Ten years on: An evaluation of the success of the Master of Engineering Practice program

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Structured Abstract

CONTEXT

The innovative Master of Engineering Practice (MEP) program allows experienced Engineering Technologists from diverse cultural, educational and employment backgrounds to re-engage in higher education and undertake learning experiences that are tailored to their individual needs and facilitate their progression to Professional Engineer. The MEP program enables students, who generally work full-time and study part-time, to use their workplace learning to complete at least half of the courses in the program. This distance education program, which is the only engineering program of its type in the world, results from a mutually beneficial collaboration between the University of Southern Queensland and Engineers Australia, who had identified the need for an accessible, efficient and relevant articulation pathway for experienced Engineering Technologists to progress their careers. The program is accredited by Engineers Australia and is enabling students and graduates to advance their careers.

It is now ten years since the program was introduced in Semester 2, 2004. During this period there has been a sustained growth in student numbers since the first offer: Three hundred and fifty one students have been admitted to the program and 80 have graduated. The median age of the students is 39 years (average 39.7 years), and nearly 16% of them are migrants, most of whom were recruited by Australian companies during the decade of skills shortages in the engineering industry.

PURPOSE

The aim of this study was to answer the following research questions:

- Has the MEP program enabled Engineering Technologists to achieve their career goals?
- How do the MEP completion rates compare with those for engineering degree programs?
- Has the program met the expectations of Engineers Australia?

APPROACH

The academic records of the students who enrolled in the program have been reviewed and the data analysed to profile the students and to assess overall attrition and completion rates. These were then compared to cohort analysis data published by the federal Department of Education in 2014. Testimonials from graduates and Engineers Australia were also used to evaluate the success of the MEP program.

OUTCOMES

The outcomes of the study were:

- A report on the profile of the students who enrolled in the program;
- An analysis of the attrition and completion rates, as well as the study patterns and other characteristics of the graduates; and
- An evaluation of the MEP program based on the perceptions of two of the key stakeholders.

CONCLUSIONS

The introduction of the MEP program has met the expectations of Engineers Australia as it is a flexible, work-based, distance education pathway that enables experienced Engineering Technologists to achieve Professional Engineer status, regardless of where they live or work in Australia. Secondly, there is strong evidence to show that, when age, location, study mode and type of attendance are considered, the completion rates of MEP students compare more than favourably with those of engineering degree programs. Finally, the program is enabling the students to achieve their career goal which, for many, is to become a Chartered Professional Engineer.

KEYWORDS: *Engineering education; Recognition of workplace learning; Graduate outcomes*

Introduction

The University of Southern Queensland's (USQ) Master of Engineering Practice (MEP) program was developed to address a specific need identified by Engineers Australia's Articulation Committee: The need for an accessible, efficient and relevant articulation pathway that enables its experienced Engineering Technologist members to gain the knowledge and skills required for them to commence practice as a Professional Engineer, i.e. demonstrate Stage 1 Competency. In line with international agreements, Engineers Australia accredits three levels of programs and, as shown in Table 1, each leads to membership in a different category. Each program is assessed against the relevant Stage 1 Competency Standard, e.g. *Stage 1 Competency Standard for Professional Engineer* (Engineers Australia, 2011*).*

Table 1: Accredited engineering programs and associated membership categories

Program	Length	Membership Category
Associate Degree or equivalent	Two years	Engineering Associate
Bachelor of Engineering Technology or equivalent	Three years	Engineering Technologist
Bachelor of Engineering or equivalent	Four years	Professional Engineer

Graduates are eligible for membership in the relevant category at the 'Graduate' level, e.g. Graduate Engineer. After three or more years of experience they may apply for full membership, e.g. Professional Engineer. An individual may then apply, and be assessed for, Chartered Membership in the relevant category, which certifies that they practice in a competent, independent and ethical manner. Engineers Australia assesses applications for Chartered status against the relevant *Stage 2 Competency Standard* (Engineers Australia, 2013). Chartered Engineers can practice independently and be listed in the national register.

Completion of a four-year Bachelor of Engineering degree is the traditional route for graduates from a three-year Engineering Technology degree to become Professional Engineers. This is particularly true for students who entered university directly from high school. However, this route is not particularly suitable for experienced, mature age Engineering Technologists who have already acquired many of the Stage 1 competencies, particularly those in the *Engineering Application Ability* and *Personal and Professional Attrib*utes categories. Furthermore, this pathway may not be appropriate for them because their work and family commitments, and geographic location, make it difficult for them to study on-campus. More importantly, because these people often work in senior positions, frequently supervising Professional Engineers, many of the undergraduate courses they would have to study in a degree program are not relevant to their current or future careers. The MEP program is designed for these people.

Research Questions

This paper reports on the key findings of a study that was undertaken to answer the following research questions:

- Has the MEP program enabled Engineering Technologists to achieve their career goals?
- How do the MEP completion rates compare with those for engineering degree programs?
- Has the MEP program met the expectations of Engineers Australia?

Approach

The academic records of all of the students who have enrolled in the program were reviewed. The data were analysed to:

- develop a profile of the students who have enrolled in the program;
- review the study patterns and other characteristics of the graduates; and
- assess overall attrition and completion rates.

The completion rates were then compared to the results of a cohort analysis undertaken by the federal Department of Education in 2014 (Department of Education, 2014). Testimonials from graduates and Engineers Australia were used to assess whether the MEP program has met the expectations of Engineers Australia and enabled experienced Engineering Technologists to achieve their career goals.

The program

Teaching and learning strategies

When Engineers Australia's Articulation Committee invited the Faculty to collaborate in the development of a distance education program for experienced Engineering Technologists, a key criterion was that *students should be able to use their workplace learning to demonstrate achievement of the objectives in up to half of the courses in the program.* The development of mechanisms to enable students to claim specific competencies based on their prior workplace learning, and to facilitate the assessment of those claims, was a significant challenge for the Faculty as academic staff were not used to assessing workplace learning.

The Master of Engineering Practice program is grounded in student-centred learning and assessment theory, and delivered using a coherent and systematic set of teaching, learning, and assessment strategies, all supported by high quality study materials (See Dowling, 2006; Dowling, 2011 for details). A coherent and systematic approach was necessary to ensure the program structure and adopted learning strategies would achieve the defined objectives.

The design and delivery strategies adopted for the program enable students to self-assess their prior learning and develop a *Pathway to Graduation Plan* in their first course. Once approved by the relevant Head of Discipline, the Pathway to Graduation Plan is regarded as a learning contract (Jarvis *et al.,* 2003). The students follow their Plan through to graduation, although they are able to renegotiate the Plan if circumstances change, or if they wish to write up new workplace experiences. The Plan also enables students to manage their learning so they can develop and demonstrate the competencies required for them to graduate in their specialist field of engineering. During this time they are supported by teaching staff who facilitate their learning and guide their career development.

Graduate Outcomes

The definition of a detailed set of graduate outcomes was critical to the success of the program as they enable students to self-assess their prior learning, including workplace learning. The set includes *generic graduate outcomes*, which all students must demonstrate, and a group of *technical graduate outcomes* for each of the specialisations in the program, e.g. Power Systems Engineering. The graduate outcomes are organised in a user-friendly framework and published in the study materials prepared for the first course.

The generic graduate outcomes defined for the MEP program were based on the Stage 1 Competency Standard for Professional Engineer (Engineers Australia, 2011) and the university's *Graduate Attribute*s. This ensures that the program meets the accreditation requirements of both institutions. The generic graduate outcomes were then expanded to include the Stage 2 Elements of Competency (Engineers Australia, 2013). This decision was based on the fact that the students would generally have the engineering experience required to demonstrate most of the Stage 2 Elements of Competency.

To facilitate this process, all of the graduate outcomes for the MEP program were written in the same format as the Stage 2 Elements of Competency, each of which has a set of Defining Activities which indicate the types of activities and level of achievement that can be used to demonstrate competency. Ten tables were prepared to define the 27 Elements of Competency, with 120 Defining Activities being listed to guide the students. For example, MEP Element of Competency 1.1 is *Manages Self* and the first Defining Activity is *Manages own time and processes*.

The *technical graduate outcomes* for each MEP major were developed by the relevant Heads of Discipline in consultation with their discipline colleagues, with three tables being defined for some majors and four for the other majors. For consistency, they were written in the same style and format as the generic graduate outcomes. For example, three tables were defined for the Electrical and Electronic Engineering major to list the eight Elements of Competency and their associated Defining Activities. The first Element of Competency is *Analyses, evaluates and selects computer components and systems.*

Importantly, these graduate outcomes were bundled so that when a student demonstrates achievement of all of the graduate outcomes in a bundle, they have demonstrated achievement of the learning outcomes for one of the Technical courses in their major.

Students write *Career Episode Reports* (CER) to use their workplace learning to demonstrate achievement of the learning outcomes specified for a course. These narratives have to be written in a format that was originally specified by Engineers Australia for Chartered status applications. The students submit drafts of each CER to course leaders for comment before submitting the final version, which must be signed by the engineer who supervised their work, normally a member of Engineers Australia.

When the students demonstrate they have acquired all of the MEP graduate outcomes they have demonstrated Stage 1 Competency and that they are also on track to demonstrate Stage 2 Competency when they apply to Engineers Australia. Because the Stage 2 Competencies and CER narratives are used in MEP program, and because high standards are set during the assessment process, graduates can use many of the documents they prepared for the MEP Workplace Portfolio courses when they apply for Chartered status. This is an important outcome for many students who undertake the MEP program.

Structure

The Master of Engineering Practice program consists of 12 units of study: eight one-unit courses, two, two-unit courses, and a zero unit Practice course (See Figure 1). There are six specialisations in the program: Civil Engineering; Electrical and Electronic Engineering; Environmental Engineering; Mechanical Engineering; Power Systems Engineering (introduced in 2009); and Structural Engineering. While the program structure is efficient and ensures that graduates have demonstrated Stage 1 Competency and ***all*** of the graduate outcomes listed for their specialisation, it has proved to be extremely flexible.

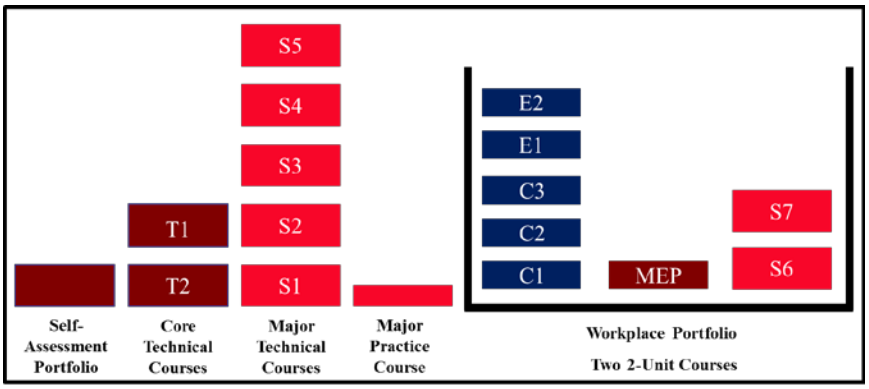

Figure 1: The structure and components of the 12 unit Master of Engineering Practice program

A one-unit Self-assessment Portfolio: The first course in the program is used to assess: (a) whether a student has, or can acquire, the workplace learning required to demonstrate achievement of the learning objectives in at least six units of study; (b) whether a student has the reflective and communication skills required to identify relevant career episodes and then prepare narratives about them that clearly demonstrate achievement of the defined learning objectives for a course; and (c) the feasibility of the student's *Pathway to Graduation Plan.*

Seven one-unit Technical courses: The students complete two prerequisite courses (T1 & T2) before completing five of the seven Technical courses in their specialisation (S1-S5). They must complete the remaining two courses in their specialisation by either gaining an exemption, or by using their workplace learning to demonstrate competence in their Workplace Portfolio (S6 & S7).

Students may complete a Technical course (or the Practice course): by studying the course; by using their workplace learning; or by receiving an exemption based on prior studies. When students plan to use their workplace learning to complete a course they list the graduate outcomes for that course in their Workplace Portfolio.

Two, two-unit Workplace Portfolio courses: The students use their workplace learning to demonstrate achievement of the learning objectives in the Workplace Portfolio, and any learning objectives from Technical courses they allocated to the Portfolio in their Pathway to Graduation Plan. To meet Australian Qualification Framework (AQFC, 2013) requirements, students who are admitted to the program after 2013 will complete the two-unit course *Industry Project* instead of the second Workplace Portfolio course.

A zero-unit Practice course: The students complete a one week residential school.

Together, the recognition of workplace learning and the self-assessment processes demonstrate the flexibility of the program structure because they cater for the diversity of knowledge, skills, prior learning, and workplace experiences that students bring to the program and allow them to negotiate an individual learning contract that suits their learning needs. *"The Self-Assessment Portfolio course was an excellent tool to identify deficiencies in my knowledge and to implement a strategy in the workplace to acquire the competencies to successfully complete the program"* (Tony, pers. comm., 2008).

The program has been accredited on three occasions by Accreditation Panels from Engineers Australia. The MEP program, and all of the majors, were fully accredited by the Accreditation Panel in 2009. Their report commended the Faculty: *"On the rigour of its selection process which involves consideration of a resume followed by the ENG8300 Self-assessment Portfolio." and "On the quality of the student work evident in the Workplace Portfolio courses, noting that this practise-based assessment is considered to be a valid alternative to traditional capstone project work. The standard of attainment reported in the CERs appears to be well beyond that to be expected from traditional capstone project activity at the bachelor or even master's level"* (Grayston**,** pers. comm., March 2011).

The students

Table 2 shows the enrolment, graduation and retention data for the program during the ten-year period from when it was first offered in Semester 2, 2004, through to Semester 1, 2014. A total of 351 students were admitted to the program during the period. Of these: 47 did not proceed with their enrolment; 80 graduated; 12 transferred to another USQ program; 65 cancelled from the program; and 147 remain active in the program. Overall, the enrolments in the MEP program have exceeded expectations, as it nearly reached the initial annual target of 20 commencing students in two of the first three full years it was offered, and has surpassed the target by a considerable margin in the following years.

As the following extracts (in italics) from the University handbook show, students must meet experience, qualification and citizenship requirements to be admitted to the MEP program:

Experience: *Applicants must be able to demonstrate that they have at least five years of relevant experience in the Engineering industry*.

Qualification: *Applicants must possess an appropriate three-year Bachelor of Engineering Science degree awarded by an Australian university, or an equivalent qualification awarded by an Australian or overseas institution, or be a Technologist Member of Engineers Australia.*

Citizenship requirement: *Applicants must be an Australian citizen or permanent resident of Australia, or a citizen of New Zealand or the holder of a 457 visa which has a duration of at*

least three years. Note: This program is not available to international students. This requirement was deemed necessary because the work experience validation process is based on engineering experiences gained in Australian.

Table 2: MEP commencing students by cohort over the ten year period 2004 to 2014.

Status	2004*	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014*	Total
Admitted to program	6	17	6	18	41	32	39	34	65	62	31	351
Admitted but never enrolled in a course	2	3	0	2	2	4	5	3	10	12	4	47
Enrolled in courses	4	14	6	16	39	28	34	31	55	50	27	304
Graduated	1	4	2	9	23	10	16	6	9	0	0	80
Still active in program	0	0	1	2	0	5	8	16	40	48	27	147
Transferred to another USQ program	0	2	0	2	2	1	3	0	2	0	0	12
Dropped out after first year in program	0	5	2	2	7	10	4	7	1	2	0	40
Re-enrolled then dropped out before 2014	3	3	1	1	7	2	3	2	3	0	0	25

Notes: The data were extracted from official University data. *The data for 2004 and 2014 are based on one semester of data, rather than a full year of data.

Some of the key characteristics of the student cohort are:

- The average age of the students when they were *admitted* to the program was 39.7 years (median 39). The youngest student admitted to the program was 25 and the oldest was 70 years of age.
- While the majority of the students are Australian (81.9%) or New Zealand (2.3%) citizens, a significant number (15.8%) have Permanent Resident status and one has a Humanitarian visa. Many of these students migrated to Australia after being recruited by Australian companies.
- The majority of the students are male, although 14 females have been admitted to the program since 2010. This gender imbalance is a reflection of the age of the students and the gender profiles of the engineering workforce 20 or 30 years ago as well as the student cohorts in engineering technician and technology programs at that time.
- The students have been recruited from all Australian states and territories, and six students are currently studying while living and working in another country. The majority of the students reside in Queensland (57.9%). The percentage of students in the other states and territories are: Western Australia (13.5%), New South Wales (10.2%), Victoria (5.9%), South Australia (4.0%), Tasmania (2.0%), the Australian Capital Territory (1.6%), and the Northern Territory (1.6%).
- Prior qualifications have been gained in many countries, including Australia, Canada, Fiji, Great Britain, Hong Kong, India, Iraq, Iran, Ireland, New Zealand, the Philippines, and South Africa.
- While the majority of the students enter the program after graduating from a Bachelor of Engineering Technology program (or equivalent), the educational experiences of the remaining students range from a 1976 Certificate in Civil Engineering through to a PhD. It is important to note, however, that regardless of type of qualification, each application is carefully assessed to ensure that only students who meet the entry requirements are admitted to the program.
- All of the students have more than five years of experience in the engineering workforce, with many having between 20 years and 30 years of experience, and some more than 30 years of experience. The breadth and depth of their work experience varies greatly.
- The percentage of the students in each engineering specialisation (major study) are: Civil Engineering (38.8%); Mechanical Engineering (18.1%); Power Systems Engineering (18.1%); Electrical and Electronic Engineering (13.8%); Structural Engineering (5.9%); and Environmental Engineering (4.6%).

The diversity of the student cohort is, in part, due to the admission requirements that were adopted for the program. For example, opening the program to Engineering Technologist

members of Engineers Australia increased the diversity and added to the program design challenge because many of those students have vocational qualifications rather than higher education qualifications.

Student progression

Although the current overall completion rate is 26.3% this is not a good indicator of student outcomes as 48.4% of the students are still enrolled in the program. The best indication of the likely attrition and completion rates are those achieved over the period 2004-2008. The current completion rate for this cohort is 49.4%, the attrition rate is 39.2%, and 7.6% of the students transferred to another program. When the three remaining active students in this cohort graduate from the program the completion rate will be 53.2%.

Australian undergraduate degree students

The results of a recent study undertaken by the federal Department of Education (Department of Education, 2014) are summarised in Table 3. The study was based on a cohort analysis of the progress of domestic bachelor students who commenced their university degree in 2005, tracked through to the end of 2012.

The data for the *Engineering and Related Technologies Broad Field of Education* is shown in the second row and includes data for three, four and five year undergraduate degrees. At the end of 2012 the completion rate was 72.8%; 7.1% of the students were still enrolled; 5.8% of the students dropped out after their first year of study; and 14.2% of students re-enrolled after first year but dropped out before the end of 2012. At the end of 2012 the overall attrition rate was therefore 20.1%.

Table 3: Completion and other rates for 2005 domestic bachelor student cohort – 2005-2012

Category	Sub-category	Percentage of Sub-Category %	Current Completion Rate %	Still enrolled %	Dropped out		Attrition rate %
					First year %	Later year %	
Overall	All disciplines	100	72.3	5.3	8.4	13.9	22.3
	Engineering*	-	72.8	7.1	5.8	14.2	20.1
All disciplines							
Study Mode	Internal	85.6	75.4	4.9	7.1	12.6	19.7
	External	8.9	44.4	9.9	20.9	24.8	45.7
	Multi-modal	5.5	69.5	5.5	8.6	16.5	25.1
Attendance Type	Full-time	83.0	77.7	4.5	6.0	11.8	17.8
	Part-time	17.0	47.1	9.3	20.0	23.6	43.6
Age	19 and under	57.5	79.1	4.8	5.1	11.0	16.1
	20-24	21.6	69.2	5.5	9.7	15.7	25.4
	25 and over	20.9	57.1	6.6	16.4	19.9	36.3
Regional Classification	Metropolitan	78.4	73.7	5.3	7.7	13.3	21.0
	Regional	20.4	68.5	5.6	10.4	15.5	25.9
	Remote	1.1	58.3	6.4	15.4	19.9	35.3

*Engineering and Related Technologies. Note: Due to rounding data may not sum to 100%

Because no data relating to study mode, attendance, age and regional classification for the *Engineering & Related Technologies Field* has been published, the data for *All disciplines* was included in the table. Many of the students would fall into two or more of these categories therefore, while each of these factors will have some impact on the completion rate for these students, it is highly unlikely the total impact will be as great as the aggregate of the impacts shown above. A conservative estimate of the total impact for mature age students studying part-time by distance education is that they would be at least 31% less than those for young students studying full-time on campus. Of course the impact could be higher, particularly for *Regional* and *Remote* students.

It is posited that the impact of these factors on completion rates for engineering students would be similar to the rates for *All disciplines*. Therefore, the completion rate for mature age

engineering students studying part-time by distance education programs is likely to be less than 40%. The current completion rate for the MEP program (49.4 %) compares more than favourably with this figure, particularly when the diversity of the student cohort is considered.

Student attrition

Of the 65 students who cancelled from the program, more than 54% had a grade point average (GPA) of 4 or more on a seven point scale, where 4 is a passing grade. Of the 32 students who cancelled after having only studied the first course in program, 65% had a GPA of 4 or more. Therefore, the majority of the students who cancelled from the program were likely to have been successful had they continued in the program. This suggests that poor performance was not a factor in their decision to leave the program, rather these mature age students appear to have made choices based on family, health, work and other factors.

Because the MEP program was designed to satisfy Engineers Australia's accreditation requirements for Bachelor of Engineering programs, it is a challenging, demanding and conceptually difficult program. As the completion rates discussed above show, it is a greater challenge for mature age students who study part-time by distance education. This is particularly true for students who return to higher education after many years in the workforce.

Stakeholder expectations

The strong enrolments in the Master of Engineering Practice program over the last five years show that it has been effective in meeting the identified need and delivered important outcomes for students, and Engineers Australia. The student data demonstrated that the MEP program has attracted diverse groups of mature age students who face the challenge of studying part-time by distance education, often in regional and remote locations. It has also improved participation in higher education as many of the MEP students who completed anonymous surveys undertaken in 2005 and 2007 stated that they would ***not*** have enrolled in any other engineering program.

The benefits for students

Students from all Australian states and territories have enrolled in the program and it has encouraged many experienced Engineering Technologists, whose careers were often at a standstill, to re-engage in higher education, realise their potential, and achieve their career goals. *"I wanted to let you know I had my Chartered status interview on Tuesday and was successful. Thanks for all your help over the past four years, it was very much appreciated. I'm still in shock as my end goal has been finally achieved."* (Mark, pers. comm., 2011).

While the majority of graduates have achieved similar outcomes, anecdotal evidence suggests that many students have benefitted from just being enrolled in the program; by being promoted or by taking higher level jobs with other employers. The data also highlights the important role the program is playing in integrating migrant Engineering Technologists into the Australian workforce and facilitating their progression to Chartered Professional Engineer status, which enables them to practice in their own right. This is also an important outcome for their employers.

Meeting the expectations of Engineers Australia

Each year, about 50% of the 100 or more people who enquire about, or apply for the program, have previously discussed their career options with Engineers Australia's National Articulation Manager, Dr. Eric Hobson, who commented: *Following publication of the Articulation Guidelines on EA's web site in 2002, I was faced with the daunting task of devising individual study programs for all Associate and Technologist Members who wished to achieve the Professional Engineer status. The situation only became manageable when the Master of Engineering Practice was introduced, taking more than 50% of the load* (*Hobson* pers. comm., July 2014).

Often these discussions begin at one of the Articulation Workshops held for members in all major Australian cities every year or so. The Workshops are organised by the Articulation Manager and attract between 10 and 30 members, depending on location. Each Workshop covers articulation options for both Engineering Associates and Engineering Technologists and includes a presentation about the MEP program. Since 2007, the events have, where possible, been scheduled so that the MEP Coordinator can attend to give the MEP presentation, and to discuss articulation options with those individuals who require further information.

The MEP Coordinator has been a member of National Articulation Committee since 2006, and presents a report on the MEP program at the annual meeting where any issues are discussed to ensure that the advice provided to prospective students by either party is consistent and current. The MEP Coordinator and the Articulation Manager are in regular contact to discuss articulation options for individual students.

In a letter to the Vice Chancellor, the Acting Chief Executive of Engineers Australia, Mr. Rupert Grayston, congratulated the university on the development and implementation of the MEP program, the result of a close collaboration between the two organisations. The letter closes with the statement that Engineers Australia is ***"****entirely satisfied with the service being supplied to our articulation program through the university's Master of Engineering Practice"* (Grayston***,*** pers. comm., March 2011). This demonstrates the success of the collaboration.

Conclusion

The introduction of the MEP program has met the expectations of Engineers Australia as it is a flexible, work-based, distance education program that enables experienced Engineering Technologists to achieve Professional Engineer status, regardless of where they live or work in Australia. There is strong evidence to show that, when age, location, study mode and type of attendance are considered, the completion rates of MEP students compare more than favourably with those of engineering degree programs. Importantly, the program is enabling the students to achieve their career goal which, for many, is to become a Chartered Professional Engineer. Thus, on all counts, the Master of Engineering Practice is meeting the expectations of its stakeholders.

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