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I Introduction

Success in an Engineering Technology programs has been traditionally evaluated based upon three factors namely, Teaching, Research and Service. While the relative ranking of these factors is arguable [1,5], it is the research (and the associated requirement of publication) which causes great anxiety for faculty in ET programs. This is specially true, in view of increasing emphasis placed on the research and publication by the ET programs in the nation. A number of articles have been written on the promotion and tenure requirements [2,3,4]. Most of these publications discuss the general requirements of promotion and tenure and the process of obtaining tenure. This articles discusses various methods by which faculty members in an undergraduate engineering Technology Program can fulfill the requirements of research and publication via capstone project courses.

II Research Environment in ET Programs

Traditionally, ET programs have placed a larger emphasis on teaching compared to research. This is specially true for programs that offer only undergraduate education in Engineering Technology. Consequently a number of faculty were hired primarily for teaching. At these institutions, a Master's degree is the terminal degree required for their faculty. One can argue that research environment in these programs is not conducive to generation of research and publication. Among the reasons cited are the lack of graduate students, lack of faculty with PhD degree. During the last decade, we have seen a shift in this paradigm. Increasing number of institutions now require externally funded research and publication by the faculty.

The various methods for meeting these requirements are discussed under two major headings, research and Publications.

III. Research

The Engineering Technology Community has adopted a more broader definition of research which in addition to "creation of new knowledge", includes applied research, industrial projects and in general any contractual technical service. These contractual technical services can be provided

under various organizational frameworks as discussed by the author and his colleagues in a previous ASEE paper [6,7]. Broadly speaking these services can be funded or unfunded.

1. Funded Research

External funding for applied research projects can be obtained through
a. Various Federal Government Agencies
b. State Government Agencies
c. Foundations and
d. Industry

In majority of the cases, the applied research projects are funded by industry. The motivation for contracting out these services lies in the fact that a number of these companies do not have the sufficient manpower to support such an effort or they may not have the desired expertise. Federal Agencies like National Science Foundation (NSF) do support development of new laboratories under programs like Course-Curriculum and Laboratory Improvement (CCLI) programs or Major Research Instrumentation Program (MRI). NSF also offers targeted funding for research in UG institutions. This paper discusses an industrial project which was funded by the Center for Innovative Technology of the State of Virginia. Technology Application Center in the College of Engineering and Technology at ODU operates on a cost shared basis between industrial client and the state government.

Case Study - Design & Fabrication of an Automated Battery Testing Machine

An automated battery testing machine was designed and built. This project was done with the help of two seniors participating in the project as part of their capstone course requirement. The two students were from the MET and EET programs and they worked on Mechanical Design and Electrical Controls respectively.

The machine is capable of testing approximately 50,000 batteries in an eight-hour shift. The batteries are fed through a vibratory feeder on to a moving chain conveyor. The conveyor takes the batteries through two testing stations. The first one performs an open circuit voltage test and the second station performs a high current test. Two programmable logic controllers control the motion of the conveyor with the help of several photo optic sensors and limit switches.

The automated battery tester designed and fabricated for Rebatt Inc. tests approx 65 AA size batteries per minute. The equipment tests the batteries under loaded and no-load conditions and separates the bad batteries from the good ones. An automatic battery feeder provides a continuous supply of batteries for the conveyor belt. The equipment has been operational at the client's facility for more than a year. The total cost of the project was approximately $ 50,000 out of which the client's share was $20,000. Based upon three shift operation and displacement of five operators earning $6.00/hr, the payback period came out to be less than a year.

The results of this project were presented at the 1999 International Mechanical Engineering Congress and Exposition [7].

2. Unfunded Research

Unfunded research can be done as part of senior project course as illustrated by the following example:

Case Study - Effect of Various Parameters on the efficacy of Material Removal in Abrasive Jet Machining.

Abrasive Jet Machining (AJM) or Microabrasive Blasting (MB) is commonly used in industry for cutting, cleaning, abrading, drilling and etching applications in the manufacturing industry. This research work was done in the Automated Manufacturing Laboratory at Old Dominion University by a group of senior students under the supervision of the author.

The material removal rate in the AJM process is dependent on five key variables. 1. Air Pressure, 2. Abrasive Flow Rate, 3. Nozzle Size, 4. Abrasive Particle Size and 5. Nozzle Distance from Workpiece. While the process has been used for many years the effect of these variables and the interactions among these variables on Material Removal Rate is not understood very well. Effect of parameters like nozzle tip distance, abrasive flow rate and nozzle tip angle on the material removal rate was specifically studied during this project.

Abrasive Jet Machining has been used for hundred of years in various forms in a variety of finishing and surface preparation operations. However its application for machining parts is a relatively recent phenomena. There is very little published data available on AJM process. Most of the research work related to AJM has been done in-house by a handful of equipment manufacturers and only part of this data is available to general public.

The results of the study show that as nozzle tip distance increases, material removal rate increases and then decreases. A similar effect was observed with respect to the other two parameters namely, abrasive flow rate and angle of inclination. The abrasive jet tends to diverge as it moves away from the nozzle and the velocity of contained particles decreases. This decreases the material removal for larger values of nozzle tip distance.

The results of this project were presented at the 2000 International Mechanical Engineering Congress and Exposition [10].

IV. Publications

General requirements on publications include books, journal article, papers in the conference proceedings, technical reports and development of laboratory manuals. While books and journal articles are universally recognized as the superior forms of publication, relative weight given to

other forms of publications is arguable [9].

1. Journals

Various journal publication opportunities are available for faculty in an undergraduate engineering technology program. These include but are not limited to:
a. Journal of Engineering Technology. b. Technology Interface (on-line journal). c. THE Journal

2. Conference Proceedings

Various opportunities for publications in the conference proceedings are available. Generally, peer reviewed articles are given more weight than those that are not peer reviewed. Engineering Technology Division of the American Society for Engineering Education (ASEE) sponsors various sessions related to Engineering Technology issues at their annual conference. Similarly MET Department Heads Committee of the American Society of Mechanical Engineers (ASME) sponsors several sessions at their annual international congress. Similar opportunities exist in other engineering technology disciplines like CET and EET.

3. Technical Reports

Technical reports submitted at the completion of a project are also acceptable form of publication for many Engineering Technology Programs. Technical reports were submitted at the conclusion of each of the two projects discussed above.

4. Laboratory Manuals

Development of Laboratory Manuals is another acceptable form of publication. Senior project courses can be used not only to develop experiments but also to create the associated documentation.

V. Summary

Faculty in undergraduate Engineering Technology Programs have enormous opportunities for research and publication using senior project courses. In face of the increasing emphasis on research and publication, lack of graduate programs and graduate students is no longer a valid argument. In absence of funded research, unfunded research can be done with the help of senior project courses. Numerous publication opportunities exist including peer reviewed journal articles and conference proceedings and non peer reviewed technical reports and laboratory manuals.

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Alok K. Verma is Associate Professor and Director of the Automated Manufacturing Laboratory at Old Dominion University. He received his B.S. in Aeronautical Engineering from the Indian Institute of Technology, Kanpur in 1978 and MS in Engineering Mechanics from Old Dominion University in 1981. He joined the Mechanical Engineering Technology Department in 1981. His publications are in the areas of Fluid Dynamics, Advanced Manufacturing Processes, CAD/CAM, and Robotics. His current research interests are in the area of non-traditional manufacturing processes and process optimization. Alok Verma has co-edited the proceedings of the International Conference on CAD/CAM & Robotics for which he was the general chairman. He is active in ASME, ASEE and SME.