# AC 2007-565: THE ROLE OF THE MASTER'S DEGREE WITHIN ENGINEERING EDUCATION

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# The Role of the Master's Degree within Engineering Education

**Introduction/purpose:**
As engineering educators and industry personnel struggle with determining the educational needs of the Engineer of 2020, there have been many arguments regarding the structure of engineering education; one such topic has been the role of the Master's degree. In an environment where some propose that engineering Bachelor's Degrees should be five years in duration, there are also proponents espousing that the Master's Degree, rather than the Baccalaureate, should be the professional degree for engineering.

This paper provides a historical perspective of Master's Degrees and shows the trends of granted degrees to the present time. It discusses these trends, broaches the pros and cons of the Master's Degree, discusses current trends in curricula, and assesses the value of the Master's Degree as currently implemented for the engineering practitioner.

**Background:**
The earliest mention of Master's Degree dates to the thirteenth century, when Master's Degree was the top of three offered degrees: Scholar, Bachelor, and Master. At this time the Master's Degree, also sometimes called Doctor or Professor, meant teacher. In the intervening years Doctor became the more common moniker for this degree.[1]

There are currently three major types of engineering Master's Degrees in the US: thesis, non-thesis with exit exam, and non-thesis course-based only. Statistics rarely show specificity beyond the degree conferred.

There were 40,650 Master's Degrees awarded in engineering in the US in 2005.[2] Over time since WWII, the ratio of Master's Degrees to Bachelor's Degrees typically awarded to US citizens each year in engineering has hovered between 1 in 3 and 1 in 4;[2,3] in recent years the differences have narrowed, as exemplified by the 70,768 Bachelor's Degrees awarded in the US in 2005.[4]

Engineering enrollment in the US in 2005 was 356,800 full-time undergraduates, 30,316 part-time undergraduates, 49,704 full-time Masters, 30,077 part-time Masters, 48,379 full-time Doctoral, and 7,565 part-time Doctoral students.[4]

Degree awards in 2005 were up from AY2001-02, when 26,015 Engineering Master's Degrees were conferred in the US. Of these, 10,792 were awarded to non-resident aliens. This is in comparison to a total of 59,481 Bachelor's Degrees awarded, 4,262 of which went to non-resident aliens. At the same time, a total of 5,195 Doctoral Degrees were awarded, of which 2,934 were to non-resident aliens.[5]

Comparison of awarded degrees in the global arena requires common classification, affected through the International Standard Classification of Education last updated in 1997 (ISCED 1997). Post-secondary education is named as ISCED Class 5 if it does not lead to an advanced research qualification; both US Associate's and Bachelor's Degrees fit into this classification as first degrees, and US Master's Degrees fit in this classification as second degrees. ISCED Class 6 describes degrees leading to an advanced research qualification; US Doctorates fall into this category.[6]

In 2002, ISCED Class 5 first degrees in engineering awarded outside North America numbered 997K versus 105K awarded within North America. For the same year, ISCED Class 6 degrees in engineering awarded outside the US numbered 30K versus 5K awarded in the US. No data was readily available for globally-awarded Class 5 second degrees in engineering.[7]

In 2004 there were roughly 1.4M engineering jobs in the US. Aggregate salary data from the same year shows only a 10.3% salary increase between those engineers holding a Bachelor's Degree and Master's Degree in engineering jobs.[8]

In a longitudinal study of over 10K baccalaureate graduates from 1992-3, engineering students who subsequently enrolled in graduate study went 12.3% to doctoral programs, 4.2% to professional programs (law, medicine, etc.), 16.5% to MBA programs, and 67.1% to other Master's programs (i.e., engineering). 17.7% of the engineers were enrolled in graduate school four years after receiving their baccalaureate degrees; part-time students outnumbered full-time students in this group three to one.[9]

66% of all US full-time professional, technical, and related employees were eligible for job-related education assistance in 2000.[10]

**Discussion:**

At its simplest definition, a professional degree is one that allows the recipient to gain professional licensure as a practitioner in a given field. Professional licensure in the field of engineering in the US is the attainment of a Professional Engineer (PE) license; rules for licensure vary by state, but this professional degree is currently the Bachelor's Degree. At this point, the technical competency provided at the baccalaureate level is adequate to pass the PE exam, and to function competently as a practicing engineer.

The engineering Master's Degree in the US is perceived as having a technically focused curriculum that is highly relevant to standard engineering practice. Course requirements vary from a typical 24 credit hours for a thesis-required degree to 30 hours for a non-thesis degree. Coursework depth and breadth requirements typically include advanced mathematics and a progression of multiple introductory to advanced courses in one or more focus areas of the studied discipline. A recent addition to the mix has been employment of distance learning in engineering Master's Degrees; several schools now offer online degrees.

Given the focused nature of the degree, it is not surprising that non-resident aliens receive 40% of Master's Degrees in the US. The Master's Degree could be thought of as having the most engineering bang for the buck. Since foreign students often are funded through their home country and even domestic Master's-only students are seldom funded through the schools (many are sent by their employers), return on investment is very important.

A full two-thirds of engineers who pursue a Master's Degree choose to study engineering. No doubt the relevance to practice is involved in this decision. Also a probable factor is the availability of job-related education assistance from employers. 38% of engineering students pursued a Master's degree part-time, presumably while working. While it can take up to five years to attain the degree in this manner, this approach can offer a manageable schedule while maintaining the income and benefits of full-time employment including, at least for two-thirds of employees, education assistance.

In engineering industry, Master's Degree holders do not typically perform work substantively different from Bachelor's Degree holders. They may be afforded more autonomy, and in some cases assigned more technically challenging tasks, but one could argue that this also occurs with normal employee development over time. In several engineering disciplines, an engineer may need a Master's Degree to stay competitive with peers in large industry regardless of licensure issues.

For those wanting to teach, most two-year colleges hire instructors with as little as a Master's Degree. Some state four-year universities employ instructors who hold a Master's Degree and are also licensed Professional Engineers.

For those intending to take the PE exam, a Master's Degree counts as one year of experience towards qualifying. The focused curriculum can also aid in preparation for the exam.

For those students who pursue a Master's Degree full-time before entering the workforce, the opportunity cost is relatively high. Basic projection to break-even for lost full-time wages during the period of study for the Master's Degree, even assuming a Teaching or Research Assistantship and tuition waiver, is on the order of a decade.

Engineers who pursue a Master's Degree while employed in industry may find wage increases for earning a Master's Degree nominal especially if the employer's education assistance program paid for the degree. Value of the degree is mostly in the added technical knowledge that can be applied specifically to the current job, and sometimes in staying "even" with the educational level of peers. One trend to watch for in industry is any reduction in the level of educational benefits offered by employers – benefit limits vary greatly by industry and by the size of the employing company.

**Conclusions:**

Graduate study in engineering in the US is still a world-class offering. Non-resident aliens receive 40% of US-awarded Master's Degrees and 60% of US-awarded Doctorates.

In recent years, progressively more Master's Degrees have been awarded. US industry has been actively encouraging employees to pursue graduate degrees via educational assistance programs.

The Master's Degree will likely always have its market niche: to provide students with focused study of engineering that will be useful in engineering practice. The trade-off of personal effort and financial resources necessary to attain a Master's Degree must balance in favor of the degree's benefits in terms of increased technical capabilities, better assignments, and higher wages; especially with the option to pursue a degree during full-time employment, the current enrollment rates indicate that the cost-benefit analysis is favorable.

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