Developing an industry sponsored Bachelor of Engineering Technology degree in asset management

Focus of the proposal:

1. Adding an asset management stream to the Bachelor of Engineering Technology Degree

2. Delivery of an asset management stream in the workplace

Background

The industry sponsored degree (degree apprenticeship) is a work-based degree that is intended to integrate academic learning with on-the-job practical training. The intention is that the degree will be co-designed by employers and ITPs, with employers leading the process with the support and guidance of curriculum developers from the ITP sector. While the pilot has a focus on Infrastructure Asset Management, it is intended that this will be a model for other such industry sponsored degrees in any field of Engineering, or indeed in any other vocational area, such as business, IT and counselling.

Prior to the development of this curriculum, considerable work was commissioned by the TEC in the area of degree apprenticeships. This is summarised in the points below:

- Professor Jane Goodyer from Massey University was contracted in June 2015 to advise the TEC on the viability of the apprenticeship model in New Zealand. This report endorsed the concept of degree apprenticeships as a viable model aimed at level 7 degrees with a key finding that to be successful, the curriculum development process needed to be driven by employers with support from educationalists. The Trailblazer model that is used in the UK was recommended as a model for the development of this new degree apprenticeship (Goodyer & Frater, 2015).
- A follow-up study was commissioned to investigate the effectiveness of the Trailblazer model was then commissioned by the TEC in July 2016. This was a case study of one of the early adopters of the degree apprenticeship idea and the final conclusion was that this model of implementation was confirmed as the most appropriate for the New Zealand context.
- In March 2017, phase one of a pilot study to implement and evaluate a degree apprenticeship commenced. Jane Goodyer was asked to lead the development of an initial apprenticeship standard, based on the Trailblazer approach as outlined by Goodyer and Frater (2015). In this phase, a collaborative approach where employers led the process was used to develop two standards, one at level 9 and the other at level 7, for the degree. This consultative process involved discussions with the three key stakeholder groups of employers in infrastructure asset management; namely the clients (mainly councils), consultants (from a range of companies) and contractors. The final apprenticeship standard was written after extensive consultation as well as workshops with these key stakeholders and presented to the TEC at the end of June (Goodyer, Poskitt & Mackay, 2017).
- In March 2018, WelTec and Otago Polytechnic won a bid to continue the development of a degree apprenticeship (subsequently called an Industry Sponsored Degree) in Asset Management. Further consultation with Industry which included an expansion and formalisation of the Industry Reference group was carried out, leading to the development of an Industry Sponsored Bachelor of Engineering Technology Degree in Asset Management.

Implementation of Degree Apprenticeships in the United Kingdom

In the United Kingdom, where degree apprenticeships are commonly offered by a number of institutions, degrees are offered that serve specific occupations and are not general qualifications, but are often focused on a specific role within an industry and sometimes, even within a particular company. These bespoke programmes, allow the industry (or company) to include very specific outcomes that are not often found in more general degrees. A good example of this is the new degree apprenticeship for aspiring McDonald's managers that is to be launched in October 2018.

According to Clarke (2018) two of the benefits of doing an apprenticeship degree over an ordinary taught degree have been found in the UK to include:

- Increase in social mobility - poorer students who are unable to pay for their studies upfront are able to obtain a degree through the work that they do
- Women do better in degree apprenticeships in some fields where they are underrepresented (40% female enrolment in the degree apprenticeship as opposed to 17% in the equivalent taught IT degree)

This means that in the training of engineering technologists, under-represented groups such as women, Maori & Pacific Islanders could be targeted and this could lead to a substantial change in the demographic profile of our engineering graduates.

In addition to this, it was found that closer ties with industry were developed for the institution. It must be noted that Manchester Metropolitan University, which is at the forefront of degree apprenticeships in the UK was once a polytechnic and has retained the strong vocational education bias of the polytechnic in its transition to university.

Why Asset Management?

Interviews with engineers in practice (see list of contributors below) have revealed that while there is a general shortage of engineers in NZ, there is a looming shortage of asset managers who have an engineering background, since many of these engineers are close to retirement. In addition, there is currently an acute shortage of engineers in rural areas, regional and district councils where in some cases there needs to be accelerated development of the infrastructure in order to address current and future demands. This has been debated at length by the Institute of Public Works Engineering Australasia (IPWEA), who have referred to this in their *Fostering our future* project. In this proposal, IPWEA have conducted an analysis of their future needs and as a result, they have developed a MOU with the TEC as well as with ourselves.

From the perspective of piloting a new degree, the development and management of the country's infrastructure represents one of the largest industries in the country (1200 members) and as such is well suited to offer apprenticeships. New Zealand does not have the large manufacturing base that the UK has that can be used to support such initiatives.

Industry Consultants

Since this curriculum is a Bachelor of Engineering Technology with a focus on Asset Management, a formal MOU with the Institute of Public Works Engineers, Australasia has been agreed to. The following members of this organisation have contributed to this submission through workshops, interviews and reviews of the curriculum as it has been developed.

Name	**Organisation**
Anna Bridgeman	Stantec
Anthony Wilson	Wellington City Council
Anton Booyzen	Aurora
Brett Williams	Engineering New Zealand
David Darwin	NZTA
David Hutchinson	Downer
Devan Singh	Wellington City Council
Geoff Swainson	Wellington Transport and Waste
Graham Carson	WelTec
Jamie Cox	WAIROA District Council
Jane Goodyer	Massey University
Janis Swan	Waikato University
Jenny Poskitt	Massey University
Jonathan Morris	Opus
Lisa Stafford	Downer
Malcolm Fair	WelTec
Mike Manion	Higgins
Michael McCartney	Horizons

Priyani de Silva-Currie	Calibre consulting
Rob Blakemore	Wellington Water
Robert van Bentum	PNCC
Ramon Strong	Horizons
Steve Scannell	Beca
Vaughn Crowther	UtilityNZ
Wayne Hatcher	Opus

The curriculum development process

The curriculum development process has been divided into three separate phases. These are shown in the diagram below and described in the paragraphs that follow.

Phase 1

A top – down curriculum development process has been used in the development of the curriculum so far. This starts in phase 1 with the end in mind which is done by defining the occupation for which the degree is designed, as described in a degree standard. This was completed in July 2017 and led by Jane Goodyer. (See appendix A for the degree standard)

Phase 2

Once the degree standard had been developed through an industry-led process, this document (which is continually being refined) was then used to inform the design of an End Point Assessment (EPA), the capstone assessment of a significant body of work which will determine whether the candidate in question has met the outcomes determined in the degree standard and hence the graduate outcomes for the degree. This piece of work was completed in July 2018 and is shown in Appendix B to this proposal. As with the degree standard, this document too is continuously being improved.

In the second part of phase 2, the outcomes defined by the industry reference group in the degree standard and used in the EPA plan, were aligned with the BEngTech curriculum to develop a three year taught BEngTech degree in asset management. In order to ensure that the new degree outcomes reflected industry needs, they and the courses developed from them were cross referenced with the following:

- The current level 6 Asset Management Diploma
- The 160+ requirements of ISO55001, (the asset management handbook)

This was then further developed into a degree that could be delivered in the workplace, as will be outlined in the next section.

The last part of phase 2 is the detailed development of new courses and the re-alignment of existing BEngTech courses in preparation for implementation ion phase 3. This will involve the development of course blueprints, which will provide substantial resources for the delivery of the degree in the workplace.

Phase 3

Phase 3 of the project will start in July 2019, and will involve piloting the approved curriculum in the workplace. The proposed mode of delivery for this phase with be discussed below. A major part of phase 3 is the evaluation of the pilot using an action research approach to further develop and refine the curriculum.

Endorsement of the curriculum development process and the products of that process by the industry reference group

The degree standard, End Point Assessment plan as well as the proposed degree structure have all been formally endorsed by the Industry reference group at a meeting held in Wellington on 10th September 2018.

Overview of the proposed degree structure

(This section refers to appendices C, D & E)

Structure of the taught degree

The first map shown in appendix C shows the structure of the BEngTech (Asset Management) as it would be taught in a standard three year BEngTech degree. All core BEngTech courses have been kept. The courses for the Asset Management major (coloured green on the degree map) include three existing BEngTech courses with an additional five new asset management courses. In addition to this an additional elective on maintenance management (see appendix D) is on offer. These new courses have been developed in alignment with the level 6 diploma in asset management, currently on offer approved by NZQA (REF: 3180).

Once students have enrolled in the core BEngTech courses as well as the Asset Management major courses, they will be able to select a themed pathways (civil, electrical and mechanical) that while not fulfilling the requirements of a civil, electrical or mechanical degree, will cover all the core civil, electrical and mechanical courses offered in a standard BEngTech. This would enable a change of direction should any student wish to do a pure civil, electrical or mechanical engineering degree. This makes this degree very flexible.

Structure of the industry sponsored version of the degree

The industry sponsored asset management degree covers identical courses as in the taught degree, except that teaching and assessment will be done differently. Work will be project based and fit in with projects designed but the employers in conjunction with the polytechnics. The overall structure of this is shown in appendix C.

In this structure, the degree is divided into three blocks, with no specific time limit on each. This means that the degree could take as long or as short as a student can manage. there is one condition and that is that the student has to pass through compulsory gateway evaluations at the end of each block. The final gateway being the end point assessment.

The red boxes show the courses that might be incorporated into a particular project. In the case of a course being incorporated into a project, the project reports and presentations may be used to assess different aspects of different courses. This integration will be reflected in the gateway assessment where students will be expected to present their industry projects in a common forum.

New Courses

Six new course have been developed specifically for the Asset Management pathway. These can be seen in appendix D. Five of these courses are reflected in the degree maps. The sixth, maintenance management is currently an elective that could be used to replace one of the other non-core BEngTech courses.

New courses have been designed so that their level will be within the standard BEngTech rules.

Entry into the Degree

The entry rules for the standard BEngTech will apply to this new degree (see appendix E: the programme document). It is envisaged that there will be multiple pathways into the degree. Examples of different pathways into the degree are listed below and include those with:

1. *Low school grades in key subjects*

For those who do not fulfil the Mathematics and Physics entry criteria, support will be offered particularly in mathematics for students to attain the equivalent entrance through already approved foundational courses that will be on offer as block courses prior to enrolment.

2. *NZDE (level 6)*

Credit will be given for the core engineering components of the programme as per the usual cross-credit arrangements (depending on the students curriculum) and the student will need to complete the asset management part of the curriculum as well as the EPA

3. *Engineering degrees*

Need to complete the asset management courses as well as the EPA

4. *Other degrees*

Credit will be given on a case by case basis depending on the initial degree

5. *Level 6 asset management diploma or a level 6 procurement certificate*

Credit will be given for some of the level 5 & 6 asset management major courses. The student will have to complete the core and civil, electrical or mechanical pathway courses and the EPA

Possible pathways

As with the entry into the degree, the plan tries to make provision for multiple paths through the degree as well as multiple exit points. While much needs to be still negotiated with other bodies (for example, with NZBED for the NZDE), it is envisaged at this point that should a student decide on a change of direction for any reason, they should be able to leave the programme of study with enough to either give them a diploma (either an NZDE or a level 6 asset management or procurement diploma). The table below shows the proportion of the qualification outcomes of three possible qualifications.

Note: These are pathways out of the degree and reflect possibilities at this stage only

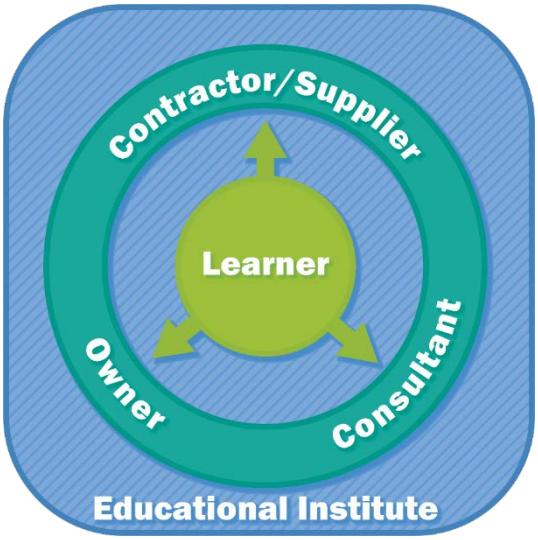
Qualification	**Total No Credits**	**Proportion represented**	**Status**
NZDE	240	Up to 50% can be cross-credited under the current rules	Still need to meet with NZBED
Level 6 Asset Management Diploma	140	All outcomes have been mapped onto this degree (100 – 120 credits)	Discussion has started Some of our level 5 and 6 courses are based on this diploma
Level 6 Procurement certificate	80	Possibly 25% - 50% of the certificate	Discussion has started
Level 7 Graduate diploma in asset management	This is still to be developed, but the possibility exists to develop a graduate diploma based on the asset management component of the new degree. This would be useful for engineers who simply need the asset management endorsement		

Mode of delivery

It is proposed that delivery of the industry sponsored degree will be through employment hubs that are designed to reflect the industry in a particular area and that can offer complementary experiences for sponsored students. Many

employers cannot offer the same breadth of experience (from macro planning to design to manufacture). A group of employers that include a consultant, a contractor and an asset owner would be sufficient to provide the full range of experience necessary for a student to learn from. This employment hub concept depicts a possible framework for ITPs and employers to manage learners through an Industry Sponsored Pathway (Note: this is not the only route available to learners). The key features are as follows:

- Industry bodies commit to participation in a local “employment hub”.
- Learners move between employment roles provided by Hub members.
- Employers provide a stipend and time release for learners to allow them to complete their studies.
- Employers provide appropriate project opportunities for learners.
- Employers provide workplace mentoring for learners.
- ITPs manage enrollment and learning pathways for each individual learner.
- ITPs provide a “learning manager” to work with each learner and ensure projects and work undertaken comply with BEngTech course requirements.
- ITPs provide learning opportunities as required for learners to complete all courses. These opportunities are to reflect section 7 (Learning, Teaching, and Assessment) of this document.
- ITPs organise and facilitate “gateway” events where industry members, ITPs and learners meet together. Learners present their projects (A,B, and C) and are assessed on their readiness to either enter the next block of the pathway or graduate.



Industry Sponsored Degree Pathway: Employment Hub Concept

Changes to the Programme Document

Changes to the programme document that reflect the inclusion of this new stream are shown in appendix E.

References

Clarke, J. (2018) Invited presentation for the Tertiary Education Commission on degree apprenticeships at Manchester Metropolitan University, Wellington, New Zealand

Goodyer, J. & Frater, G. (2015). *Stepping into one another’s world: Apprenticeships – Transforming Engineering Technologist Education in New Zealand.* Commissioned report for the Tertiary Education Commission, Ministry of Education, New Zealand, June 2015.

Goodyer, J., Poskitt, J. & Mackay, J. (2017). *Pilot study of the application of degree apprenticeships in New Zealand: A focus on infrastructure asset management.* Commissioned report for the Tertiary Education Commission, Ministry of Education, New Zealand, June 2017.

(http://www.engineeringe2e.org.nz/Documents/The-application-of-degree-apprenticeships-in-New-Zealand.pdf

Appendices

A: Degree standard (developed in Phase 1)

B: End Point Assessment plan (EPA) – Separate Document

C: Asset Management Major Programme Pathways

D: New Courses

E: BEngTech Programme document with changes added in – Separate Document

Appendix A: PILOT DEGREE APPRENTICESHIP STANDARD:

INFRASTRUCTURE ASSET MANAGEMENT TECHNOLOGIST

Background

The Institute of Public Works Engineers Australasia NZ (IPWEA NZ) has a prime goal to uphold and improve the status of engineering and management of public infrastructure assets in NZ. In its document, *Fostering our future* – a strategic assessment on the future capacity and capability of the public works profession,
IPWEA NZ expressed urgency in the need to attract innovative, resilient and enthusiastic people to the profession.

Occupation(s)

The occupation covered by this standard is Public Works Infrastructure Management Technologist. Typical job titles can include: Engineering Technology Practitioner, Asset Management Analyst, Asset Management Engineer, Road Asset Manager, Contracts and Asset Manager, Maintenance Manager, Service Planning Engineer, Service Planning Analyst. They are associated with management of water, water treatment, waste water, transportation and associated infrastructure.

Occupational profile

An infrastructure asset management technologist is responsible for supporting implementation and maintenance of core infrastructure assets, relating to water, transportation and electrical distribution. They ensure that these assets are operating in accordance with NZ Law and associated Acts and maintain high levels of performance for their users. They create detailed analysis of sub-systems and make recommendations for improvement. They optimise technology use to anticipate and meet stakeholder's needs, problem-solve current problems and future-proof the resilience of assets.

Requirements: Behaviours, Skills and Knowledge

Behaviour	**Be able to**:
Professional	Operate in a punctual, timely, respectful and courteous manner with colleagues and clients. Be 'work ready'. Complete work ahead of deadlines in accordance with ethical and professional standards and code of practice. Be meticulous, thorough and reliable. Adaptable and responsive to existing and emerging community needs. Recognize limits of own knowledge/skills and exercise good judgment in consulting with or requesting appropriate expertise when required. Display interest, aptitude, initiative and willingness to learn.
Stakeholder Communication	Listen to and negotiate with colleagues and clients. Seek and gather information from pertinent sources. Explain concepts and tasks with the appropriate level of technical expertise according to the audience. Produce accurate and relevant documentation. Use appropriate format and formalities. Interact confidently and competently with individuals or small groups of stakeholders, with due cultural consideration.
Flexible thinking	Be open to new information. Ask thoughtful, information or clarification-seeking questions and seek out alternatives. Consider potential unexpected indicators. Understand limits in data, extract value from it and create alternative options. Adjust solutions to meet technical, financial, community and environmental service needs. Display curiosity and inquiring mind-set; initiative.
Working with people	Able to give and respond to orders. Manage small teams of technicians/subcontractors. Identify, champion and develop others for whom responsible. Application of tactical strategies. Understand why and ensure things happen within project. Aware of professional expectations and recognises when to make recommendations. Work reliably and appropriately with team members and stakeholders.
Commitment & Accountability	Be resilient and show commitment to the apprenticeship and to the employing organisation. In rural areas, commitment and contribution to the wider community. Systematic implementation processes (accuracy, thoroughness, check, re-do or change if required). Meticulous, timely record-keeping and attention to detail.
Listening & negotiation	Use open-ended questions, skills in summarising and basic negotiation, related to technical matters with the project team.

Skills	**Be able to:**
Communication	Select and use appropriate communication methods (written, verbal, graphic, software, social media) in timely manner at an appropriate level for their stakeholder. Identify appropriate stakeholders (who is affected, by what, how much – identify, measure and audit). Ability to produce operation and maintenance manuals.
Risk Management Literacy	Identify, quantify, analyse and predict trends in maintenance and deterioration of assets. Analyse likely failure, identify weak points and consequences to mitigate risk. Analyse, prioritize and evaluate risk (qualitative and quantitative) to installed and planned infrastructure asset components. Identify how these risks can be minimised or mitigated against. Establish appropriate levels of service. Balance trade-offs with providing essential services with limited resources. Use risk matrix framework and feedback loops to identify when tasks need to be done.
Systems Thinking	Understand a system, its elements and how they interact to provide a service. Think critically to identify, define and solve problems. Understand asset condition, use data analysis to model current state of an asset's condition profile and extrapolate what's required to achieve future state. Understand scope, the extent of the problem and the limits of your capability.
Engineering	Apply practical engineering solutions using established technologies. Apply life cycle costs, accounting and evaluation procedures. Supervise configuration procedures. Understand purpose, functionality, classification and configuration of an asset: as expected and perform at optimal level of service. Apply incident and problem recording and notification procedures.
Problem-solving and critical thinking	Ability to identify and define technical (or asset sub-system) problem(s). Propose and justify a range of solutions (cost, time, consequences and implications). Awareness of impact of potential solution on other parts of the system(s). Use cause and effect to ensure solving correct problem and be aware of change in system and consequence of failure.
Project Management	Follow a systematic methodology for initiating, planning, executing, controlling, and closing asset projects. Apply industry standard processes, methods, techniques and tools to execute small to medium-level projects.
Computer and data analysis/ utilisation	Use databases to enter, manipulate and analyse data in order to identify normal/abnormal variability or trends. Use technology, where appropriate, for greater accuracy and efficiency (including the use of GPS and BIM).
Optimised decision-making skills	Support awareness of assets' working condition through feedback and identification of weak points. Generate a number of options using multi-criteria analysis to make recommendations or decisions related to areas of responsibility within projects, such as related to specific subsystems within a larger system. Show awareness of various constraints and competing demands, and factor into reasoned recommendations.
Business	Develop well-reasoned evidence based proposals for smaller-to medium level projects. Show awareness of the importance of affordability, availability, timeliness and fit-for-purpose considerations.
Service-oriented to stakeholder	Measure and analyse service level need. Make judgements on service priority level adjustments required and convert to technical requirements. Incorporate and action solutions, either for aspects within larger projects or small-scale projects, related to community problems.
Technical Knowledge	**Knows and understands:**
Engineering	Material properties in order to understand the assets and why they change (normal changes and detect causes of unusual changes). Understand function, design capacity and outcomes. Statistical concepts for setting up and interpreting databases, variability analysis, statistical modelling, interpretation of trends. Basic

	engineering (civil, mechanical, electrical, chemical and materials) concepts with specific knowledge in at least one field of engineering science. Concepts related to systems thinking, evaluation and improvement.
Environmental and social impact of technical solutions	The short and long term impact of the current project on the local environment and various categories of human activity. Modify small –scale plans, designs or projects to minimise detrimental, and optimise positive, consequences.
Asset Management Planning	Understand the purpose of the assets, configuration, capacity, asset parameters and functionality. Understand condition assessment (what is happening and why), modelling of current and forecasting future states, acceptable levels of service. Know lives of assets, use, maintenance, targets and limits. Determine causes (beyond symptoms) of deterioration and failure; when to do further investigation. Incorporate resilience and new global knowledge for disaster management. Contribute to, interpret and implement asset management plans. Where appropriate, ask thought-provoking questions or suggest changes, including modelling, forecasting and life cycle costing.
Business and Financial	Basic concepts and principles of financial management and economics. How budgeting, monitoring and projection of spending can contribute to evaluating options and making a business case for expenditure. Knowledge of contracts and contractual arrangements. Develop, tender and manage a small to medium–scale contract.
Cultural and social impact	Treaty of Waitangi principles and the implications for: consulting with local iwi, and asset management. Understand how, when and on what to consult or engage effectively with local iwi. Appropriately adjust plans and procedures to accommodate iwi wishes. Historical events in the area that impact on asset management. Basic concepts of human geography and interaction with the environment that relate to asset management (e.g. demographic patterns, migration, social structures and change, cultural identity, politics, natural and human resource availability, impact of geomorphology) and implications for asset management.
Legal impact framework	Familiarity with The Resource Management Act (RMA); NZ Law, Health and Safety; Local Government Act (2002), local by-laws and relevant standards. Understand implications of relevant laws for asset management, health and safety of human, physical and environmental resources. Develop and monitor safe asset practice. Incorporate legal understandings in plans, management and evaluation of local and smaller-medium scale projects.
Project management	How to deliver a 'regular' or small-medium-scale technology solution project accurately, efficiently, on-time and within budget
Resilience	Understand the future drivers and consequences of catastrophic failure. Knowledge about global trends and investments in design for asset system resilience.

Duration

The typical duration is likely to be three years but will depend on previous experience of the apprentice, and access to opportunities to demonstrate the full range of competence.

Entry requirements

As the qualification will be achieved at Level 7 of the New Zealand Qualifications Framework, the typical entry requirements for this Apprenticeship may be New Zealand Diploma in Engineering or NZ Diploma in Infrastructure Asset Management. If direct from school, apprentices will need to have achieved University Entrance, and preferably NCEA Level 3 mathematics and one or more science subjects. However, in conjunction with individual employers, accredited ITPs may consider applicants with relevant work experience under provision of Recognition for Prior Learning (RPL) requirements.

Qualifications

The following qualification will be gained: Degree Apprenticeship in Infrastructure Asset Management.

Link to professional registration

This Apprenticeship will include the knowledge, skills and behaviours required to achieve engineering technologist status with the Institute of Professional Engineers New Zealand (IPENZ).

Level

This apprenticeship Standard is at Level 7 NZQA Framework.

Review date

This apprenticeship standard will be reviewed three years after the date of approval.

Appendix C: Asset Management Major Programme Pathways

Asset Management Major – Taught Pathway

Year 1		Year 2		Year 3	
Engineering Mathematics 1 L5 MG5004 Common Compulsory	**Engineering Computing L5** MG5001 Common Compulsory	**Finance for Asset Managers L6** MG6XX1 Asset Management Compulsory	**Data Analytics and Statistics L6** MG6XX4 Asset Management Compulsory	**Engineering Development Project L7** **MG7101** Common Compulsory	
Engineering Communication L5 MG5003 Common Compulsory	**Engineering Design and Drawing L5** MG5005 Common Compulsory	**Asset Planning and Decision Making L6** MG6XX2 Asset Management Compulsory	**Asset Systems Management L6** MG6XX3 Asset Management	**Professional Engineering Practice L7** MG7121 Common Compulsory	**Project Management L7** MG7025 Asset Management Compulsory
Engineering Mechanics L5 MG5002 Common Compulsory	**Engineering Management Principles L6** MG6103 Common Compulsory	**Elective (Common or any Major) L5**	**Elective (Common or any Major) L6**	**Risk management L7** MG7026 Asset Management Compulsory	**Resource and Environmental Management L7** MG7109 Asset Management Compulsory
Introduction to Asset Management L5 MG5XXX Asset Management	**Elective (Common or any Major) L5**	**Elective (Common or any Major) L5**	**Elective (Common or any Major) L6**	**Elective (Common or any Major) L6/7**	**Elective (Common or any Major) L6/7**
Year 1 = 120 credits		Year 2 = 120 credits		Year 3 = 120 credits	

The order of courses is indicative only. However, MG7101 and MG7121 should occur as close to the end of the programme of study as practical.
Note that prerequisite flows for all courses must be observed, see current course descriptor for current prerequisites.

Electives within each major are to be selected from courses within that major or from courses from the programme with a coherent relationship to that major. See programme regulations for more details about electives.

Asset Management Major – Industry Sponsored Pathway

Block 1			Block 2			Block 3		
Introduction to Asset Management L5 **Project A** MG5XXX Asset Management Compulsory	**Engineering Communication L5** **Project A** MG5003 Common Compulsory	Gateway Evaluation (Sign off Camp)	**Finance for Asset Managers L6** **Project B** MG6XX1 Asset Management Compulsory	**Data Analytics and Statistics L6** **Project B** MG6XX4 Asset Management Compulsory	Gateway Evaluation (Sign off Camp)	**Engineering Development Project L7** **Project C** **MG7101** Common Compulsory		Reflective EPA Assessment
Engineering Design and Drawing L5 **Project A** MG5005 Common Compulsory	**Engineering Management Principles L6** **Project A** MG6103 Common Compulsory		**Asset Planning and Decision Making L6** **Project B** MG6XX2 Asset Management Compulsory	**Asset Systems Management L6** **Project B** MG6XX3 Asset Management Compulsory		**Professional Engineering Practice L7** **Project C** MG7121 Common Compulsory	**Project Management L7** **Project C** MG7025 Asset Management Compulsory	
Engineering Computing L5 MG5001 Common Compulsory	**Engineering Mechanics L5** MG5002 Common Compulsory		**Elective (Common or any Major) L5**	**Elective (Common or any Major) L6**		**Risk management L7** **Project C** MG7026 Asset Management Compulsory	**Resource and Environmental Management L7** **Project C** MG7109 Asset Management Compulsory	
Engineering Mathematics 1 L5 MG5004 Common Compulsory	**Elective (Common or any Major) L5**		**Elective (Common or any Major) L5**	**Elective (Common or any Major) L6**		**Elective (Common or any Major) L6/7**	**Elective (Common or any Major) L6/7**	
Block 1 = 120 Credits			Block 2 = 120 Credits			Block 3 = 120 credits		

The order of courses is indicative only. However, Project A must be completed prior to and signed off at a Gateway Evaluation session prior to commencement of Project B. Project B must be must be completed prior to and signed off at a Gateway Evaluation session prior to commencement of Project C.
Note that prerequisite flows for all courses must be observed, see current course descriptor for current prerequisites.

Electives within each major are to be selected from courses within that major or from courses from the programme with a coherent relationship to that major. See programme regulations for more details about electives.

Asset Management Major Compulsory Courses

Course Name		Credits	Level	Pre-requisites
MG5XXX	Introduction to Asset Management	15	5	Nil
MG6XX1	Finance for Asset Managers	15	6	MG5XXX
MG6XX2	Asset Planning and Decision Making	15	6	MG5XXX
MG6XX3	Asset Systems Management	15	6	MG5XXX
MG6XX4	Data Analytics and Statistics	15	6	MG5XXX
MG7025	Project Management	15	7	Nil
MG7026	Risk Management	15	7	Nil
MG7109	Resource and Environmental Management	15	7	Nil

Asset Management Elective Course

Electives for the Asset Management major are to be selected from the existing Civil, Electrical, and Mechanical majors.

Asset Management Pathways
Note: Pathways are indicative only

Example civil themed pathways

Structural Pathway

Year/ Block	Course Name		Credits	Level	Pre-requisites
1	MG5107	Civil Materials	15	5	Nil
2	MG5009	Engineering Site Investigation	15	5	Nil
	MG5032	Basic Structures	15	5	Nil
2	MG6046	Structural Principles	15	6	MG5032 MG5107
2	MG6007	Structural Steel and Timber	15	6	MG6046
3	MG6008	Structural Concrete	15	6	MG6046
3	MG7004	Design of Structures	15	7	MG6007 MG6008

Roading/Transportation Pathway

Year/ Block	Course Name		Credits	Level	Pre-requisites
1	MG5107	Civil Materials	15	5	Nil
2	MG5009	Engineering Site Investigation	15	5	Nil
2	MG5015	Highway Engineering	15	5	MG5009
2	MG6014	Highway Design and Maintenance	15	6	MG5012
2	MG6012	Geotechnical Engineering A	15	6	MG5009
3	MG6015	Traffic Engineering	15	6	MG5012 MG5004 (CoReq)
3	MG7007	Urban Transport Planning	15	7	MG5012

Water and Water Waste Pathway

Year/ Block	Course Name		Credits	Level	Pre-requisites
1	MG5107	Civil Materials	15	5	Nil
2	MG5009	Engineering Site Investigation	15	5	Nil
2	MG5008	Fluid Mechanics (Civil)	15	5	Nil
2	MG6109	Water and Waste Engineering	15	6	MG5008 (CoReq)
2	MG6110	Water and Waste Treatment	15	6	Nil
3	MG6011	Hydrology and Erosion Management	15	6	Nil
3	MG7005	Urban Drainage Systems	15	7	MG6109

Example Electrical Themed Pathway:

Power Pathway

Year/ Block	Course Name		Credits	Level	Pre-requisites
1	MG5034	Electrical Principles	15	5	Nil
2	MG5035	Electronic Principles	15	5	Nil
2	MG6136	Design	15	6	MG5003 MG5005
2	MG5016	Elements of Power Engineering	15	5	MG5015 or MG5034
2	MG6117	Power Distribution	15	6	MG5016

Year/ Block	Course Name		Credits	Level	Pre-requisites
3	MG6118	Sustainable Energy and Power Electronics	15	6	MG5004 MG5014 or MG5034 MG5015 or MG5035
3	MG7110	Power Systems	15	7	MG5016

Example Mechanical Themed Pathway:

Year/ Block	Course Name		Credits	Level	Pre-requisites
1	MG5033 MG5034	Electrical Fundamentals OR Electrical Principles	15	5	Nil
2	MG5028	Materials Science	15	5	Nil
2	MG5029	Strength of Materials 1	15	6	MG5002 MG5004
2	MG6032	Fluid Mechanics (Mech)	15	5	MG5002 MG5004
2	MG5030	Thermodynamics & Heat Transfer	15	6	MG5004
3	MG6033	Mechanics of Machines	15	6	MG5002 MG5004
3	MG6XX5	Maintenance Management	15	6	MG5002 MG5004
3	MG6038 MG6037 MG6136	Strength of Materials 2 OR Advanced Thermodynamics OR Design	15	6	MG5029 OR MG5030 OR MG5005

Appendix D: New Course descriptors

MG5XX1 Introduction to Asset Management

Level 5 Credits 15 Version August 2018

INDICATIVE HOURS Directed Hours	Self-directed Hours	Total Hours
75	75	150

PREREQUISITE
Nil

CO-REQUISITE
Nil

AIM
To enable students to gain an introduction to the principles and practice of Asset Management

LEARNING OUTCOMES

On the successful completion of this course the student will be able to:

1. Explain process for developing levels of service for infrastructure assets.
2. Develop and measure levels of service for an infrastructure asset group.
3. Explain demand management practices for infrastructure assets.
4. Produce a demand management analysis report for an infrastructure asset group.

CONTENT

- Levels of service for infrastructure assets, including, but not limited to: customer value, project plan, describing service levels and options, communicating with customers, decision-making, delivering value
- Service level review
- Customer service standards
- Customer communication plan development and implementation
- Defining and measuring levels of service
- Demand management practices for infrastructure assets, including, but not limited to: consideration of current use, timeframe, future use, intervention strategies, valuation of options, acceptability, stakeholder response, corporate strategies, future capital works programme, demographics.
- Demand management analysis report for an infrastructure asset group

ASSESSMENT

Assessment Description	Assessment Type	Weighting	Outcomes Assessed
Assessment 1	Assignment	40%	1.2
Assessment 2	Test	20%	3
Assessment 3	Report	40%	4

SUPPORTING MATERIALS

Relevant documents, legislation and standards include, but are not limited to:

- IIMM
- CCV manual

MG6XX1 Finance for asset managers

Level 6 Credits 15 Version August 2018

INDICATIVE HOURS Directed Hours	Self-directed Hours	Total Hours
75	75	150

PREREQUISITE
Nil

CO-REQUISITE
Nil

AIM
To enable students to gain an understanding of the financial principles and practice of Asset Management

LEARNING OUTCOMES

On the successful completion of this course the student will be able to:

1. Demonstrate knowledge of valuation and depreciation of infrastructure assets.
2. Demonstrate knowledge of components of life-cycle financial models for infrastructure assets.
3. Demonstrate knowledge of contracts for infrastructure assets.
4. Form a contract for infrastructure assets.[i]
5. Manage contracts for infrastructure assets
6. Manage tendering for an infrastructure asset

CONTENT

- *Valuation and depreciation of infrastructure assets*, including but not limited to consideration of: fair value, market value, depreciated replacement cost, book value, and optimised deprival value

- *Component levels and bases for valuation of infrastructure assets*
- *Evaluate asset component remaining lives*, including but not limited to consideration of; material type, method of installation, operating range, maintenance history, criticality, obsolescence, and replacement options.
- Annual depreciation and depreciation replacement cost
- *Financial models in relation to total life costs*, including but not limited to consideration of; operational costs, depreciation, maintenance costs, economic impacts, renewals, cost of finance, capital improvements, disposal, sensitivity analysis, and basis of assumptions.
- *Elements of valid contracts for infrastructure assets*
- *Procurement processes*, including but not limited to consideration of: design and build, design build operate, design build operate transfer, private public partnership, conventional, supply and install, supply install maintain.
- *Tender evaluation, communication, and administration*
- *Administration of contracts*, including but not limited to consideration of: performance, communication, variations, payments, documentation (generation and storage), and non-performance procedures.
- *Completion of contracts*, including but not limited to consideration of: maintenance certificate, completion certificate, operational manual, as-built information, release of bond and/or retention, guarantees and/or warranties, producer statement, update of asset management information system.

ASSESSMENT

Assessment Description	Assessment Type	Weighting	Outcomes Assessed
Assessment 1	Test	40%	1.2, 3
Assessment 2	Assignment	20%	4
Assessment 3	Report	40%	5,6

SUPPORTING MATERIALS

Relevant documents, legislation and standards may include, but are not limited to:

- IMM
- IAVD
- NAMS Property Manual,
- NZIAS-16,
- NZS 3910:2013,
- FIDIC,
- ACENZ/IPENZ professional services conditions,
- Local Government Act 2002,
- Health and Safety in Employment Act 1992;
- Resource Management Act 1991;
- Hazardous Substances and New Organisms Act 1996;
- Local Government Act 2002;
- Treaty of Waitangi Act 1975,
- Building Act 2004;
- Copyright Act 1994;
- Health Act 1956,

- Public Works Act 1981;
- Construction Contracts Act 2002;
- Transit New Zealand Act 1989;
- Land Transport Management Amendment Act 2008;
- Transport (Vehicular Traffic Road Closure) Regulations 1965;
- CoPTTM, Road Opening Code

MG6XX2 Asset Planning and Decision Making

Level 6 Credits 15 Version August 2018

INDICATIVE HOURS Directed Hours	Self-directed Hours	Total Hours
75	75	150

PREREQUISITE
MG5XX1

CO-REQUISITE
Nil

AIM
To enable students to conduct asset management planning with a focus on specific assets

LEARNING OUTCOMES

On the successful completion of this course the student will be able to:

1. Understand the purpose of the assets within a wider system.
2. Understand condition assessment.
3. Determine causes (beyond symptoms) of deterioration and failure;
4. Contribute to, interpret and implement asset management plans.

CONTENT

- Configuration, capacity, asset parameters and functionality
- Modelling of current and forecasting future states
- Acceptable levels of service
- Lives of assets; use, maintenance, targets and limits
- When to do further investigation
- Incorporating resilience
- Recognising the need for, and managing, changes
- Options for addressing problems and opportunities including, but not limited to; do nothing, maintain, rehabilitate, replace, upgrade, non-asset solution or solutions.
- Cost/benefit analysis of options in terms of financial, environmental, social, and cultural implications.

- Creation and evaluation of criteria to assist decision making
- Reporting, documenting, recording of determination

ASSESSMENT

Assessment Description	Assessment Type	Weighting	Outcomes Assessed
Assessment 1	Test	40%	1.2,
Assessment 2	Assignment	20%	3
Assessment 3	Report	40%	4

SUPPORTING MATERIALS

Relevant documents, legislation and standards may include, but are not limited to:

- IIMM guidelines
- NAMS guidelines
- ISO 31000
- ISO 55000

MG6XX3 Asset Systems Management

Level 6 Credits 15 Version August 2018

INDICATIVE HOURS Directed Hours	Self-directed Hours	Total Hours
75	75	150

PREREQUISITE
MG5XX1

CO-REQUISITE
Nil

AIM
To enable students to make sound decisions regarding asset systems

LEARNING OUTCOMES

On the successful completion of this course the student will be able to:

1. Understand how different asset systems interact with and impact upon one another
2. Explain optimised decision-making process in relation to infrastructure asset system management.
3. Define the problem and/or opportunity and determine a range of options for infrastructure asset system management.
4. Determine and report the optimal decision in relation to infrastructure asset system management problem and/or opportunity.

CONTENT

- Elements of a system
- Optimised decision-making process for infrastructure asset system management
- Identifying problems and opportunities
- Options for addressing problems and opportunities including, but not limited to; do nothing, maintain, rehabilitate, replace, upgrade, non-asset solution or solutions.
- Cost/benefit analysis of options in terms of financial, environmental, social, and cultural implications.
- Creation and evaluation of criteria to assist decision making
- Reporting, documenting, recording of determination
- Utilising global knowledge for disaster management

ASSESSMENT

Assessment Description	Assessment Type	Weighting	Outcomes Assessed
Assessment 1	Test	20%	1.2
Assessment 2	Assignment	40%	1,2,3
Assessment 3	Report	40%	3

SUPPORTING MATERIALS

Relevant documents, legislation and standards include, but are not limited to:

- IIMM
- ODM Guidelines

MG6XX4 Data Analytics and Statistics

Level 6 Credits 15 Version August 2018

INDICATIVE HOURS Directed Hours	Self-directed Hours	Total Hours
75	75	150

PREREQUISITE
MG5XX1

CO-REQUISITE
Nil

AIM
To enable students to utilise data analytics and statistics in relation to asset management.

LEARNING OUTCOMES

On the successful completion of this course the student will be able to use data analytics and statistics to:

1. Understand a system and analyse asset conditions

2. Think critically to identify, define and solve systems problems
3. Adjust solutions to meet constraints
4. Make informed predictions from a range of data sources
5. Select and use appropriate data analytical and statistical software

CONTENT

- Gather and/or clarify a range of data from sources including; existing databases, qualitative resources, and quantitative resources.
- Identify data types and apply appropriate statistical analysis
- Interpret outcomes of statistical tests, correlations, and analysis to make informed decisions, understanding the limitations of the data
- Model the current state of an asset's condition profile, generate and evaluate options for continued asset management
- Consider potential unexpected indicators.
- Use existing software to construct a database

ASSESSMENT

Assessment Description	Assessment Type	Weighting	Outcomes Assessed
Assessment 1	Test	20%	1
Assessment 2	Assignment	30%	2
Assessment 3	Report	50%	3, 4

SUPPORTING MATERIALS

Relevant documents, legislation and standards include, but are not limited to:

- IIMM

MG6XX5 MAINTENANCE MANAGEMENT

Level 6 Credits 15 Version August 2018

INDICATIVE HOURS Directed Hours	Self-directed Hours	Total Hours
75	75	150

PREREQUISITE
MG5XX1

CO-REQUISITE
Nil

AIM

To develop a comprehensive understanding of modern maintenance management practices, strategies, and measures, and their links to maintenance performance, and to be

able to develop a valid maintenance improvement plan.

LEARNING OUTCOMES

On successful completion of this course, the student should be able to:

1 Describe modern maintenance philosophies and their alignment with maintenance business goals

2 Describe maintenance strategies and their selection

3 Distinguish between, and select appropriate maintenance methodologies

4 Relate the need for well-developed planning and scheduling as part of the overall maintenance function

5 Justify maintenance improvements

6 Develop a maintenance improvement strategy or plan

CONTENT

- Maintenance management philosophies
- Optimisation of plant operation through enhanced maintenance performance
- Maintenance techniques, strategies, and tools
- Reliability centred maintenance and associated methodologies
- Maintenance planning and scheduling
- Performance measurement for maintenance

ASSESSMENT

Assessment Description	**Assessment Type**	**Weighting**	**Outcomes Assessed**
Assessment 1	Test	20%	1, 2
Assessment 2	Assignment	30%	3, 4
Assessment 3	Report	50%	5, 6