Doctoral Level Studies for Engineering Technology Faculty

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Abstract

This paper reviews the growth of graduate level programs in engineering technology, identifies the need for doctoral level education for engineering technology faculty, and presents the mechanisms available for such an education. The paper presents case studies on three doctoral programs that are currently available for engineering technology educators. It discusses the curricular aspects of the programs, outlines the differences in their approach to learning and research, and promotes independent research and scholarly publications as an important means to an advanced degree in engineering technology.

Introduction

The doctoral level education has become an essential qualification for anyone interested in becoming an engineering technology faculty member. Although there are no doctoral level programs in engineering technology, producing graduates at the present time, the evolution in the field will soon lead to the establishment of new doctoral programs. At the present time, for those who are teaching in engineering technology and are interested in programs leading to doctorate degrees in a closely related field, there are three options: 1) follow a traditional path, which involves full time study of course work, and a dissertation in an engineering discipline, 2) join in a more flexible and yet structured program in technology management and complete the degree without major disruptions to one's career, and 3) undertake a program that requires independent research and a thesis based on peer reviewed publications as the primary means to complete the degree. This paper identifies the need for doctoral level education in engineering technology and presents case studies on three of the doctoral degree programs currently available for engineering technology faculty. The paper does not deal with the traditional, course work based doctoral programs in science or engineering. It also does not deal with programs in such areas as education or other non-technical fields.

Evolution of Engineering Technology Education

The Engineering Technology degree programs were formally established at the associate degree level in the early 1950s. They were created primarily as one of the means to provide continuing education opportunities for the technicians coming out of the armed forces at the end of the second world war. [1]. The associate degree programs in engineering technology grew in size and scope during the 1960s and led to the creation of baccalaureate level programs in engineering technology. By the mid 1980s, the engineering technology programs produced in excess of 12,000 graduates annually. Graduation from the programs that were accredited by the Technology Accreditation Commission of the Accreditation Board for Engineering and Technology (TAC/ABET) became a requirement for the graduates seeking employment in many of the large industrial organizations. [2]. The overall growth of engineering technology degree programs since their inception, their accreditation status, industry's acceptance of the engineering technology graduates and the extent to which the engineering technology faculty participated in applied research contributed to the need for and the possibilities in creating advanced level education in engineering technology. By the early 1990s, major engineering technology schools in the country started offering graduate level programs in engineering technology. [3, 4, 5, 6, 7]. Further, doctoral level education became a preferred qualification to become engineering technology faculty in many of the universities and colleges. The leaders in engineering technology also started exploring the possibilities in doctoral level education in engineering technology. [3, 6].

In the earlier days of the growth of engineering technology education, vocational education and the education of technology teachers played an important role. In those days, a sizeable portion of the engineering technology faculty members had vocational education as their higher education background. Over the years, the composition of the engineering technology faculty has changed to almost 100% of the faculty members having higher degrees in engineering. Industry's demand for engineering skills and competencies, the extent of engineering fundamentals that became part of the technology programs and the accreditation criteria for faculty have helped the engineering technology programs to shed the vocational element entirely. [2]. Strong engineering fundamentals, extensive laboratory experience and integrated co-operative education became the hallmarks of well received engineering technology programs. [3,4,6,8,9,10]. The engineering technology graduates have received placement offers comparable to those of engineering graduates and have gone on to seek professional licensing in many states. These developments and many of the built-in characteristics of the programs have contributed to the maturity of the engineering technology programs and the need to create graduate level education in engineering technology.

In parallel with the growth of the engineering technology programs, vocational technical education has also grown over the years. For the most part, the technology component of vocational education programs became part of the industrial technology programs. The industrial technology programs have grown in number and scope over the years. A separate accrediting body, known as the National Association of Industrial Technology (NAIT) became the agency responsible for the accreditation of the industrial technology programs. [11]. In comparing their evolution over a 30 year period, one can conclude that the industrial technology

programs retained the characteristics of vocational education while the engineering technology programs have gained an increased characteristics of engineering education. Engineering Technology and Industrial Technology programs have matured to the point that adding doctoral level programs in both areas have become part of their natural evolution. However, it must be pointed out that being in the shadow of engineering education have delayed the addition of graduate level studies and doctoral level programs to engineering technology. The industrial technology programs on the other hand had the flexibility and independence to witness the growth of doctoral level education in the field.

Graduate Level Education in Engineering Technology

The graduate level programs in engineering technology became reality in the early 1980. Universities such as Brigham Young, Arizona State and Texas A&M led the technology schools in creating master's level education in engineering technology. This was followed by Purdue University, University of Houston, Rochester Institute of Technology, Southern Polytechnic and State University and others. Today, there are dozens of masters level programs in engineering technology in the country, graduating nearly 500 students annually. In addition, the need for master's level education for the graduates of engineering technology programs have created a unique partnership between engineering and engineering technology schools, leading to joint degree programs in engineering. For instance, the Engineering Management program at Old Dominion, the Manufacturing Systems Engineering program at Penn State Erie and the Computer Integrated Manufacturing at the Rochester Institute of Technology are essentially joint programs between engineering and engineering technology offering graduate degrees for engineering as well as the engineering technology graduates. [4, 12, 13].

The growth of graduate level education in engineering technology has contributed to well developed laboratory facilities, industry sponsored applied research, increased competition for grant funds offered by the governmental and other funding agencies, peer reviewed publications, and a level of independence from engineering that was non existent in the past. The growth of graduate level programs have also increased the involvement of faculty in research, their ability to offer financial assistance to graduate students and added provisions to undertake sponsored projects in industry. The most significant impact of the growth of the engineering technology programs is the increased demand for faculty with doctoral level education. As of Fall 2001, a larger proportion of the universities and colleges seeking engineering technology faculty have made doctoral level education as their preferred qualification for appointment. [14].

Doctoral Programs for Engineering Technology Faculty

The evolution of engineering technology programs in the USA over the past 50 years has not created a single doctoral level program in the field. This is an unusual phenomenon compared to the other academic disciplines in the country. This is also the case when the engineering technology programs are compared to the corresponding programs in other countries such as the United Kingdom or Australia. The primary reason for this is the dependence of the engineering technology programs on the schools of engineering. For the most part, the current teaching faculty in engineering technology are graduates of the programs in engineering. In those cases, where the faculty possess doctoral level education in a technical field, they would have

invariably received their education in the schools of engineering. If there are cases, where the engineering technology faculty possess doctoral level education, but the degree is not in engineering, they would have opted for such an education primarily due to lack of programs in engineering technology. The faculty in those cases may have attained their degrees in management, information technology, vocational education or in a related field of study.

The need for doctoral level education for the faculty in engineering technology is well established. The issue now is to create doctoral programs, which assure the following: 1) provide opportunities for higher levels of learning in their chosen field, 2) enable faculty to undertake independent research in their area of interest, 3) relevant to their field of involvement and interest, 4) applied in nature, 5) the work is part of the natural progression of the profession and help increase the interests in research and teaching, 6) do not involve undue hardship to carry out research towards the degree, 7) enable the faculty to complete the research in a timely manner, 8) elimination of traditional barriers and creation of new opportunities, 9) flexible in terms of time, and residency requirements and 10) do not require unreasonable amount of resources to complete the program.

The traditional doctoral education process in the USA has been restrictive. The procedures established a century ago are still in use to encourage research and enable higher levels of learning. This is especially the situation in the case of engineering doctorates. There are signs of change in some of the major universities. But those changes are still within the confines of the traditional doctoral level education and within the procedural norms created many decades ago. If we are to increase the number of faculty with doctoral level education in engineering technology, new thinking in education and new ways of encouraging faculty to undertake independent research must be found.

This paper presents three separate doctoral degree programs of interest to the faculty in engineering technology. First will be a Ph.D. program in Technology Management offered by a consortium of US universities, led by Indiana State University. The program is delivered through a unique partnership arrangement among the participating institutions. It offers significant advantages to the engineering technology faculty over the traditional doctoral programs. Second will be the Doctor of Industrial Technology program offered by the University of Northern Iowa. This is a traditional doctoral program for anyone interested in undergoing a full time study in technology. Finally, the Farmingdale State University of New York, in collaborations with the Leeds Metropolitan University, Leeds, England and Oxford Brookes University, Oxford, England offers a research based doctoral degree program in engineering, management and information technology for practicing engineers and the faculty in engineering technologies.

Indiana State University's Doctoral Program in Technology Management

A consortium of universities that includes Indiana State University, Bowling Green State University, Eastern Carolina University, North Carolina A&T University, and the Central Missouri State University offers a unique program leading to a Ph.D. degree in Technology Management. [15]. The program includes many of the normal characteristics of a traditional doctoral degree, while offering flexibility to candidates to finish the program without having to disrupt the career responsibilities. The program requirements are as follows:

Research Core	27-33 hours
General technology core	15
Major area of specialization	24-30
Concentrated Study in technology	12-18
Internship	6
Total minimum	90 hours

The residency requirements can be completed by attending two consecutive semesters of courses, and spending two five day programs at the campus of the Indiana State University during the residency period. The courses may be taken either as online courses or in the regular class room format. The courses may be taken at Indiana State or at one of the member institutions of the consortium. The arrangement essentially offers the students the flexibility to complete the degree requirements primarily through distance education and the provisions to pay only the resident tuition fees to their local institution. It also enables a candidate to select a research mentor at the local institution and continue to work on a problem of interest without undue interruptions. The degree program offers specialization in the following areas: general technology, manufacturing systems, quality systems, construction management, digital communications and human resources development and training. The degree requirements include 18 hours of dissertation research.

Although the program is very structured in terms of its contents and requirements, it offers flexibility for a faculty member in engineering technology to complete the degree requirements without disruptions to his/her career. The program places its primary emphasis on learning through formal instruction. As such, it is more suitable for someone who might need additional formal education leading to research and a doctoral thesis. For a faculty member with years of experience in teaching and an ability to carry out independent research, the program does not offer adequate provisions to place a higher emphasis on research over learning through instruction. However as the only program of its kind in the country, it offers unique opportunities for engineering technology faculty.

Northern Iowa's Doctoral Program in Industrial Technology

The Doctor of Engineering Technology (DIT) program offered by the University of Northern Iowa is one of only a handful of programs that deal directly with technology subjects of interest to engineering technology faculty. [16]. The DIT is a traditional doctoral degree program requiring one year of on-campus residency, and 64 hours of formal course of study and research. The subject matters included in the program are:

Industrial Technology Foundations:	12 Hours
Research Methods & seminar:	13
Internship & dissertation:	18
Technology courses:	21
Total:	64 Hours

As a traditional doctoral program, it emphasizes instruction based learning. The program requires for 75% of the work to be completed in the form of formal class room work. The program will be

of value to engineering technology faculty interested in pursuing a full time study leading to DIT. The program offers neither the flexibility needed for the engineering technology faculty to complete the degree according to his/her own schedule nor it places an emphasis on independent research.

Doctoral Degree Programs at Farmingdale State University of New York

Starting Fall of 2003, the Leeds Metropolitan University (LMU), Leeds, England, in collaboration with the Farmingdale State University of New York (SUNY) and industry sponsors in the USA has been offering an opportunity to anyone interested in undertaking research leading to Ph.D. and D.Eng. degrees granted by LMU. [17, 18] Faculty members and practicing engineers with master's degrees in engineering can complete the requirements for the doctoral degrees without interruptions to their professional careers.

Entrance requirements for the doctoral degree program includes a minimum of a master's degree in the field, experience in teaching or industry practice, and demonstrated ability to carry out independent research. The requirements for the degree will include mastery of the subject matter through guided learning and research, directed independent research on a topic of significance, contribution to the field of knowledge as demonstrated through peer reviewed publications, completion of a doctoral thesis, and oral examination and defense of the thesis in front of a panel of experts.

There are no specific course requirements associated with either of the degrees. However, mastery of the subject matter and proficiency in the research methodologies will require extensive self-study and directed learning. There are no requirements relating to formal residency. However, the students enrolled in the doctoral program will meet with their respective faculty advisors once a year at the Farmingdale State University campus, Farmingdale, New York. The meeting may last up to a week. The program has no minimum time limit to complete the degree. The maximum time allowed to complete the degree is six years.

The program requires each of the doctoral candidates to undertake an in-depth study of a problem in industry or at a university, gather data, analyze the results and publish the outcomes of the study in peer reviewed journals. It is expected that a student would publish up to six research papers as part of the doctoral work and incorporate the results into the final thesis. The student may choose to work with a local company in selecting a practical problem for research and utilize the resources of the company to complete the research. A qualified industry partner may function as a member of the faculty team guiding the doctoral research.

The primary nature of the program is to place all its emphasis on independent research. The program is appropriate only for those who are capable of undertaking extensive self study, and has the determination and willingness to carry out research with very little direct supervision. It is very appropriate for a faculty member with experience in independent research, a high degree of self discipline, motivation and a clear understanding of the scope of the research project. The program offers total flexibility and the means to earn broader recognition for the research

through publications. It offers the best means to work on problems that are directly related to the interests of the faculty and to the sponsoring organization.

Farmingdale State University also facilitates a similar doctoral degree program in engineering offered by the Oxford Brookes University, Oxford, England. [19]. The program follows the same guidelines and procedures outlined for the doctoral degrees offered by LMU. Oxford Brookes offers yet another avenue for independent research in engineering and technologies.

Summary

The doctoral degree programs presented here offer distinct features for faculty members interested in advanced degrees. For anyone interested in a formal program of study, followed by dissertation research and a thesis may prefer a program such as the one offered by the University of Northern Iowa. On the other hand, for a faculty member interested in a structured program that also offers considerable flexibility, the Indiana State University's program in Technology Management may be ideal. The doctoral program offered through Farmingdale State University of New York would be appropriate for a faculty member with a strong technical background, a desire to carry out independent research and a willingness to publish the results in peer reviewed journals. A comparison of these programs reveal that each one offers unique characteristics for those interested in the doctoral degree.

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