual Conference & Exposition*, June 26-29, 2016, New Orleans, LA.

[16] K. L. Meyers, M. W. Ohland, A. L. Pawley, S. E. Silliman, and K. A. Smith. “Factors relating to engineering identity,” *Global Journal of Engineering Education*, vol. 14, no. 1, pp. 119-131, 2012.

[17] A. Godwin, G. Potvin, Z. Hazari, and R. Lock. “Identity, critical agency, and engineering: an affective model for predicting engineering as a career choice,” *Journal of Engineering Education*, vol. 15, no. 2, pp. 312-340, 2016.

[18] J. Hewlett, C. Hoessler, and S. Maw. “Engineering education: does our training reflect student employment trajectories?,” *Canadian Engineering Education Association (CEEA) Conference*, May 31-June 3, 2015, Hamilton, ON.

[19] A. Godwin. “The development of a measure of engineering identity,” *American Society for Engineering Education Annual Conference & Exposition*, June 26-29, 2016, New Orleans, LA.

Appendix

Table A1: Survey questions supporting the three Research Questions

Research Question 1 Survey Questions	**Options**
The list below shows 4 general types of organizations where one might work. Please indicate, for each type of organization, how much you think you'd want to work in that general type of organization.	The four types of organizations were: *Private Industry, Government, Academia, Non-Profits/NGOs*. For each type of organization, respondents picked one of: *definitely do not want to work in this type of organization, probably do not want to, unsure, probably do want to, and definitely want to*. Multiple choice per org type.
When you graduate with your engineering degree, what specific activities do you really want to be doing as an engineer? Check your top 3 answers. If one is missing, describe it using Other.	18 check-box choices plus an "other" option i.e. multi-choice. Students could select any number of the check-boxes.
What engineering program are you currently in?	All programs offered at a given institution. Students could choose one.

Research Question 2 Survey Questions	**Options**
Why did you go into engineering? Check any boxes that were reasons that helped influence you to take engineering. If you have a reason that does not appear on the list, please use the Other response box.	20 check-box choices plus an "other" option i.e. multi-choice. Students could select any number of the check-boxes.
To what extent do you agree with the following sentence: I see myself as an engineer (in training).	Multiple choice 7-category symmetric Likert scale.
What engineering program are you currently in?	All programs offered at a given institution (same question used to address Research Question 1)

Research Question 3 Survey Questions	**Options**
The list below shows 18 types of jobs that you might get after your schooling. Please	18 types of employment trajectories e.g. start a technology-based business. For each option, respondents picked one of: *definitely do not*

indicate, for each type of job, how much you would want that type of job.	*want this type of job, probably do not want it, unsure, probably do want it, definitely want it.* Multiple choice per job type.
What engineering program are you currently in?	All programs offered at a given institution (same question used to address Research Question 1)

Table A2: Institutional Program Names, Major Codes and Cluster Allocations

Program (Major) Name	**Major code**	**Major**	**Cluster code**	**Cluster**
1st Year	1	First year	10	FYU
First Year Engineering Program	1	First year	10	FYU
Architectural Engineering	2	Architectural	5	ACGM
Bioengineering	3	Bioengineering	1	BBB
Biomedical Engineering	4	Biomedical	1	BBB
Chemical	5	Chemical	3	CEC
Chemical Engineering	5	Chemical	3	CEC
Chemical/Biological	6	Chemical and Biological	3	CEC
Chemical/Chemical and Biological Engineering	6	Chemical and Biological	3	CEC
Civil	7	Civil	5	ACGM
Civil Engineering	7	Civil	5	ACGM
Computer	8	Computer	6	ECS
Computer Engineering	8	Computer	6	ECS
Electrical	9	Electrical	6	ECS
Electrical Engineering	9	Electrical	6	ECS
Engineering Chemistry	10	Engineering Chemistry	3	CEC
Engineering Physics	11	Engineering Physics	4	AMESEP
Environmental	12	Environmental	7	ES
Environmental Engineering	12	Environmental	7	ES
Geological	13	Geological	5	ACGM
Geological Engineering	13	Geological	5	ACGM
Integrated Engineering	14	Integrated	8	ISNM
Management Engineering	15	Management	8	ISNM
Manufacturing Engineering	16	Manufacturing	2	MMM
Materials	17	Materials	2	MMM
Materials Engineering	17	Materials	2	MMM
Mathematics and Engineering	18	Mathematics and Engineering	4	AMESEP
Mechanical	19	Mechanical	2	MMM

Mechanical Engineering	19	Mechanical	2	MMM
Mechanical and Materials	20	Mechanical and Materials	2	MMM
Mechatronics and Robotics	21	Mechatronics	9	MR
Mechatronics Engineering	21	Mechatronics	9	MR
Mining	22	Mining	5	ACGM
Mining Engineering	22	Mining	5	ACGM
Nanotechnology Engineering	23	Nanotechnology	8	ISNM
Software	24	Software	6	ECS
Software Engineering	24	Software	6	ECS
Sustainability - Bioresources	25	Sustainability - Bioresources	7	ES
Sustainability - MechT	26	Sustainability - MechT	7	ES
Sustainable Energy	27	Sustainable Energy	7	ES
Systems Design Engineering	28	Systems Design Engineering	8	ISNM
Undeclared	29	Undeclared	10	FYI

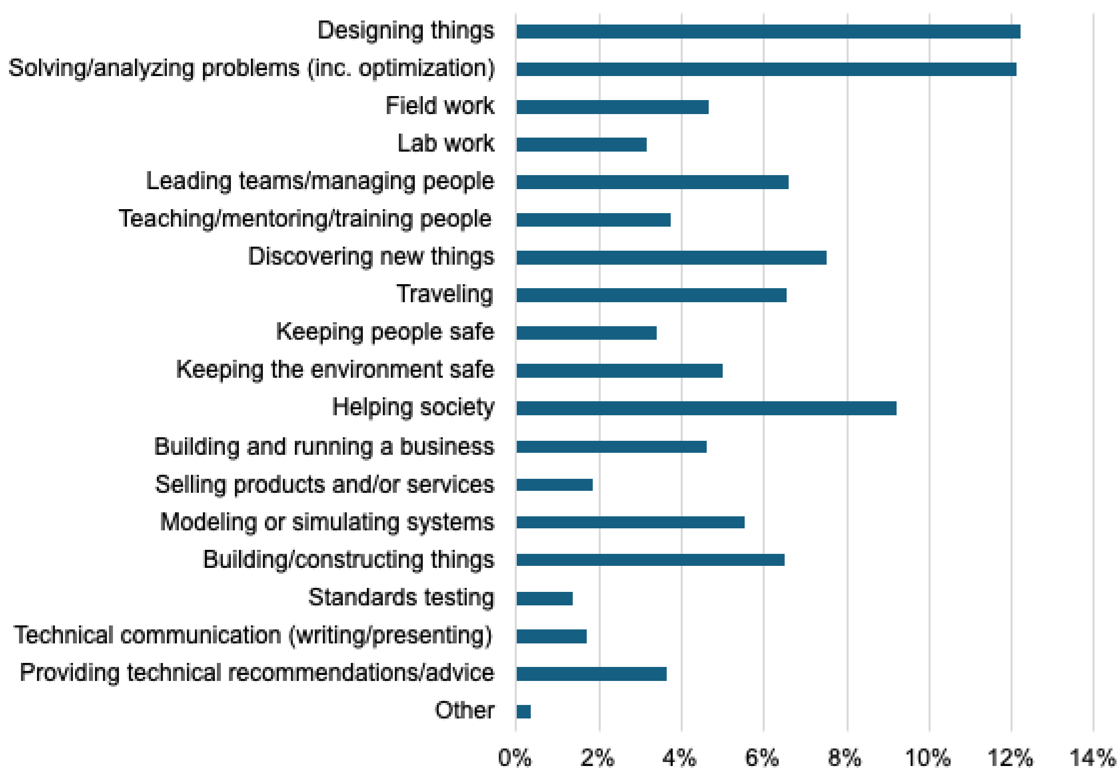

Figure A1: Activities that students want to be doing as practicing engineers: percentages of all responses across all respondents (n=1856 respondents, 7942 responses).

Figure A2: Why students went into engineering: percentages of all responses across all respondents, broken down by common majors (n=1873 respondents, 9075 responses).