

# Curriculum Alignment between High School and Engineering Industry Training

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## Abstract

*Education reform has been a common theme in New Zealand over the last two decades. In particular, the Industry Training Act (1992), the Modern Apprenticeship Training Act (2000) and the Unit Standards based National Qualifications Framework have fundamentally changed the nature of engineering trades qualifications. Over the same period, curriculum change and implementation of the National Certificate of Educational Achievement (NCEA) has occurred in secondary schools.*

*For engineering, the school and industry reforms have not been well coordinated. There are now no clear pathways to encourage students into engineering trades and industry training. Skill shortages in the engineering industry have created an urgent need to gain better alignment between the school and industry training systems.*

*This paper reports on stage one initiatives to review the secondary school curriculum and identify curriculum strands which may give pathways between school, tertiary and industry training, specifically for the electrical and metal trades. The aim of stage one is to identify misalignment opportunities and anomalies that form barriers to smooth progression.*

## 1. Introduction

A New Zealand industry training strategy was developed during the 1990's resulting in the introduction of the Industry Training Act (1992). Traditional trades training qualifications were replaced with Unit Standard based qualifications using a National Qualifications Framework (NQF) system. The NQF is administered by the New Zealand Qualifications Authority (NZQA) and is designed to give quality assured, nationally recognized and accredited qualification pathways. The specific Unit Standards required to gain a particular trade qualification are specified and developed by the relevant Industry Training Organizations (ITO).

Also during the 1990's a Technology Curriculum development for secondary schools was initiated by the Ministry of Education (MoE). The aim was to improve student achievement and meet the needs of the technological based industries. The process involved a consultation phase and included scrutiny of technology education developments in other countries. Draft

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Technology Curriculum statements were circulated to schools and industry groups for comment and discussion. The final version took into account the many responses that were received to the draft statements. The resulting Technology Curriculum aimed to increase technological literacy and focused on three integrated learning strands designed to enable students to participate fully in the technological society and economy.<sup>1</sup>

## **2. Recent Educational Reform**

Educational reform over the last three to four years has now resulted in the complete introduction of the National Certificate of Educational Achievement (NCEA) as the qualification for senior secondary school students in New Zealand. Level 1 of NCEA was first introduced in 2002 and replaced the long established School Certificate qualification for year 11 students. NCEA level 2 was introduced in 2003, followed by NCEA level 3 in 2004, replacing the traditional University Bursary examinations. NCEA was set up to be integrated with the NQF so as to provide a linked pathway for secondary school students into tertiary education and workplace training.<sup>2</sup>

NCEA was designed as a standards based, qualification made up of Achievement and/or Unit Standard credits. Achievement Standards have been written for most conventional school subject areas. They differ from Unit Standards in that they recognize three grades of award (Achievement, Merit and Excellence) and allow for flexible assessment practices and recognize a wide range of individual learning experiences, styles and attainment levels.

To gain the award of an NCEA a student must accumulate at least 80 credits, 60 of which must be at the level of the awarded qualification. The range of Achievement or Unit Standards that a student can choose from is very wide and generally only limited by those standards that a particular school can deliver. Currently there is little coordination between the curriculum offered by the schools and those offered by the tertiary education providers.

## **3. National Secondary Tertiary Curriculum Alignment**

To direct better pathways into particular careers a National Secondary Tertiary Curriculum Alignment Project was commissioned by the New Zealand Ministry of Education (MoE) in 2004. Western Institute of Technology at Taranaki (WITT) joined the project group of 19 institutions in February 2005 with the aim of helping secondary school students in years 11 to 13 achieve Unit Standards aligned with the electrical and metal trade areas.

The main driver for this initiative was the significant and ongoing shortage of skilled trade and technician level personnel for the engineering and manufacturing industries. The desired outcome was to have secondary school students take subjects more relevant to the skill needs of these industries.

The WITT project was set up under the control of a steering group made up of five secondary school (mainly principals) representatives and four WITT management representatives. Under the control of the steering group a Curriculum Operational Group (COG) was established to carry out a five stage approach.

The WITT regional Engineering Liaison Coordinator was appointed to lead the initial COG of four tutors with specialist knowledge in electrical and metal trades. The overall directive for

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the COG team was to research what Unit Standards would give best alignment between the secondary school Technology Curriculum, and its usual method of implementation and the requirements of the ITO qualifications specified on the NQF.

#### **4. Curriculum Alignment Project Stages**

The steering group set out a project plan of work made up of the following five stages:

1. Selected specialist tutors to research what electrical and metal trades related Unit Standards were most likely to give alignment to secondary school activities. Research to include a comparison of secondary school Technology Curriculum achievement statements and Unit Standard achievement statements.
2. Specialist tutors to consult with secondary school technology subject teachers in the identified schools to arrive at a workable alignment plan.
3. Industry Training Organizations (ITO) and industry personnel to be invited to contribute to the alignment plans and engagement with schools. Offers of work experience placements for secondary school students to be established.
4. Agreed alignment details to be circulated to all schools involved. Action plan to be developed and trial implementation to be conducted in 2006.
5. Review and development of 2006 trial implementation to improve on areas of difficulty and reinforce areas of strength. Feedback to National Secondary Tertiary Curriculum Alignment Project group with the aim of a national implementation.

This paper reports on Stage one of the project and discusses some potential difficulties that may arise with the implementation of Stage two.

#### **5. Curriculum Alignment Project - Stage One**

The Curriculum Operational Group (COG) under the advice of the WITT Dean of Faculty of Engineering and Trades set out a stage one plan as follows:

1. Review the secondary school Technology Curriculum to understand the achievement objectives and compare these to learning objectives of the specified Unit Standards.
2. Establish target group of industry based qualifications to which secondary school curriculum should be aligned and specify the most likely types of Unit Standards which would give desired pathway for students to follow.
3. Establish a target group of regional secondary schools to engage in the alignment project. Approach the technology subject teachers at these schools.
4. After initial consultation with secondary school technology subject teachers present refined draft alignment proposal to steering group for consideration.

#### **5.1 The New Zealand Technology Curriculum**

Literature research has confirmed that the Technology in New Zealand Curriculum<sup>3</sup> statements provide the basis for all technology programmes in schools from junior classes in

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primary schools, through years 9 to 13 (forms 3 to 7) in secondary schools. The technology section of the Te Kete Ipurangi – Online Learning Centre web site<sup>4</sup> gives details and examplars on how the Technology Curriculum can be assessed across its eight levels of achievement. Achievement levels five to six roughly equate to year 11 of secondary school studies or level one of NCEA Achievement Standards.

The COG found that the Technology in New Zealand Curriculum<sup>3</sup> statements are set out in three consistent strands across all eight levels of achievement. The three strands are:

- Technological Knowledge and Understanding
- Technological Capability
- Technology and Society

Each strand involves a number of achievement objectives. A topic or unit of work in technology often involves all of the strands and can also involve achievement objectives from other essential learning areas with the secondary school curriculum.<sup>4</sup> In setting assessment tasks it is important to have a clear focus on each specific technological strand and objective.

<p><b>TECHNOLOGY CURRICULUM - MATERIALS TECHNOLOGY</b></p> <p>This must include the investigation, use and development of materials to achieve a desired result. It must involve knowledge of the qualities and suitability of different types of materials, including wood, textiles, composites, metals, plastics, synthetics and fuels, as well as the processing, preservation and recycling of materials. Materials technology contributes too many other areas, especially Structures and Mechanisms. Note that the technology curriculum is organised in three inter-related learning strands. Within each strand there are sets of achievement objectives, which are numbered for ease of reference. The numbering does not imply a hierarchy, and the different number of objectives in each strand does not imply weighting of significance or time allocation</p>
<p><b>STRAND A: TECHNOLOGICAL KNOWLEDGE AND UNDERSTANDING</b></p> <p>1. understanding the use and operation of technologies                  2. understanding technological principles and systems                  3. understanding the nature of technological practice                  4. understanding strategies for communication, promotion and evaluation of technological ideas</p>
<p><b>STRAND B: TECHNOLOGICAL CAPABILITY</b></p> <p>5. identifying needs and opportunities                  6. with reference to following identified needs and opportunities                      a: generating, selecting, developing and adapting appropriate solutions                      b: managing time, human and physical resources to produce outcomes, products and systems                      c: presenting and promoting ideas, strategies, and outcomes                      d: evaluating designs, strategies, and outcomes</p>
<p><b>STRAND C: TECHNOLOGY AND SOCIETY</b></p> <p>7. understanding the ways the beliefs, values, and ethics of individuals and groups:                      - promote or constrain technological development                      - influence attitudes towards technological development                  8. understanding the impacts of technology on society and the environment:                      - in the past, present, and possible future                      - in local, national, and international settings</p>

**Table 1: Technology Curriculum – Materials Technology Achievement Statements<sup>3</sup>**

To enable comparison with industry training assessment requirements, an outline of assessment for the Technology Curriculum is shown in Table 1 for a unit of work in Materials Technology. Again it was found that it is often the case in secondary schools that a topic or

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unit of work for students is designed to cover a number of different areas so as to give an integrated approach and understanding about the application of technology.<sup>4</sup>

## 5.2 NCEA Achievement Standards and the Technology Curriculum

Within the context of the NCEA Achievement Standards, research by the COG has shown that secondary school students are expected to explore and demonstrate knowledge of how the nature and practice of technology is influenced by responsibilities to the wider community and show understanding of how this impacts on wider society and the environment.<sup>2</sup> This expectation is consistent with the New Zealand Technology Curriculum.<sup>3</sup>

Award of an NCEA at a particular level requires accumulation of at least 80 credits. The required credits can be either Achievement Standard or Unit Standard based or any mix thereof. Research has shown that the range of subject matter is only limited by the standards that a particular school can deliver. It was however confirmed that in practice a balanced amount of credits for the traditional range of secondary school subjects was the norm.<sup>6</sup> Typical Achievement Standard statements are shown in Table 2 for Materials Technology.

Achievement Standard - 90371					
<b>Subject Reference</b>		Materials Technology 2.6			
<b>Title</b>		Examine technological knowledge in materials technology practice			
<b>Level</b>	2	<b>Credits</b>	4	<b>Assessment</b>	External
<b>Subfield</b>	Technology				
<b>Domain</b>	Technology – General Education				
<b>Registration date</b>		18 January 2005		<b>Date version published</b>	
				18 January 2005	
This achievement standard involves examining technological knowledge underpinning the development of a materials technology outcome through identifying the knowledge and explaining how this knowledge informs one's own technological practice.					
<b>Achievement Criteria</b>					
<b>Achievement</b>		<b>Achievement with Merit</b>		<b>Achievement with Excellence</b>	
<ul style="list-style-type: none"> <li>Identify the technological knowledge that underpins the development of a materials technology outcome.</li> </ul>		<ul style="list-style-type: none"> <li>Explain the technological knowledge that underpins the development of a materials technology outcome.</li> </ul>		<ul style="list-style-type: none"> <li>Discuss the technological knowledge that underpins the development of materials technology outcomes.</li> </ul>	
<ul style="list-style-type: none"> <li>Explain how this knowledge informs own technological practice in addressing an identified issue(s).</li> </ul>		<ul style="list-style-type: none"> <li>Explain how this knowledge informs own technological practice in addressing an identified issue(s).</li> </ul>		<ul style="list-style-type: none"> <li>Discuss how this knowledge informs own technological practice in addressing an identified issue(s).</li> </ul>	

**Table 2: NCEA - Materials Technology Achievement Standard<sup>6</sup>**

To gain achievement a student must at least identify the technological knowledge that underpins the development of a materials technology outcome. To gain achievement with merit a student must identify and explain. To gain achievement with excellence a student must

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in addition discuss in detail the technological knowledge that underpins the development of a range of materials technology outcomes.

A Technology Matrix<sup>5</sup> links Technology Curriculum achievement objectives to the relevant Achievement Standards at NCEA levels 1 to 3. Technology areas covered include food technology, biotechnology, electronics and control technology, information and communications technology, materials technology, plus structures and mechanisms.

Achievement Standard statements have been developed for each of these technology areas and are searchable on the NCEA section of the NZQA web site, directly alongside the NQF section.<sup>6</sup> The levels one to three of the NCEA Achievement Standards are directly comparable to the respective levels; one to three of the Unit Standards based NQF.

### 5.3 Industry Based Unit Standards

Research by the COG has shown that industry based Unit Standards are prescriptive in content with the aim being to assess when an industry trainee is competent to perform particular tasks within a defined setting and range of activities. Typical Unit Standard statements are shown in Table 3 for a materials technology related unit of work.

<b>UNIT STANDARD - ENGINEERING MACHINING AND TOOLMAKING</b>		
<b>Unit: 20917</b>	<b>Demonstrate basic knowledge of engineering materials</b>	
<b>Level: 2</b>	<b>Credit: 2</b>	<b>Version: 1</b>
<b>Purpose:</b> People credited with this unit standard are able to, in terms of engineering materials, identify types and performance characteristics and describe their selection and use.		
<b>Element 1</b> Identify the types and performance characteristics of engineering materials.		
<p><b>Performance criteria</b></p> <p>1.1 Types of materials traditionally used in engineering applications are identified. Range: includes but not limited to – wood, rubber, plastic, metal, concrete, polymers.</p> <p>1.2 Engineering materials are compared in terms of their performance characteristics. Range: includes but not limited to – machinability, strength, ductility, density, hardness, lustre, thermal conductivity, electrical conductivity, durability, wear resistance.</p>		
<b>Element 2</b> Describe the selection and use of engineering materials.		
<p><b>Performance criteria</b></p> <p>2.1 The description includes how materials are used in common engineering applications. Range: includes but not limited to – boat building, bridge construction, precision tools, casts and moulds, roofing.</p> <p>2.2 The description includes factors influencing the selection of materials. Range: includes but not limited to – cost, availability, preparation time, appropriateness for job, ease of working, mechanical properties.</p>		

**Table 3: Industry Based - Engineering Materials Unit Standard<sup>7</sup>**

A Unit Standard is generally made up of one to five element statements which specify the required learning outcomes. Each element has associated performance criteria which guide the extent and range of the activities expected to be assessed within each learning outcome

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area. A study of the Unit Standards registered on the NZQA web site shows that there is wide range of subject matter even within the electrical and metal trade qualification areas.<sup>7</sup>

## 5.4 Target Industry Qualifications

The COG team identified five specific areas out of the twenty three available sub-field areas under the main “Engineering and Technology” field of study on the NQF.<sup>7</sup> Unfortunately the selected sub-field areas did not contain a consistent set of Unit Standards that could be used to form the basis of a curriculum alignment. A common theme of subject areas however was evident across the selected sub-fields and it was considered that these could be useful in guiding the selection of a suitable mix of Unit Standards. The selected sub-fields and resulting common theme of subject areas are shown in Table 4 and Table 5.

NQF - Field of Study	Selected Sub-field
Engineering and Technology Ref: <a href="http://www.nzqa.govt.nz/framework/explore/index.do">Explore Framework [ NZQA ]</a> <a href="http://www.nzqa.govt.nz/framework/explore/index.do">http://www.nzqa.govt.nz/framework/explore/index.do</a>	Electrical Engineering Electrical Supply Electronic Engineering Mechanical Engineering Technology

**Table 4: National Qualification Framework – Selected Sub-fields**

Potential Subject Study Areas for Curriculum Alignment Project	Potential NQF - Unit Standards Ref: <a href="http://www.nzqa.govt.nz/framework">http://www.nzqa.govt.nz/framework</a>
Mathematics	5223, 5226, 5228, 5251, 15847, 16954
Health and Safety	479, 1177, 1178, 2824, 6401, 6402, 17593
Computers	2433, 2748, 2780, 5966, 18743, 18758
Technical Drawing	2430, 2431, 2432, 15845, 19504, 19505
Materials and Measurement	4432, 4433, 4435, 4436, 4795, 7522, 7525
Hand Tools	750, 2387, 2396, 7523, 7526, 15849, 16407
Engineering Experience	2387, 2397, 7542, 16991, 18242, 18243

**Table 5: Potential Subject Study Areas and Unit Standards**

The target industry qualifications have preliminarily been set as per Table 6. These qualifications align well with the future training needs of the Taranaki region and can be supported by the local industry.<sup>7</sup>

Qualification Level	Name of Qualification
Level 1	National Certificate in Manufacturing Engineering
Level 2	National Certificate in Engineering (General Engineering)
Level 2	National Certificate in Electrical Engineering
Level 2	National Certificate in Electronic Engineering
Level 4	National Certificate in Electrical Engineering (Electrician)
Level 4	National Certificate in Maintenance and Diagnostics
Level 4	National Certificate in Refrigeration and Air Conditioning

**Table 6: Preliminary Targeted National Engineering Qualifications**

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## **5.5 Consultation with Secondary Schools**

The COG is currently working on consultation with four Taranaki Regional secondary schools. These schools will be approached over the next month or so and a draft plan of subject areas and corresponding Unit Standards will be developed to suit the need of industry training and secondary schools. These developments will be reported at the conference presentation.

## **6. Discussion**

The Materials Technology assessment statements presented are difficult to match within both the Achievement and Unit Standard requirements. The Achievement Standards are wide in outlook while the Unit Standards are prescriptive and focused. The curriculum approach is open ended and flexible and integrates so many areas that it is difficult for students to achieve a focused result and therefore a competency standard that particular employers and ITO's can accept as directly applicable to their needs. One system is designed to achieve outcomes for industry and the other is designed to achieve a general overall knowledge base for a multitude of industries and businesses.

The Technology in New Zealand Curriculum document indicates its intended focus when it states that "Technology education explores choice and the factors that influence choice, including culture and society, costs and benefits, aesthetics, and fitness for purpose. It seeks to empower students to make informed choices in the use of technology and in their responses to technological change." In contrast industry trade qualifications are focused around the Unit Standards which are designed to be specific building blocks that come together to form a qualification that indicates that a person is competent to undertake particular tasks across a professional trade area. Achievement of Unit Standards does not necessarily require any direct teaching. Learners are required only to demonstrate a competency in a particular Unit Standard in order to gain credit for that achievement. The learner, having achieved the required competencies in the prescribed set of Unit Standards, will be awarded a qualification.

## **7. Conclusion**

The concept of a seamless education system is that people will be able to move freely between different learning environments; schools, polytechnics, work places. The need to align these environments is critical to the supply of sufficient skilled technician and trade professionals to meet New Zealand's economic development needs. This study has concluded that the identified anomalies in outlook present a significant barrier to the transition from secondary school to industry focused training. The fusing of philosophical outlooks of the two approaches is the main barrier to be addressed if true cooperative alignment is to be achieved.

The task of the Curriculum Alignment team is to refine the set of identified Unit Standards to meet the intent of the Technology Curriculum. The linkage of the new NCEA qualifications to the NQF allow for this to occur even when the full intent of the Technology Curriculum may not be met. It is clear that progress can be made to give better alignment of secondary school qualifications with engineering industry training needs.

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