Is a Graduate Degree in Your Future?

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Overview

Pursuing an engineering graduate degree – a master's degree and/or a doctorate – is a potentially attractive alternative to immediately entering the work force upon receipt of a bachelor's degree. However, many undergraduate engineering students lack important information about the option of attending graduate school in engineering. This tutorial addresses many of the questions facing undergraduates as they attempt to make a decision regarding whether to seek employment or continue their engineering education.

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1. After you graduate – graduate school?

As you think about your career goals and make decisions about what companies you want to interview with, you should also give some consideration to engineering graduate school as a potential post-graduation path. Most undergraduates know very little about what it means to be a graduate student. Often, what they think they know is obtained only through limited interactions with laboratory teaching assistants. However, entering graduate school after receiving the B.S. degree is the right choice for many engineering students, and this document provides some of the information you will need to decide whether it is the right choice for you.

Graduate school is about education. The more value you place on education, and the more you value being around educated people, the better your attitude will be in graduate school. Although the product of a graduate education will certainly be worth the effort, a good attitude will help enormously in getting the most out of it, and will help ensure a successful outcome.

Graduate school can also further what ambitions you may have with regards to higher salary, more responsibility, greater opportunities to advance faster in a company, etc. It is reasonable to expect that a graduate education will pay off in all of these tangible ways, plus the intangible benefit of gaining the respect that comes with an advanced degree.

2. What do we mean here by "graduate school?"

There are many educational opportunities besides engineering graduate school that are available for engineering B.S. holders. These include most frequently the master of business administration (MBA) degree, a law degree (JD), and a medical degree (MD). The topic addressed here pertains specifically to engineering graduate school – i.e., the pursuit of a master's degree or doctorate in engineering. Nevertheless, it should be emphasized that the engineering bachelor's degree is superb training for continuing on in many fields. Many of the technical and organizational skills learned in your engineering program will serve you well no matter what path you take. Approximately half of all engineering students eventually obtain a master's degree at some time, although not necessarily in engineering. No matter what you do, the pursuit of life-long learning is an important activity for keeping your career relevant to the job market.

3. Graduate student life

Life doesn't stop in graduate school. Many people value for the rest of their lives the time spent in the invigorating environment of a college campus. The opportunities for social interactions, meaningful and personally rewarding activities, and self-improvement are unique. The stereotype of the "poor graduate student" is only partially true. Engineering graduate students are usually paid a stipend (see "How do I pay for graduate school?") to work as either a teaching assistant (TA) or a research assistant (RA). Normal TA responsibilities are less than 20 hours per week,

and often much less. Often, first-year graduate students are brought in as TAs and later assume an RA position as they get to know the faculty and become involved in a research project.

Being a TA offers unique opportunities that you may never get to experience again. The experience of working closely with undergraduates in laboratory or classroom settings can provide enormous satisfaction. Laboratory exercises are critical to the learning and success of undergraduates, as you likely know. An excellent TA can make a world of difference in the success of an undergraduate student. In this sense, the responsibility of being a TA can teach you important lessons about leadership and social interactions.

You might think of a teaching assistantship as something done mostly in service to your department, while a research assistantship is something done mainly for yourself. The work you carry out as an RA will be your introduction to the world of research; it will help you develop your own research specialty and give you a chance to establish a reputation within your research community. You should claim "ownership" of your research project and be willing to commit whatever it takes to do an excellent job of it. It is an apprenticeship in the truest sense of the word.

4. Graduate school in engineering is not just "more school"

Graduate school is a transition – from being "just a student" to being a researcher and assistant manager of a research program. The first year of graduate school is mostly working as a TA, coursework and preparing for exams – although you typically take fewer courses than you did as an undergraduate. While the focus during your first year is still coursework, it is certainly a good idea to be as "research active" as possible, both to gain experience and knowledge about ongoing research projects, and to impress the professors who might take you in as a research assistant in their group. As the graduate program develops, a student generally ramps up the research and tapers off the coursework. Towards the end of the experience, you will likely be devoting all of your time to research. In this sense, it isn't like being "in school" at all – it is a job that takes nearly all of your resources, and your level of dedication to your own research project will be a strong determiner of your level of success.

5. How do I pay for graduate school?

The norm in engineering graduate school is to be paid a stipend to perform services as either a teaching assistant (TA) or a research assistant (RA). These stipends pay approximately $1800 to $2300 per month and may be on a 9- or 12-month basis, depending on the specifics of your appointment. Keep in mind that tuition is almost always included in your appointment, so the total package could be considered to be as much as $80k/year (considering tax implications of the tuition). Another possibility is to receive a fellowship that pays a stipend and tuition as well.

- *Teaching Assistantship:* You might feel from your undergraduate classes that you know what a TA does. TAs are most often responsible for running laboratory sessions and

performing grading for a course, but they can sometimes be called on as well to teach recitation sections or even give some lectures. This can be among the most valuable experiences that you ever have. It can give you insight into academia as a career, but more importantly it can help you to develop interpersonal skills, and help you learn material at a depth that can be achieved in no other way besides teaching.

- *Research Assistantship:* Carrying out research is central to the professional life of most university faculty members. To fund their research activity, faculty members develop ideas and perform some initial investigation, and then write up and submit research proposals to a host of government agencies or industry. These funds pay the salaries of the research assistants working for the professor, and the participation of those RAs is vital to the success of the research projects. Since the reputations and careers of the professors depend on a successful outcome, you can be reasonably assured that your performance as an RA will be taken very seriously. This same success will form the foundation of your career, as well.
- *Fellowship:* Winning a "fellowship" to graduate school is (approximately) equivalent to winning a "scholarship" to fund your undergraduate education. Fellowships come in two flavors: external fellowships (such as those provided by the US National Science Foundation or the US Department of Defense) that are made directly from the sponsoring organization to the students, and internal fellowships, which are bestowed by the university to some selected incoming students. (Often these internal fellowships bear the name of a university donor who provided the funding for the fellowship.) Unlike TA or RA positions, there is usually no service required in exchange for fellowship support. However, like any other grad student, a fellowship recipient must carry out a research program and must have a faculty research advisor to guide that program. If a fellowship recipient can impress a professor and as a result is given the opportunity to work in that professor's research group, then the fellowship pays the student's salary and tuition, thereby providing "free labor" to the advisor – a "win/win" situation for the student and faculty member. One word of advice: don't wait too long to find a research advisor or join a research group. Time often slips by, and opportunities can be lost. Fellowship recipients should move quickly to determine their research directions.

6. Master's or Ph.D.?

If you think you might want to be a college or university professor someday, then this question has an easy answer: You must have a Ph.D. (or some other "terminal degree" doctorate) to be hired as a professor. If you're reasonably sure you don't want to be a professor, then the answer is a little less obvious.

The goal of a Ph.D. program is to produce certified experts in a particular discipline. Certainly there are occupations where such a designation is a de facto requirement – the head of a research lab, perhaps. However, for most positions, a Ph.D. is not a requirement, and in some cases obtaining a Ph.D. may actually preclude you from some positions because it is inherently more

narrowly focused than an M.S. degree. (See “What does it take to get in?” below for a discussion of this topic.)

Ultimately, whether you continue on to obtain a Ph.D. or stop with an M.S. degree will depend on how you answer questions like these: How important is it to you to be working at the very edge of technological innovation? How excited are you by the kind of research you’re carrying out as a grad student? And how important is it to you that your career never be impeded due to a perceived lack of technical depth?

One caveat about applying to graduate school: Most graduate programs will be far more likely to admit you and provide support if you indicate you are pursuing a Ph.D. as your ultimate goal than they will if you check the “M.S. only” box. The reason for this is simple: By providing you with tuition and a stipend, a university is making a substantial investment in you, and if you leave after only two years with an M.S. degree you will probably not have “repaid” that investment in terms of your research output.

For this reason, if you are unsure about whether you intend to stay for the Ph.D. or leave with an M.S., it is better to indicate that you intend to pursue the Ph.D. This is not legally binding, and you can always change your mind later; however, if you indicate “M.S. only” when you are in fact unsure about your plans, then you are seriously hurting your chances for admission and support. (Of course, if you are quite sure you do not want to pursue a Ph.D., then it is unethical to indicate you do simply to increase your chances of admission.)

7. What does it take to get an M.S. or Ph.D.?

The degree requirements vary considerably, and you should check the web site of the department you’re interested in for details. However, most M.S. degrees require on the order of about 30 semester credit hours – which typically take about two years to complete. These often come in “thesis” and “non-thesis” options; a non-thesis M.S. degree requires only coursework, while a thesis M.S. requires a fairly in-depth research investigation, which is written up into a master’s thesis and defended. (The master’s thesis is a substantial document, but not as deep as a Ph.D. dissertation.)

One difference between M.S.-level research and Ph.D.-level research often cited is that M.S. work does not necessarily have to be original work that is publishable in the technical literature – although it often is. Often, a reasonably sophisticated effort at accomplishing technical goals is sufficient, but it must be at a demonstrably higher level than a typical undergraduate could accomplish.

The road to a doctorate is not short, and programs are not identical, but often have similar features. The steps include two or three years of coursework, some kind of qualifying exam based on engineering fundamentals (often taken early in the program), a comprehensive exam that is more focused on research skills, the successful completion of a major research project, writing up this research for publication in journals, writing a dissertation consisting often of

hundreds of pages, and finally the successful "defense" of the dissertation. Although this sounds like a lot, it forms a continuous stream of progress that seems natural over time. Development of skills, both technical and otherwise, accompanies each step, until, by the end, the student is transformed into a professional, fully capable of taking on advanced research and administrative tasks.

8. Coming back to graduate school after working for awhile

Frequently, students take jobs believing that they will go back to graduate school after they've gained a few years of practical experience. And in theory this is a good idea; the maturity and clarity that students bring with them after a few years in industry can make for a more successful graduate program. However, the simple truth is that for every student who carries out this plan, there are many who never go back. Once you get out in the "real world" – making "real money" and taking on "real responsibilities" – the option of returning to school can fade to impracticality. It means taking a substantial pay cut – from the $70,000+ that a working engineer with a couple years of experience makes to the (approximately) $25,000 stipend that a grad student makes. By comparison, pursuing graduate school right after completing an undergraduate degree means a step up in terms of financial stability; a grad stipend of $25,000 per year might not compare well with an engineer's salary, but it's probably more than your undergraduate institution is paying you to attend. And another potential down side of putting off grad school: It's possible that some of your analytical skills might get a little rusty after a few years in industry, making the transition "back to school" that much more difficult.

So if you are considering putting off grad school for "a couple years," make the decision with a clear mind. It's a good idea in theory, but there's a good chance you might never carry it out.

9. What about part-time study?

This is another plan commonly cited by graduating seniors – "I'll start a part-time M.S. program next Fall." Again, there's nothing wrong with this plan – especially since many employers offer tuition benefits, making the M.S. degree "free." However, pursuing an M.S. degree part time is a long undertaking; what takes two years of full-time study can take five or six years of part time study. And five or six years of working a full-time job and then taking classes and/or doing homework in the evening can be a long, hard slog. Pursuing a Ph.D. on a part-time basis is such a long-term project that only a very few of the most dedicated and tireless engineers will carry it through to the end.

10. What does it take to get in?

If you have a GPA that is above 3.0 from an accredited engineering program, then there are colleges and universities that will admit you and provide you with support. Just which colleges and universities depends on a host of factors. The first thing that most graduate admissions

committees look at is your undergraduate record: Where did you go to school and what kinds of grades did you get? Obviously, getting a 3.95 at MIT will open a lot more doors than getting 3.05 at Beltbuckle State Technical College. (But there are graduate programs for the loyal sons and daughters of Beltbuckle, too!) Certainly, your performance on the Graduate Record Exam (see "What about entrance exams – GREs?") will also be taken into consideration, especially if your undergraduate institution is not as well known (or as well regarded) as those of the other applicants. Finally, undergraduate research projects that you have been involved with can be a big boost – especially if you're applying to grad school in a technical area similar to the one in which you worked as an undergraduate.

This brings up a crucial difference between undergraduate study and graduate study. While you were trained as an undergraduate in a wide array of areas – with much technical breadth – your focus as a grad student will be much narrower and much deeper. The goal of a Ph.D. program (and to a lesser extent an M.S. program) is to create an expert in a particular sub-discipline. While most quality graduate programs will provide significant technical breadth as well, the real emphasis in graduate education – namely research – is, by its very nature, narrow. So when you are applying to graduate schools you will be expected to identify a sub-discipline you would like to be a part of – e.g., not just "electrical engineering" but "signal and image processing," not just "chemical engineering" but "chemical process control systems." Don't be too concerned if you aren't 100% sure what niche you want to be a part of; after all, as an undergraduate student you're only starting to become aware of what the niches are. However, it's important to do an inventory of your interests as you think about graduate school to identify the kinds of things you want to study.

11. Where should I apply?

One of the best places to get information about potential graduate schools is from your undergraduate professors. Go to the professors whose technical specialties you find interesting and ask them what schools they think are the best. (Of course, where you actually apply might be determined in part by the strength of your own undergraduate record – see "What does it take to get in?") University and departmental web sites are an obvious source of much useful information.

12. What about entrance exams – GREs?

Virtually all engineering graduate programs require that you take the Graduate Record Exam (GRE) General Test and submit your results as part of the application process. (See www.gre.org for details about the test and the university's graduate web site for specific requirements.) One word of advice – preparing for the GREs by studying and taking practice exams can, in fact, improve your score significantly. Higher scores will translate directly into more opportunities.

13. How long will I be in graduate school?

There are some coursework-only master's degrees that can be completed in as short as one year of study. (Some universities refer to these as a "Master of Engineering" or a "Professional" Master's degree; they can be thought of as a one-year extension to the BS degree, and they rarely provide financial support.) However, most M.S. degrees take two years to complete. To obtain a Ph.D. typically requires four to six years of post-B.S. study.

14. Summary

In summary, the decision to pursue graduate school is an important one that involves many considerations. It is tempting to transition out of the academic mode into that of the work world, but delaying that decision can have life-long important consequences for career advancement and opportunities. If you have had enough of the student life, then it might be best to move on to new challenges. If the university setting is at least tolerable for the sake of the long-term benefits, then getting an advanced degree may be your best choice. Good luck with all of your future plans!