

The Challenges of Educating Engineering and Technology Managers

Dr David Thorpe

University of Southern Queensland, Toowoomba, Australia
thorpe@usq.edu.au

***Abstract:** The Master of Technology Management (MTM) program aims to produce graduates equipped with essential management knowledge and an appreciation of technologies outside their initial specialisation. The skill set would therefore allow these graduates to manage complex technological or engineering businesses.*

The MTM is being developed by the University of Southern Queensland's Faculty of Engineering and Surveying, and is written by engineers for engineers and other technologists. It is closely linked with the University's MBA program. Its courses will be offered in part-time, external mode. On-line delivery, and short courses based on the written material, are being considered in the future. Ensuring that the courses offered in the MTM develop the skills required to manage technology in a dynamic environment has provided a number of challenges to the team developing them. As well as experienced academics, this team includes staff who have come directly from industry, are enthused about the MTM and can contribute significantly to it, but have also had to learn the course development process.

Through this combination of people who have come from industry with experienced academics, the challenges are being addressed so that the Master of Technology Management aims to provide a solid learning experience for the student, and in doing so to develop highly effective engineering and technology managers.

***Keywords:** engineering, technology management, innovation*

Introduction

The Master of Technology Management (MTM) is a postgraduate coursework program being developed by the Faculty of Engineering and Surveying at the University of Southern Queensland (USQ).

It aims to produce graduates that are equipped with essential management knowledge and an appreciation of the latest technologies much broader than their initial specialisation. In doing so, it aims to develop graduates who will manage complex technological or engineering businesses (University of Southern Queensland, 2002, p.7).

The MTM is a six-semester part time program consisting of twelve related courses. Four of these courses are core Master of Business Administration (MBA) courses and eight are specialised technology management courses (University of Southern Queensland, 2002a,

pp.7-9). Conversely, an MBA with Technology Management specialisation is offered. It has four core MTM courses plus eight MBA courses

A Master of Professional Engineering, which is oriented to engineers desiring a higher level of engineering specialisation than offered by either the MBA or the MTM, completes the suite of programs (University of Southern Queensland, 2002b).

The MTM will be delivered in part-time external mode. On-line delivery, and short courses based on the written material, are being considered for the future.

Development of the MTM as an effective program for educating engineering and technology managers has provided both challenges and rewards for the development team, which consists of both experienced academics and staff who have joined the University directly from industry.

The Challenges of Technology Management

Definitions

One of the first challenges in developing the MTM courses was to develop meaningful definitions of the terms “technology” and “technology management.” A particular challenge was to move beyond the popular view that technology is mainly concerned with information management systems.

The definition adopted for “technology” by the project development team considered both existing definitions and the desired outcome from the MTM, and was “the scientific knowledge base whose outputs are the systems, processes and know-how that are integrated into engineered systems and processes for the betterment of the world.”

The definition of “management of technology” was amended from that of the National Research Council, USA (1987). It is as follows:

“Management of technology links engineering, science, and management disciplines to plan, develop, and implement technological capabilities to shape and accomplish the strategic and operational objectives of an organisation and enhance its innovation competency.”

Thus, the management of technology encompasses not only the management of existing technology but also the development of organisations so that they are effective and efficient innovators and can implement new technologies.

Development of Managers for a Dynamic Environment

A further challenge has been to develop courses that equip graduates who can effectively and efficiently manage, over the long term, the ever-changing field of technology.

As Tschirky (2001) explains, the discipline of technology management is itself also changing over time. The initial aim of technology management was to close the link between the technological disciplines and general management. The next step was a paradigm shift that brought technology into management, and the third is a new enterprise science view that fully integrates technology-awareness into general management. It is based on the assumption that in research it is possible to draw on all the relevant empirical and science-based areas of scientific knowledge to describe the enterprise.

There are organisations in all three of these stages, and accordingly the MTM – if it is to be successful – will need to address all of them, and also look towards a possible future in which managers of technology will increasingly determine the strategic and operational direction of their organisations.

Description of the MTM

Management courses have been part of undergraduate engineering programs for some time. Ward (1998) chronicles the development of such a course at the University of Technology, Sydney. He notes the importance of aspects such as the human side of management, and the need for management to win.

The MTM endeavours to take the specialised engineering management program into the postgraduate environment. It embraces the above elements, and adds others, in an integrated program that offers:

- Core Master of Business Administration courses (delivered by the University's Faculty of Business) in management and organisational behaviour, economics, accounting and law.
- An integrated suite of specialised technology management courses in technological impact and its management, asset management, risk management and sustainable development.

A choice of four out of six other courses, which logically follow from the four specialised technology management courses.

Complementary Certificate and Graduate Diploma programs are also available.

As well as taking graduate engineering and technology management education beyond that at undergraduate level, the MTM aims to develop the skills needed to compete and be successful in the complex world of technology, engineering and entrepreneurship in which the advanced technological manager will work.

The MTM program was developed out of the recognition that a large number of engineers and other practicing professionals aspire to managerial positions in a technology or engineering environment. It was also recognised that qualified managers of technology play a crucial role in technologically advanced as well as developing societies. Thus it was reasonable to expect that many of these professionals would want to achieve postgraduate qualification in a coursework-based management-focused program (University of Southern Queensland, 2002a, p. 11).

Some of these professionals would be interested in undertaking the MBA with a technology management specialisation. Others would be interested in a more specific technology management oriented master's level business qualification, such as the MTM. There is also an option for students to undertake the Master of Professional Engineering, which allows students to undertake a research project as well as a selected number of MTM and MBA courses.

This structure allows students to select a program that has a mix of closely related business and technology management courses aimed at meeting their particular needs.

This use of a limited number of closely related courses to meet the requirements of three different, yet related programs (Master of Business Administration with technology management specialisation, Master of Technology Management, Master of Professional Engineering) differentiates this set of programs from several of the postgraduate technology management programs offered elsewhere. It allows students to select a program suited to their needs, and know that the courses they are studying are designed to integrate with the other courses in that program. This program structure should therefore be attractive to students interested in a focused postgraduate engineering or technology management program that suits their requirements.

Through being designed as postgraduate programs aimed at ambitious professionals, and accordingly designed to challenge students at a high level, the MTM and its associated programs are distinguished from undergraduate double degrees in engineering and business, which would be expected to appeal to a different group of students.

As there will be an ongoing challenge to maintain and enhance the above features so that they remain relevant to engineering and technology managers into the future, courses in these programs are being designed for maintainability as well as academic rigour.

The MTM and its associated programs are being developed to meet both the requirements expected of coursework postgraduate degrees and the expectations of industry. This presents a further challenge, as the program will be offered in both Australia and overseas, and requirements and expectations may differ across geographical and political regions.

Figure 1 shows the MTM course structure.

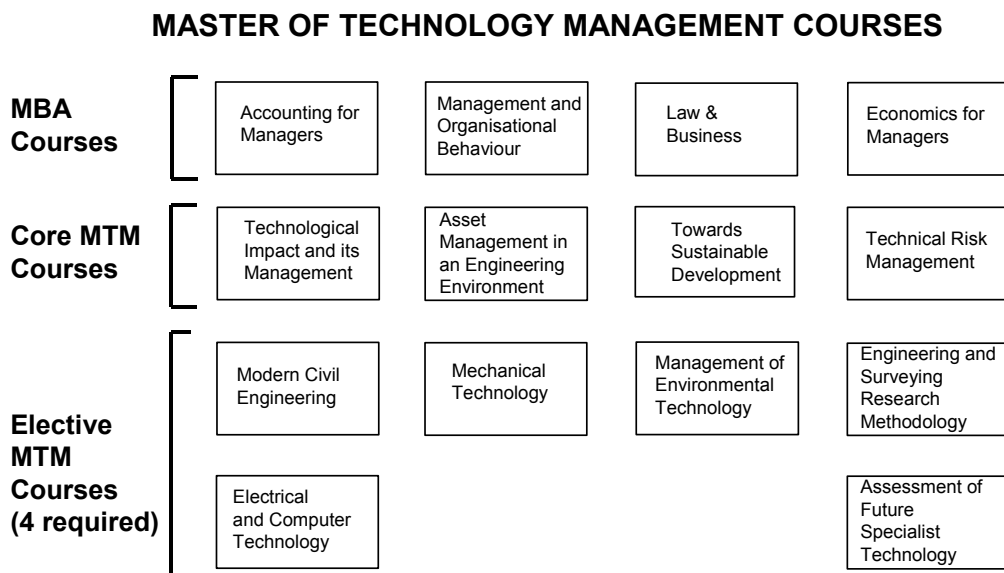


Figure 1 – Master of Technology Management Courses

Delivery of the MTM Courses

Use of Distance Education

One of the factors in developing the MTM was the estimate by the Australian government in 2001 that a total of 240,000 people would take up a loan to undertake postgraduate

coursework study over the following five years. Although specific statistics for engineering were not available, there was a clear indication that there was a sizeable market for coursework programs, which could complement the current research programs.

However, the demise of traditional on-campus Masters degrees was evident within Australia and possibly overseas. Therefore, the market demand must be serviced by the non-traditional means of distance education. This tended to be supported by overseas evidence (University of Southern Queensland, 2002a, p. 10).

Therefore, it has been decided to use distance education – a strength of the University of Southern Queensland - to deliver the MTM courses. Teaching and assessment are to be similar to current Faculty of Engineering and Surveying practice.

The combination of strength in distance education with an integrated technology management program that combines the specialist skills of academics in business and engineering skills is expected to develop the MTM into a program that provides students – both in Australia and elsewhere - with a rounded technological management qualification tailored to their needs.

Enhancing the Learning Experience

The MTM courses will be delivered through written documentation, using prepared course material supplemented by texts and readings. Online methods of teaching, which appear to have a number of positive features, will supplement the written materials.

There are numerous studies in the literature on online learning. For example, Macdonald (2001) reported on the use of online interactivity in assignment development and feedback in Britain's Open University, and noted that use of an electronic network allowed for delivery within a controlled time frame whilst providing an interactive environment for debate on alternative perspectives.

In the Australian engineering education environment, Deeks (1999) discussed the use of web-based assignments for structural analysis, and noted that this system was expected to improve the deep learning of the material presented. Another paper by Kirkpatrick and McLaughlan (1999), discussed use of a web based learning environment incorporating computer mediated technologies for student interaction for problem based learning and professional skills development (a similar environment to that expected for the MTM courses). It provided flexible and responsive support for student interaction and communication.

From studies such as these, online learning has both advantages and challenges, but is likely to be quite useful in promoting student interaction and in the formative assessment process. In the MTM, it is therefore expected that both online discussion groups and directed web-based research will be used. A later stage of development could incorporate online feedback of sample answers to research questions.

This approach will assist in overcoming another challenge in developing the MTM courses so that they effectively educate engineering and technology managers - balancing the amount of detail provided in material between basic material needed to meet learning objectives and the more detailed information demanded by the more enquiring students. The strategy adopted in this case is to provide sufficient material in the written course material, prescribed text and prescribed readings to give basic information; then supplement this material with directed and

challenging research, reflection and problem solving tasks. Much of this supplementary material will use online resources.

To facilitate this process, student tasks are classified as “essential”, “important”, “background” or “other”. The material studied in essential tasks provides basic knowledge of the course material, and is usually a key principle in the written course notes or text. Important tasks include reading and understanding explanatory course or text material, or undertaking a reading or exercise that aids understanding of the principles being explained. Examples of background tasks may be directed or undirected research that enhances understanding of course material. Other tasks provide additional learning for students who want to understand a particular topic in more depth. They would typically be undirected research using suggested resources.

Material in essential and important tasks is examinable, while material in background and other tasks is not examinable.

The Course Development Process

Challenges in Course Development

The special challenges of equipping managers of technology to be effective managers and innovators in a dynamic environment, on an ongoing basis, have required careful attention to be given to the MTM course development process.

As apart from the MBA courses and the existing “Engineering and Surveying Research Methodology” course, none of the MTM courses had previously been taught at USQ, a further challenge was that new material had to be written for these courses.

Another challenge arose from the desire to equip managers of technology to play a significant role in determining the direction of their organisations in a dynamic environment, at both a strategic and operational level. To do so, it has been necessary to both keep the course objectives and material suitable for management students at a postgraduate level while providing sufficient detailed information to enable them to understand operational issues. In time, further courses at the more detailed management level might be needed to meet this need (refer example discussed below).

Finally, the author, who has been responsible for developing a number of the courses, came to the university directly from industry and therefore had to meet the challenge of learning much in a short period of time.

Meeting the Challenges

The first step in meeting the challenges was to form a group responsible for developing the courses in the MTM. The author is a full-time member of this group, and has the support of a number of experienced academics who provide input into the development process and give feedback.

There has also been close liaison with the university’s Faculty of Business, which has also provided assistance, input and advice. In addition, there is close liaison with an Instructional Designer from the university’s Distance Education Centre to ensure that course material is based on sound flexible learning practices, stimulates active learning and meets university guidelines.

An example of this development process is the course “Asset Management in an Engineering Environment”, which deals with the life cycle management and economics of technological assets.

As with the definitions of “technology” and “technology management”, one of the first tasks in developing this course was to define what was meant by those assets that should be managed by an engineer or technologist – the “technological assets.”

A further challenge was to decide on the way in which the course should be organised and presented to meet the course objectives and to challenge learners. It was decided to use a strategic approach to asset management, starting with the life-cycle outcomes to be achieved then following with the methods and tools, such as economic decision-making and information systems, to support this process. A final section – combining these approaches into an integrated whole - is aimed at equipping asset managers to operate in a dynamic environment.

A textbook, based on infrastructure management, was selected. However, the variety of technological assets, and the need to challenge advanced learners, meant that other study resources were required. Thus, the course uses guided research of the type discussed previously – reflection, research into key issues (supplemented by a series of questions to prompt the research process), development of opinions and problem solving. Extensive use is made of on-line research to supplement written material.

The availability of considerable information on this topic has presented another educational challenge – what to keep and what to omit so that the higher level needs of management students at a postgraduate level could be met, while also providing sufficient detailed information to enable the students to understand operational issues. One solution has been to adopt the “essential, important, background and other” classification of study material discussed previously. Development of a future subsequent course in the more detailed aspects of asset management might be a further option.

Development of this course has been a steep learning curve for the author, whose next step is to deliver it in the first semester of 2004.

Implementation of the MTM

The MTM aims to be a postgraduate degree that combines expertise from the disciplines of business, engineering and surveying into an integrated package aimed at the innovative management of today’s and tomorrow’s technology based organisations. It combines both theoretical and practical aspects and therefore should appeal to the modern manager of technology.

As discussed previously, it is being initially delivered to practising engineers and technologists through part-time distance education, supplemented by on-line discussion and research. Possible future full on-line delivery may be used to improve course delivery and flexibility.

While the MTM can be seen as an integrated program, its courses are also being developed as “stand alone” packages that can be studied independently of each other. These courses are

being developed in a modular fashion that permits selected modules to be offered as future short courses.

Conclusions

The Master of Technology Management and its associated programs are being developed in response to a changing world and changing demands on engineering and technology professionals.

Because of the developing environment in which graduates from the program will work, and because of the changing needs of managers of technology, development of the MTM will be a dynamic process. It has been a particular challenge to the author, who has joined the University environment directly from industry and has had to learn how to develop courses.

Conversely, the recent industry experience of some of the staff developing the MTM courses has lent enthusiasm and an understanding of the need for technology management and innovation, and has therefore – in combination with the knowledge of experienced academics - benefited the development process. As a result, it has been possible to identify and address any development issues, and in the process produce a balanced program suitable for today's dynamic technological environment.

Through overcoming the challenges of developing the Master of Technology Management, it is expected to develop an interesting and challenging learning experience for the student, and equip its graduates to be innovative; in tune with both the engineering and business worlds; and able to effectively, efficiently and proactively manage both existing technology and that of the future.

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