

AC 2008-985: GRADUATE SCHOOL OR NOT: ENGINEERING STUDENTS CONSIDER CONTINUING THEIR EDUCATION IN CO-TERMINAL PROGRAMS

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**Graduate School or Not: Engineering Students Consider
Continuing Their Education in Dual Degree Programs**

Abstract

This research highlights how institutional structures may influence students' decisions to continue their education through a Master's degree. Some universities strive to encourage more students to continue their education with dual degree programs, programs in which undergraduates can count courses from the last two or more terms of their undergraduate career towards their Master's degree. In this paper, we look at engineering students' decisions to enter into a dual degree graduate school at a mid-sized private university. We focus on the questions: *Are these students critically evaluating their decision to pursue a graduate degree? What process are they going through to choose their program?* Our research suggests that while universities with dual degree programs may encourage more students to pursue Master's degrees, these dual degree programs may allow some students to avoid systematically considering their decisions.

Introduction

The paths students follow after completing a bachelor's degree in an engineering field are varied. According to the model presented by Sheppard and Silva based on students graduating with an engineering BS in 1996, three in 10 of these graduates will step into non-engineering employment or education, and the other seven will pursue engineering work or graduate education¹. Of these seven, 46 percent (or 32 percent of the original 10) will eventually get a graduate degree in engineering. This number is consistent with data published by Saks² looking at long-term national trends, and with more recent "degrees awarded" data from NSF³. We are interested in exploring how decisions to do graduate work in engineering are made. Among the questions to be examined are: *What factors do students consider? How do students decide where to apply for graduate work and in what field? Who is involved in the decision?*

In this paper we develop some preliminary answers to these questions for one particular group of students---those choosing to pursue a dual degree in engineering. Some universities offer students the option of completing their undergraduate degree and a master's degree concurrently in a dual degree program after accumulating a certain number of units/hours towards their undergraduate degree. The timeframe to enter into a dual degree program is usually equivalent to mid-way through the student's junior year or later. The availability of these degree options is fairly common; 51 percent of the 96 engineering schools in U.S. universities categorized as Doctoral Research University-Very High Research Activity⁴ have dual degree programs (see Appendix A for a listing of these schools).

We note that schools have several names of their programs, such as a concurrent BS/MS degree program, accelerated dual degree program, dual degree program, BS-MS program, coterminal degree program, and accelerated joint degree program. No matter the name, these are programs allowing students to work simultaneously on their last few units of their undergraduate program while beginning work on their graduate studies. We further note that of 51 percent of engineering schools with at least one dual degree program, several have created such a program in the last few years. For example, since 2005 there are new programs at the University of Colorado at Boulder Mechanical Engineering Department⁵ and at the University of Texas at Austin Petroleum Engineering Department⁶. Finally, we note that the concept of dual degree

programs is consistent with recommendations contained in recent reports regarding the relationship between undergraduate and graduate education (advocating that we move towards the master's degree being the professional engineering degree^{7,8}).

With more schools adding dual degree programs, we believe that schools need a greater understanding of how students decide to pursue a dual degree or other graduate degree. The information about this decision process should enable programs to better support their students' in this phase of their education and career planning. It will also give schools insights into how to structure effective dual-degree programs to support the students considering graduate work through a dual degree program.

The particular cohort of students we consider in this study was part of the larger Academic Pathways Study (APS) Longitudinal Cohort^{9,10}. The Longitudinal Cohort consisted of 160 students (40 at each of four core institutions) who matriculated college having expressed interest in studying engineering. These students were followed from their freshmen year until their senior year to identify the various ways in which engineering identity and skills develop, how institutional structures support (or inhibit) this development, and what factors are important in persistence in engineering. The methods that have supported this research are structured and semi-structured interviews, engineering design tasks, academic transcripts, and surveys.

While three of the four core APS schools offer dual degree programs in engineering, in this paper we only look at the 40 students at one of the institutions; we will refer to this particular institution as "the School" throughout the rest of the paper. Our rationale for focusing on this one institution for this initial study is that this School has a long tradition and deep culture of promoting graduate studies as exemplified by university-wide dual degree programs. Fifty-nine percent of the 217 engineering students who completed the Academic Pathways of People Learning Engineering Survey—APPLES—at this School in Spring 2007 reported plans to attend graduate school in engineering within three years of completing their bachelors degree¹¹. The popularity of entering into a dual degree program appears to be growing; in mechanical engineering at this School, the number of students has grown to twenty percent. The School's dual degree requirements are shown in Table 1.

Table 1. Academic Requirements to enter *The School's* Dual Degree Program

- Applicants must have earned a minimum of 120 units toward graduation (UTG) as shown on the undergraduate unofficial transcript. This includes allowable Advanced Placement (AP) and transfer credit.
- Applicants must submit their application and, if admitted, respond to the offer of admission no later than the quarter prior to the expected completion of their undergraduate degree. This is normally the Winter Quarter prior to Spring Quarter graduation.
- Applicants must meet the requirements and deadlines established by the department or program to which they are applying.
- Applicants are only permitted to apply to one dual degree program per term.

Requirements of the Engineering Departments

- Typically a GPA of 3.5 is expected.
- The same standards for general acceptance into the Master's program are applied to the dual degree students.

In looking at the APS Longitudinal Cohort at the School and focusing on those students who have chosen a dual degree program, we start laying the groundwork for addressing such questions as: *Are the students carefully considering their options or are they taking the path that allows them to delay facing what they see as the real world? Should schools encourage their students to look at all the options such as other graduate programs, a job in engineering, or even a job in something other than engineering?* In this paper, these questions are studied using findings from semi-structured interviews as well as survey and questionnaire data, as described in the next section.

Research Methods and Participants

The engineering students considering and then selecting to undertake a master's through a dual degree program need to be identified. Given that we were focusing on the 40 Longitudinal Cohort students at one of the APS core schools (as described above), how might we identify the subset of these students who considered a dual degree program, and then elected to enter such a program? How do we tap into this subset in such a manner that allows probing to better understand their decision? We designed a three-step process.

The first step relied on data collected from the 40 students as part of the longitudinal study. As detailed in Clark et.al.¹⁰, all 40 students completed seven surveys (referred to as the Persistence in Engineering, PIE, Survey¹²) throughout their undergraduate career. In addition, 16 of the 40 were interviewed once a year using a semi-structured method, while the other 24 were interviewed using a structured method in years one through three of the study. We looked for the students' general plans in their responses given in the final administration of the survey (May 7-14, 2007 of their senior year) and given in the latest semi-structured interviews (conducted March 26-June 5, 2007).

The questions we considered on this final PIE survey were: "What do you plan to do after graduating from college?" and "If you are thinking of going to graduate school in a field other than engineering, please mark your most probable area of study." From the semi-structured interview, we looked for the answers to questions similar to the following questions: "Please map out for me your post-graduation plans, how you're making the decisions, and what factors you're thinking about?" We put each student's answers to these survey and interview questions into a description of that student's general plan. Each general plan was then categorized as one of the following: students planning to pursue a dual degree program, students planning to pursue graduate work at another graduate school, or students pursuing a job. Nine students were identified as planning to pursue a dual degree program.

In the second step, we aimed to verify the student's general plan as obtained via the survey and interview, and to gain more detailed and up-to-date information about all 40 students' after-graduation plans. In order to do this we created a closure questionnaire that the students completed during the last few weeks of the school year (June 2007). Each questionnaire was customized for the student, based on the classification in step one. A set of questions for each of the three classifications was created. The particular questionnaire developed for those students pursuing a dual degree is shown in Figure 1. Like all of the questionnaires, it verified what we thought we knew about the student's plans (based on the survey and interview data), and then

asked questions about the specific factors the student may have considered in deciding on the dual degree program.

Figure 1: Final Questionnaire for Dual Degree Student
Academic Pathways Study (APS) Year 4 Final Questionnaire

Instructions: Please verify your responses about your graduation and post graduation plans. To navigate between the highlighted answer fields use the 'Tab' key. You may enter an unlimited amount of text in the answer fields.

Please complete the following information about your undergraduate and graduate degree plans.

D1 Undergraduate Degree: [redacted]
D2 Undergraduate Minor: [redacted]
D3 Date of Completion of Undergraduate Degree: [redacted]
D4 Dual Degree Master's Program: [redacted]
D5 Application Status: [redacted]
D6 Anticipated Master's Program Start Date: [redacted]
D7 Anticipated Date of Completion of Master's Degree: [redacted]
D8 Any Additional information or corrections?
[redacted]

Please verify the following information about your plans following the completion of your undergraduate degree.

P1 Plans for after graduation: [redacted]
P2 How have your plans changed since you have been at *the school*?
[redacted]
P3 Other than going to graduate school, what other options did you consider after graduating from college?
[redacted]
P4 Please describe those in more detail.
a Graduate School: [redacted]
b Working: [redacted]
c Other: [redacted]

Please tell us about how you chose your dual degree master's program.

M1 How did you search for graduate school programs?
[redacted]
M2 What fields were you interested in studying?
[redacted]
M3 What factors did you consider in your decision to pursue graduate studies in this field?
[redacted]
M4 How did you choose your dual degree master's program?
[redacted]
M5 Please describe the range of graduate programs and/or schools you applied to.
[redacted]
M6 How would you describe the graduate school application process?
[redacted]
M7 How prepared do you feel to pursue your graduate studies in _____?
[redacted]
M8 What are you looking forward to?
[redacted]
M9 Any concerns?
[redacted]

Please tell us about your job search process after you complete your dual degree.	
J1	How are you planning to search for jobs? [redacted]
J2	In what fields are you interested in working? [redacted]
J3	What factors will you consider in your decision to pursue jobs in this field? [redacted]
J4	How will you chose your job? [redacted]
J5	Please describe the range of jobs you will apply to. [redacted]
J6	How would you describe the interview process? [redacted]
J7	How prepared do you feel to work in _____? [redacted]
J8	What are you looking forward to? [redacted]
J9	Any concerns? [redacted]
Please tell us about your plans for the future.	
F1	Please describe your plans over the next 5 years. What would you want to do after you complete your dual degree program? [redacted]
F2	Are you interested in pursuing any additional graduate degrees in the future? Please list all the fields and degree programs of interest.
a	Anticipated Graduate Program(s): [redacted]
b	Anticipated Graduate Degree(s): [redacted]
c	Anticipated Start Date(s): [redacted]

Students could select to receive this questionnaire in electronic or hard-copy form. From these completed questionnaires, one student who had not been identified through the final survey and interviews, told us of plans to pursue a dual degree program, bringing our total to 10 total students pursuing dual degrees. Six of these 10 students had participated in the APS semi-structured interviews, four in structured interviews.

With the dual degree students identified, we began the third-step---to make meaning of their answers. The questionnaires and semi-structured interviews were coded. The 11 codes (shown in Figure 2) were developed to capture different components of the students' decision about their post-graduation plans. Sub-codes were applied as appropriate to classify both categorical variables and ordinal discrete variables (variables that have an order). These codes and sub-codes are generic, in that they were designed to capture factors important in students' planning, regardless of the final plan.

Figure 2: Coding Scheme

Major Codes	Sub-codes
Basic Plans (confirmed)	
Search process for program/job	internet resources, hard-copy resources, friends, family, mentors, career centers
Fields of interest	what type of engineering or non-engineering field, how specific, how many, how broad

Factors considered in decision	enjoyment, financial, future opportunities, comfort, past experience, interest in field, none considered
Decision process/Reasons	sought advice, past experience, easy to stay, fall back plan, future goals
Range of programs/jobs (applied)	For all students considering dual degrees, this was only this school they to which they applied.
Application Process Description	easy, straight-forward, some trouble, hard to manage time, confusion about the process
Level of preparedness	not prepared, poorly prepared, ok, well prepared, and very well prepared (ordinal variable)
Excitement	classes/curriculum, research, staying around for another year, people
Concerns	burnout, finishing in a year, work load, none
Transition (from one area to another)	*Here the students explained their transition, if they changed areas of study. Only two students fell into this category.

A theme that emerged through this coding process was related to the intentionality of the decision to pursue a dual degree. The codes that are particularly salient to this theme are highlighted in Figure 2 and include search process, factors considered in the decision, decision process, and range of programs to which the student applied. A student who appeared, based on the data, to make a decision with strong intention can be described by certain attributes in those four coded areas. Also, a student that appeared from the data to make a decision with less or no intention can be described with other attributes in those coded areas.

We give an example to illustrate this. Consider a hypothetical student, Susie. She used multiple tools in her search process for graduate schools. The range of schools and programs Susie considered was broad, but also specific. She considered different types of schools, but had specific programs of interest at these schools. In the factors code, she listed that she wanted a dual degree that would open doors to jobs in design engineering, would allow her to take the classes she wanted to take but had not yet had the opportunity, and would support and build upon the work she had accomplished in her undergraduate career and internship opportunities. During Susie’s decision process, she talked to her faculty advisor, other mentors at work, friends, and

family, while she considered the factors she listed. We would say that Susie had made her decision with intention.

On the other extreme is Ken, the hypothetical student who has made a decision with little intention. Ken did not search for graduate programs. He found information about the dual degree program at the School by overhearing his friends' conversations. He applied for the dual degree program to give himself the option later. As his senior year continued, he missed application deadlines for other graduate programs. He did not actively seek a job, so he decided to stay for the dual degree, because it would most likely help him find a job later. He is relieved that he will not have to change locations or adjust to a new program. He does not believe this program will be very different from his undergraduate program.

None of the 10 students we identified at our study school were as extreme in their decision-making as Susie or Ken. On the other hand, we were able to place them into a grouping that show distinctive patterns of how these students went about deciding to enter a dual degree program. Next we illustrate what these patterns look like.

Results

One of the reasons we were interested in looking at students who had decided to pursue a BS/MS dual degree program is our concern that students pursuing this option are choosing it because they perceive the process of finding information about the school and program and filling out the application as easy. They may not have fully investigated other graduate or career options. As we began to look into the data, we did see phrases that concerned us about the students' decision, but were surprised by the thoughtful reasons for pursuing the dual degree that some of the students did show.

One of the areas in the questionnaire that first concerned us included the responses to a question about the number of programs to which the students applied. All 10 students applied exclusively to one of the School's dual degree programs. They completed no other graduate applications. Can this be interpreted to mean the students are simply being funneled into the graduate program at the School and not fully considering the decision? Not completely. When looking at each student individually, we began to see students who had more intention behind their decision, as well as students who may not have as much intention behind their decision. Four students could be clearly classified in the *decision with intention* group, and four students could be clearly classified in the *decision with less intention* group. Two students were harder to classify.

The quotes that follow were taken from the transcripts and questionnaires. Some quotes have been slightly edited in order to remove distracting words, such as "like," "um/uh," etc.

What does A Decision with Intention look like?

The students who we classified as making their decision with intention came to their decision in several different ways. They may have planned the dual degree from the beginning of their college career or know that the degree will help them accomplish the work that they would like

to pursue. To give a better idea of how these students make their decision, several stories are illuminating.

Molly is a student in a program that combines engineering and management. In her questionnaire she responds to the question about her search for the right program by saying,

I heard of this program at admit weekend and it was one of the reasons why I decided to go to [the school] to be able to continue on with a [dual degree program]. (Questionnaire)

Molly considered this program before she came to the School; in fact it was part of her decision to come to the School. She talks a little more about the importance of this program when asked about how she decided on her program, offering that

This is the closest equivalent to the program I would have done if I had stayed in [A Euro-Nation]. (Questionnaire)

She also talks about how the program will enable her to do the job she wants to pursue. An external factor driving Molly's decision process is her desire for a program similar to the program in her country.

Next, **Anna**, a Civil Engineering student, also has an external factor driving her decision process: she has had experience in the workforce. Her experience motivated her to want to pursue the dual degree.

I knew I was going to apply for the [dual degree], just because, I think last year in some of the classes and over the summer internship, I guess, I thought I wanted to learn more about [civil engineering]. So, at the beginning of this year, I knew I wanted to apply, and so I was working on that [my application] fall quarter. (Semi-Structured Interview)

However, Anna does not want to go straight through with the degree. She is planning to take two terms off in order to gain

a different understanding of the materials, I think. And, maybe you're able to grasp it better, just because, you know, what are the problems that'll come up, and you can think about the problems and ask better questions. (Semi-Structured Interview)

Anna plans to make her degree more meaningful by taking some time during her degree to gain more practical experience.

Tim is another interesting case with a different external factor. His external factor is centered on his goal of further education. He did not academically persist in engineering; instead, he declared a major in the physical sciences. However, he decided to pursue a dual degree with a physics bachelor's degree and a computational engineering master's degree. He talks about his reasons for this degree in his questionnaire response,

I'm very interested in programming, data analysis, and modeling. I also felt the [dual degree] would make me more attractive to Physics PhD schools. (Questionnaire)

He searched for his specific dual degree by comparing the programs available in the engineering departments at the School: Mechanical Engineering, Electrical Engineering, Civil and Environmental Engineering, Material Science, Mathematics and Computational Engineering, and

Computer Science. He sought the advice of faculty and found the degree he felt would best prepare him for his PhD work.

What does a decision with less intention look like?

Like the students we just described, the students who appear to have made their decision without as much intention also came to their decision in different ways, although there appears to be more similarity in their considerations. These students tend to decide to pursue a dual degree because it appears they perceive as an easy and comfortable path, or they were unsure what else to do. To give a better idea of how these students make their decision, here are several of their stories.

Logan, a computer science student, gives one of the typical responses of this type of student. He is the unsure student who stays for the master's because it is easy. He did not consider many options when making post-graduation plans. When asked how he searched for graduate programs of interest and the factors he considered, he simply said,

I really only considered [this school]. I decided that it would be worth it to get a Master's in a year, especially since I wasn't sure what I wanted to do several years from now. (Questionnaire)

Logan did not talk much about how the master's might benefit him. He is not even sure what he will be doing, so he can not know if the degree will benefit him.

Mike is a computer engineering undergraduate major, who chose to pursue a dual degree with a master's in mechanical engineering. He gives different, but still typical answers centered on the ease of staying at this school. He justifies his choice on his questionnaire with the following quote.

I felt that continuing at [this school] would be the most practical, since I already am familiar with the school, and already have a research assistantship lined up for next year. (Questionnaire)

Mike has let his circumstances dictate his actions. He also states,

I had initially thought that work experience would be more valuable than immediately beginning grad school, but if I continue straight to grad school, I will probably understand more, since much of my previous coursework is still fresh in my mind. (Questionnaire)

He specifically applied only to this school's program, because he had missed the deadline for many other graduate programs. Because of his late decision to pursue a graduate degree before joining the workforce, he only has one option: the option of staying where he is currently, where he is familiar with the surroundings, and where he can find the information he needs about the program easily.

These students' decisions are less methodologically decided and less goal-driven and the ones described before. They have reasons such as obtaining the master's degree in a short time but no articulated use for the degree.

What the difficult to categorize decisions look like?

The final student we describe is **Carson**. He is more difficult to place into either of the two above categories. He has an external purpose behind his decision, but it is slightly wavering. In his answers to the questionnaire, he states that he planned to choose this school's dual degree program a while ago, yet still did some internet searches for other schools. In his interview he also talks of his on-going plan to pursue the dual degree,

I had always intended to do a [dual degree] at [this school]. I said there were times when I wasn't sure if I really should be here, but I've always seen the [dual degree] as a good thing to do, it's one year, you take a couple extra classes during your undergrad career, you can get your master's degree done in one year. (Semi-Structured Interview)

Carson's on-going plan is similar to Molly's case. He also says that "past experience in the field [and] recommendation[s] of peers and faculty" factored into his decision to stay for the dual degree, which is similar to Anna. However, in the interview he begins to allude to regretting his decision. He states,

But, me, in my infinite wisdom, decided to sign up to [do a dual degree], so instead of lying out on the grass and taking a nap on a beach towel, I am taking grad classes. So, gone are the dreams of gliding gracefully into graduation, and right now it's looking more like my graduation will be like a train into a brick wall(Semi-Structured Interview)

In his interview Carson also mentions having a back-up plan in case he is not accepted into the dual degree program. He says,

The only thing that really concerned me about getting in was that it was so last-minute. So, I was looking—at the same time, during this whole week of crazy things, I was also doing job interviews and looking for full-time offers and things like that, because I had to have a cushion, had to have a landing pad, in case this fell through. (Semi-Structured Interview)

Carson has some intention to pursue the dual degree, but is concerned about the challenges and even has a back-up plan. He does not mention strong reasons for wanting to pursue the dual degree other than the ability to obtain the master's in only one extra year. He is challenging to classify in either group fully.

Conclusions and More Exploration

This small sample of students reveals some distinct patterns. Some students perceive the dual degree as a means to an end, allowing them to add to their undergraduate degree in ways that will better prepare them to enter various opportunities. In the case of Molly, this means going back to her country of origin as a more prepared engineer, and in the case of Tim, this means better preparation for a PhD program. Other students see it as an opportunity to maintain what they perceive as a comfortable life-style a little longer. Students in the former group appeared more intentional in their decision to pursue a dual degree, whereas those in the latter seem less intentional. While this small sample does not allow us to fully explore the dimensions of these two categories, it does allow us to identify that the two groups (and perhaps more) exist. We expect these and other patterns to appear in the more general population at the School.

This paper is a preliminary exploration of the decisions students make about graduate education. It is “just the tip of the iceberg” in considering the undergraduate-to-graduate school transition; the decision to pursue a dual degree or graduate work is one part of the transition process. The findings in this paper raise as many questions as they answer. For example, what role does the faculty play in students’ consideration of the dual degree program? What other factors (e.g., parents’ education, co-op experience, undergraduate research experience, availability of funding for graduate school, socio-economic status, and institutional culture around graduate study) come into play? Some of these questions will be addressed in additional analysis of the APS longitudinal and APPLS data¹⁰.

With more schools adding dual degree programs, we hope that these results provide insight into how students decide to pursue the degree, and will add to the rather limited literature on students entering engineering graduate programs. However, we do note that there have been a few studies in the last 10 years that explored diversifying the graduate student populations, and how undergraduate research might inspire pursuit of graduate degrees^{13,14}. Additional studies are needed that examine the decisions of students to pursue graduate education at schools that do not have dual degree programs to see if there are differences in the students’ decision process. Understanding these differences may give dual-degree schools insights regarding better support for their students’ in this phase of their education and career planning, and give other schools insights into how to structure effective dual-degree programs.

There is still much more to understand about the undergraduate-to-graduate decision process and transition. This is becoming increasingly important as more students undertake graduate education, and as national leadership calls for a debate on the relationship between undergraduate and graduate education, and the practice of engineering^{7,8}.

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Appendix A List of RU/VH Schools with Dual Degree Programs in Engineering
Found online at school websites on January 14, 2008

University of Pittsburgh-Main Campus	University of California-Davis
Boston University	University of California-San Diego
Brown University	University of California-Santa Barbara
Carnegie Mellon University	University of California-Santa Cruz
Case Western Reserve University	University of Cincinnati-Main Campus
Colorado State University	University of Colorado at Boulder
Columbia University in the City of New York	University of Florida
Duke University	University of Illinois at Chicago
Emory University	University of Illinois at Urbana-Champaign
Florida State University	University of Iowa
Georgia Institute of Technology-Main Campus	University of Maryland-College Park
Iowa State University	University of Miami
Kansas State University	University of Michigan-Ann Arbor
Michigan State University	University of Minnesota-Twin Cities
North Carolina State University at Raleigh	University of Pennsylvania
Northwestern University	University of Rochester
Ohio State University-Main Campus	University of South Carolina-Columbia
Oregon State University	University of Southern California
Pennsylvania State University-Main Campus	University of Texas at Austin, The
Rutgers University-New Brunswick	University of Utah
Stanford University	University of Washington-Seattle Campus
Texas A & M University	Virginia Polytechnic Institute and State University
Tufts University	Washington State University
Tulane University of Louisiana	Washington University in St. Louis
University of California-Berkeley	Wayne State University
	Yale University