Engineering or Technology: Which Path to Take?

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Abstract: This paper contrasts the principal differences between the two manners of practice of a discipline, the type of career path graduates should expect, and share experiences gained from involvement in the courses' design and delivery at the University of Western Sydney, Nepean. Although based on the author's experience with Mechatronics, the comments made in the paper are applicable, in a wider context, to all engineering or technology disciplines.

Engineering comprises a wide range of activities, including research, development, design, testing, manufacturing, maintenance, marketing and sales. Participation in all of these activities does not require the same amount of educational preparation, which has led to the development of two main professional streams: the engineering one with the greater emphasis on engineering fundamentals and the technological one. Both options represent viable professional paths, and students need carefully to consider their abilities, interests and personal career objectives before selecting a specific program.

The Bachelor of Technology Program and Bachelor of Engineering Program at the University of Western Sydney have proved to be complementary. Articulation with Technical Colleges provided an avenue for further academic progression for suitably motivated diploma graduates that is proving increasingly popular, not only with local students, but internationally as well. Opportunities for offshore courses delivery as well as articulation also look promising and are being developed. Experience has shown that progression from a trade course through a diploma, a technology degree to an engineering degree produced graduates with outstanding skills who are keenly sought by industry. However, graduates of either stream can expect to follow satisfying and useful career paths.

Keywords: engineering, technology, education, accreditation

1. Introduction

One dictionary [1] definition of engineering as *the art or science of making practical application of the knowledge of pure sciences, such as physics, chemistry, biology, etc.* may be contrasted with the definition of technology, in the same dictionary, as: *the branch of knowledge that deals with science and engineering, or its practice, as applied to industry, applied science*. It typically illustrates a lack of precision which, in microcosm reflects perceptions in the society at large, and a dilemma that a high school graduate is facing when deciding which career path to take. Some perceptions accord engineering solutions to problems as long term and stemming from considerations of the fundamental precepts, while technological remedies are technical responses to immediate or short range problems, using the existing knowledge base.

This paper aims to elaborate on the difference between engineering and technology paths, not only to help the potential student plan his or her career, but also to help the tertiary curriculum developer judiciously structure the course content of the two different professional streams. The educator is especially aware of the need to be vigilant and perceptive of the needs of the industry, as recent publications may suggest [2-4]. Furthermore, the professional accreditation process demands periodic review of accredited courses to ensure their continued relevance.

2. Engineering versus Technology Education

Occupational categories involving Professional Engineers and Engineering Technologists are reflected in the evolution of specialist courses catering for the specific needs of each group. The relevance and professional standard of each course is guaranteed by the accreditation of the appropriate professional association: the Institution of Engineers, Australia or recognised equivalent.

Professional Engineers are generally serviced by a four year undergraduate engineering degree course. The course provides fundamental knowledge of aspects of physical sciences that could be applied to a solution of any problems in their field of specialisation. The course involves an obligatory period of industrial practice in a capacity utilising this knowledge, before the degree could be awarded. Following an initial induction into the practice of their profession, graduate engineers can work independently and display leadership in creating and applying new engineering practices on a regular basis They are able to reframe situations better to appreciate the costs to the community of development proposals; they have the ability to comprehend complexity and work with multi-disciplinary and cross-cultural teams to achieve the desired outcome. Most importantly, they have the ability to plan and design original and novel solutions using well developed powers of analysis and synthesis [5].

On the other hand, Engineering Technologists are generally serviced by a three year full-time undergraduate engineering technologist course, also professionally accredited by the Institution of Engineers, Australia or recognised equivalent. The course provides a smaller knowledge base than for professional Engineers, but as experienced professionals, their knowledge in niche areas may be of greater depth. In general, as practicing professionals, Engineering Technologists are expected to modify established engineering practices and apply newly developed engineering practices on a regular basis, especially in their planning and design activities. Their leadership and management qualities, combined with an understanding of the application and advancement of engineering technology (devices, processes and systems), enable deployment of human, physical and financial resources to meet enterprise needs [5].

At the University of Western Sydney, the engineering stream is fully serviced by the university, while the Bachelor of Technology stream is split between Institutes of Technical and Further Education (TAFE) and the university. In the latter case, a student obtains a diploma from an Institute of TAFE after the fourth semester, and the degree after the sixth. However, a student may wish to proceed to a Bachelor of Engineering course. That would normally take four additional semesters. Before being admitted into the university however, a TAFE student needs to undertake additional mathematics subjects that are equivalent to the first year mathematics of a BE course. The Technology stream has currently its own subjects which are an adaptation of Engineering subjects but with an emphasis on the technological aspects.

3. National Generic Competency Standards

The Institution of Engineers, Australia has issued Competency Standards [5] to provide the bases for distinguishing between Professional Engineers, Engineering Technologists and Engineering Associates for the purposes of

- determination of occupational standing of employed professionals
- assessment for the purposes of professional registration
- the design of undergraduate and postgraduate engineering courses intended to prepare candidates for membership of The Institution of Engineers, Australia.
- the derivation of industry specific, or operational, competency standards and associated competency based training.
- planning of continuing professional development for advancement to further stages.
- determining job specifications, and appropriate levels of employment for the guidance of employers

In general, the criteria for the differentiation between Professional Engineering and Engineering Technologist practices have been based on the following competencies:

- Engineering practice
- Engineering planing and design
- Self management in the engineering workplace

- Contribution to business strategies through the provision of specialist engineering knowledge and experience:
- Scoping and managing engineering projects within a program of work ensuring that time, cost and quality are managed effectively and that progress is maintained to achieve the outcomes within and across a number of projects.
- Managing significant ongoing engineering operations and make complex decisions to optimize the performance of the plant/system in a dynamic environment.
- Selecting safe and sustainable materials, components and systems which are a part of solutions to engineering problems and meet client and community expectations,
- Examining and determining the environmental management requirements of engineering work.
- Identifying and responding to opportunities for engineering investigation and to making recommendations that solve engineering problems or improve present applications.
- Identifying R & D opportunities, identifying commercial opportunities for the outcomes and planning and designing for the research.

Reference [5] provides an in-depth appraisal of each above criterion for the professions. It is apparent, by way of a summary, that the Professional Engineer is expected to have an overall system view and provide overall leadership and have greater responsibility for the project outcomes. A Technologist focuses on interactions within the system, management and the operational aspects of the part of the project.

4. Students' Course Selection and Career Guide

It is instructive to compare some performance features and characteristics of the two professional streams adapted from fttp://www.asme.org:

- An Engineering Graduate is expected to be an innovator – who is able to interweave a knowledge of advanced mathematics, the natural and engineering sciences, and engineering principles and practices with considerations of economic, social, environmental and ethical issues to create new systems and products. He or she can develop new procedures to advance the state of the art.

  On the other hand, a Technologist is seen as a ɔber or implementor – one who is able to apply a basic knowledge of mathematics, the natural and engineering sciences, current engineering practices and an understanding of economic principles to the solution of design problems and to the operation or testing of engineering and manufacturing systems. He or she can apply established procedures which utilize the current state of the art.

- The Engineering course aims, among other things, to provide the knowledge necessary to design and manufacture state-of-the-art products and systems needed to meet the current and future needs of society.

  The Technologist course stresses development of methods of analysis and solutions for open-ended-design problems. Emphasis is on applying current knowledge and practices to the solution of specific technical problems.

- In respect of the courses objectives, the Engineering develops conceptual abilities, while the Technology course develops application abilities.

- Engineering courses emphasise the underlying theory as well as current and potential applications in business and industry. Technology courses stress the application of technical knowledge and methods in the solution of current industrial type problems.

- In an Engineering course, laboratory practice provides an intensive overview of experimental methods and of the related underlying theories. In Technology courses, laboratory practice aims at practical design solutions as well as manufacturing and evaluation techniques appropriate for industrial type problems.

- General design principles and tools applicable to a wide variety of new problem situations are heavily stressed in an Engineering course. In a Technology course, current design procedures of complex but well-established nature are developed and applied to problems in a specialised technical area.

- It is generally easier (in terms of subject credits and time) to transfer from an Engineering course program to a Technology course program, than the other way around.

In respect of career opportunities, it is also instructive to consider the following features between the two professions:

- An Engineering graduate entering industry would most likely aspire to an entry-level position in conceptual design, systems engineering, manufacturing or product R & D. A Technology graduate upon entering industry would most likely aspire to an entry-level position in product design, development, testing, technical operations or technical services and sales.

- In respect of technical interest, it is considered that an Engineering graduate has broad interests and an analytical, creative mind challenged by open-ended technical problems. On the other hand, a Technology graduate is relatively specialised and has an application orientation, challenged by specific technical problems.

- Concerning adaptability to current industrial practices, an Engineering graduate typically requires a period of "internship" since engineering programs stress fundamentals. A Technology graduate is generally prepared immediately to begin technical assignments since technology programs stress current industrial practices and design procedures.

- Many Engineering graduates eventually move into management positions, while Technology graduates can move into industrial supervisory positions.

- In respect of Professional Registration with The Institution of Engineers, Australia, Engineering graduates may apply for Engineering membership while Technology graduates may apply for Technology membership.

- Suitably qualified graduate Engineers may apply for postgraduate study. Postgraduate studies are generally not available for Technology graduates.

5. Conclusions & Recommendations

This paper provided an overview of the Engineering and Technology paths by contrasting the major features of the courses and respective careers that aspiring students of Engineering and Technology may find informative. On the other hand, course developers may find it useful to use the information provided here as the basis of curriculum development.

6. References

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