FUTURE SUBJECTS OF TECHNOLOGY

Exploring specific technological knowledge and skills

Purpose

Identify what might become the future subjects of technology to support coherent learning programmes for students; and, in this context, develop technological knowledge and skills to support programmes in senior secondary technology through the provision of:

- Context specific knowledge and skill achievement standards for technology, and
- Technology Teaching and Learning Guides.

Background

The learning area of Technology was reviewed as part of *The New Zealand Curriculum* in 2007. The curriculum presents the generic aspects of technology education for teachers and students i.e. the concepts and practices common to all learning in technology. These concepts and practices are grouped into 3 strands and 8 components (see table 1). The curriculum and supporting material on Techlink emphasise the need to develop specific learning experiences for students. The basis for specific learning centres on key technological knowledge and skills.

The technological knowledge and skills work sits within larger technology education developments following the release of *The New Zealand Curriculum* in 2007. The NZC articulates the 'big ideas' in technology education and presents generic understandings for students and teachers. However actual teaching and learning programmes are often very specific in nature and student understandings of the 'big ideas' are developed through a range of specific learning experiences. It is important therefore that teaching, learning and assessment opportunities recognise both the generic and specific aspects of the technology education programmes in schools.

Many concepts important in specific contexts are also appropriate for others. These are described in the generic knowledge strands of the curriculum: *Technological Knowledge* and *The Nature of Technology*. These strands explore knowledge at a conceptual level but do not seek to apply the concepts in practice. The *Technological* Practice strand provides opportunity for students to embed these, and other specific knowledge and skills, into their own practice. Specific knowledge and skills enhance the decision making within all components of technological practice and enhance the quality of the technological outcome. Allowing opportunity for some of these key specific knowledge and skills to be validated is therefore important for qualification purposes.

Technology as a Link in the Study Chain

As students progress in technology to Years 11-13 the outcomes sought from study in technology become broader and deeper. This leads to increased specialisation. There is still the requirement for the development of generic knowledge and skills, this is particularly important as students start to consider career options including future work or study options. As students move through the senior school there is a need for their study in technology to become more focussed. This is different from the earlier years where technology sought to develop a broad-based literacy.

A variety of relevant career options can be identified – ranging from apprenticeships to Bachelors degrees, and in disciplines from applied sciences to technology, engineering, information and communications technology, architecture and design to name but a few. It is simply not possible to resource, deliver and assess all possible options. Rather, as occurs in other learning areas, the emergence of recognised 'subject' categories which can form part of coherent learning programmes and which can be supported on a national basis would be advantageous. This approach has the advantage of supporting breadth and depth while also maintaining a level of national coherency.

Table 1: Generic and specific learning outcomes reflected in Technology education programmes

TECHNOLOGY EDUCATION PROGRAMMES

Generic Technology Education

Technological Practice	Technological Knowledge	The Nature of Technology
Brief Development *Planning for Practice* *Outcome Development and Evaluation*	*Technological Modelling* *Technological Products* *Technological Systems*	*Characteristics of Technology* *Characteristics of Technological Outcomes*

Technological Knowledge and Skills

Digital Technologies
- *Electronics & Control*
- *Programming & Computer Science*
- *Digital Information Tools*
- *Digital Media*
- *Hardware*

Graphics
- *Graphics Practice*
- *Design*
- *Drawing*

Material and Processing Technologies
- *Working with materials/components*
- *Creating materials*
- *Testing materials/ components*
- *Presentation, packaging & labelling*
- *Production Process*
- *Safety plans & legal considerations*
- *Structures*
- *Mechanics*

Those subjects need to meet the needs of students in their progression beyond secondary school. It is recognised that the bulk of students will exit school with the intentions of undertaking further study or training.

In attempting to meet the needs it is proposed that the specific technological knowledge and skills set out in the curriculum be loosely grouped under three 'subject' categories:

- Graphics,
- Material and Processing Technologies[1],

[1] This category title is up for consideration as part of the consultation. **Process and Product Technologies** is also being considered as a title.

- Digital Technologies.

These categories seek to make sensible groupings of the key knowledge and skills for schools, tertiary institutions, industry and parents.

Wider Activities Towards Defining Future Subjects

During early May 2009, at the initiation of a group of ITPs, Universities and Industry Training Organisations involved in developing a national engineering education plan, two consultation meetings were held with a wide range of tertiary and industry stakeholders. These indicated a preference towards no more than 3 or 4 future subjects in the technology learning area.

Two models are presented here. A 3 subject category model based on work with teachers and invited tertiary and industry representatives (see Table 1). A 4 subject category model was discussed during the consultation meetings. This model effectively splits the Material and Processing Technologies category into two: Process Technology and Construction & Manufacturing (see Figure 1). It was argued that the four subjects were still broad in nature, but focussed enough for tertiary disciplines and sectors of industry to align with a specific subject, something they fail to do with a generic technology subject. The detailed notes taken in the two consultation meetings are available at Techlink. The view from the Ministry work to date is that three categories are appropriate based on the commonality of the knowledge and skills groupings in Table 1 and specifically for Material and Processing Technologies in Table 2. The alternative model (see Figure 1) that splits this category into two may provide a better description and grouping for tertiary and industry stakeholders. Both options would support the same level of detail and eventual standards development.

Given that resourcing to support multiple subjects in schools is limited, an approach that allows schools to concentrate their resources is desirable. Hence the question that lies unresolved is whether there is a real need for the splitting of the third category (from the tertiary sector or employers), and even if that need exists, is that split desirable or achievable in a school context?

All parties agreed that national consistency and coherence were important and that focussing on key technological knowledge and skills was vital in achieving this.

Development and Consultation

The nature of what are key knowledge and skills for senior secondary technology programmes is in its initial stages and has a heavy emphasis on consultation with key stakeholders: technology teachers, tertiary technologists and industry representatives.

The three categories are being developed by three sets of teachers, tertiary and industry representatives for the purposes of consultation. Graphics has had its first round of consultation (completed May 25th). Material and Processing Technologies will be available for consultation by mid June with Digital Technologies available for consultation by mid July. Groups of teachers, industry and tertiary representatives were asked to articulate the key technological knowledge and skills appropriate to their areas of expertise. This process also involved providing examples of what students could do at each level as well as potential teaching foci.

Specific consultation materials will be available on Techlink. Over the latter part of June and into July a series of specific documents will be added to the consultation package. These will provide additional detail about the technological knowledge and skills and allow all stakeholders an opportunity to comment on the material under development.

What does key mean?

Key knowledge and skills are deemed to be those that:

- most programmes would expect to explore in their particular context/focus area; and/or
- most students need to have an understanding of and ability in, in order to progress to more involved and complex practice.

Often the skills depicted are more accurately described as techniques in that they are a collection of smaller skills applied in a scenario along with appropriate knowledge.

The notion of scenario based learning is important when looking at the proposed key knowledge and skills. A scenario as defined here is a situation that supports students to develop knowledge and skills focussed on a particular task. This is a smaller exploration than that defined within technological practice and allows students to gain a broad set of knowledge and skills from which they can make decisions within their technological practice, and to help explore other ideas within technology (e.g. technological modelling).

The Structure of Future 'Subject' Categories of Technology

Groupings of Key Knowledge and Skills - MATERIAL AND PROCESSING TECHNOLOGIES

The following groupings were developed after two meetings and represent material developed with teacher and industry input. The nature of the knowledge and skills described varied to some degree across contexts especially in terms of emphasis (see Table 2).

Working with materials/components

- Skills and knowledge involved in the safe use of tools and equipment to shape, modify and join materials and components

Creating materials

- Skills and knowledge involved in the creation of new materials for a specific purpose including combining materials

Testing materials/components

- Skills and knowledge involved in the testing of material and component properties

Presentation, packaging and labelling

- Skills and knowledge involved in the presentation, packaging and labelling of technological outcomes[2].

Production Process

- Skills and knowledge involved in the multi-unit production of technological outcomes

Safety plans & legal considerations

- Skills and knowledge involved in safety practice, the presentation of legal codes of practice (e.g. food labelling). *Note: safe use of equipment is considered in WORKING MATERIALS AND COMPONENTS above.*

[2] Technology in *The New Zealand Curriculum* defines technological outcomes as technological products and technological systems.

Structures

- Skills and knowledge involved in the resolution of static forces in technological products.

Mechanics

- Skills and knowledge involved in the resolution of dynamic forces in technological products.

The table below presents an initial view of the relative importance of the groups of knowledge and skill to each context. This importance is reflected in the draft material for consultation.

Table 2: Emphases of key knowledge and skills across contexts in Material and Processing Technologies

Groups of key knowledge & skills / *Context*	*Textiles/ Fashion*	*Hard Materials*	*Food*	*Bio- and Chemical related*	*Electronics*[3]
Working with materials/ components	✓✓✓	✓✓✓	✓	✓	✓✓✓
Creating materials	✓✓✓		✓✓✓	✓✓✓	
Testing materials/ components	✓✓	✓	✓✓	✓✓✓	
Presentation, packaging and labelling	✓✓		✓✓	✓	
Production Process	✓✓		✓✓	✓	
Safety plans & legal considerations	✓	✓	✓✓✓	✓	
Structures	✓✓✓	✓✓			✓✓
Mechanics	✓	✓✓			✓✓

✓✓✓ All programmes; ✓✓ Many programmes; ✓ Some programmes; [shaded] Few programmes

Groupings of Key Knowledge and Skills - Digital Technologies

The following groupings were developed after one meeting and represent material with teacher and industry input. The material presented draws on the considerable work of Digital Technologies Guidelines project and a wide range of teachers of digital technologies.

Electronics and Control

- Demonstrate an understanding of the devices, methods, protocols and concepts underlying the design and construction of Electronic and Embedded software systems.
- Be able to design and analyse systems to solve problems using electronic and software elements.
- Be able to construct, test, debug, and modify electronic and embedded software systems given a design.

[3] The nature of Electronics programmes in secondary schools also links the learning to aspects of Digital Technologies.

PROGRAMMING AND COMPUTER SCIENCE

- Demonstrate an understanding of a range of concepts across Computer Science and Software Engineering
- Be able to understand, select, design, and analyse data types, data structures, algorithms, program structures and user interfaces for a program to meet specified requirements.
- Be able to read, understand, write, and debug software programs in an appropriate programming language and using appropriate programming tools and a recognized software development process.

DIGITAL INFORMATION TOOLS

Digital Concepts and Tools (Year 11)

- Students will be able to use digital tools competently to gather, manage, integrate and present information.

Information Systems (Year 12 and 13)

- Demonstrate an understanding of the role, functions and components of information systems
- Be able to design and construct databases and web information tools to manage complex information
- Be able to design integrated systems of databases, web servers, and other digital tools to manage given information for a specific purpose

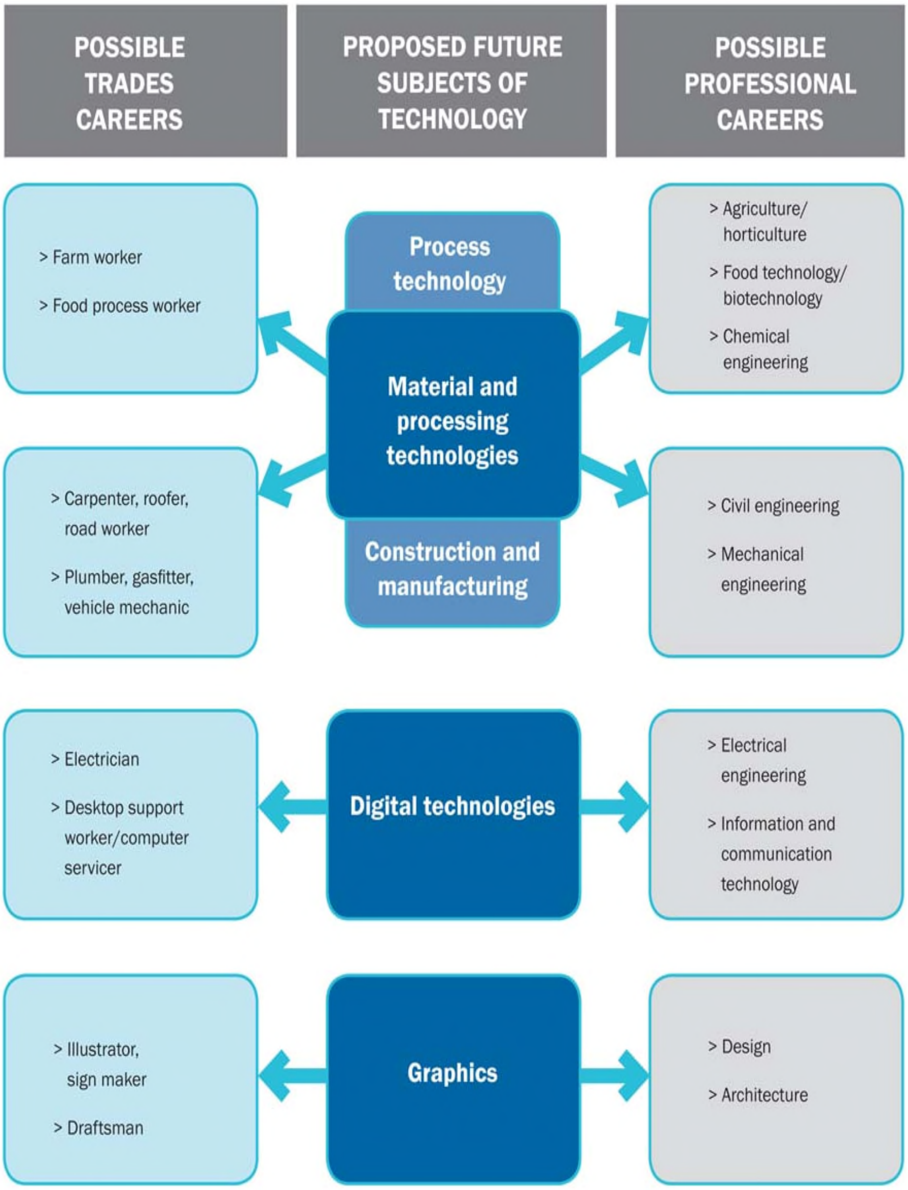
DIGITAL MEDIA

- Demonstrate an understanding of the types of digital media, and the tools and processes that support its development.
- Be able to use a range of digital media tools
- Be able to select tools, and design, create, and publish quality digital media artefacts for a specified purpose

HARDWARE (Digital hardware and networks)

- Demonstrate an understanding of computers, digital hardware and digital networks and their components
- Be able to design, analyse and evaluate digital systems for a specified purpose
- Be able to configure, install and maintain computers, digital hardware and networks

Figure 1: Possible future 'subjects' of technology and relationships to trades and professional careers.



Groupings of Key Knowledge and Skills - GRAPHICS

The following objectives[4] were those presented in the first consultation round for Graphics. The feedback from this consultation will inform the next version.

GRAPHICS PRACTICE

The creative application of drawing and design knowledge and techniques in the development of a conceptual outcome to address a brief or a technological outcome of a graphical nature.

Curriculum level 6 (NCEA L1)

- apply drawing and design knowledge and techniques to visually communicate design ideas in the development of a conceptual outcome to address a brief, through the generation, testing, and evaluation of design ideas.

[4] The development of Graphics Teaching and Learning Guides began in 2008. The length of the development has provided more refined teaching, learning and assessment structures, in the form of objectives, than the other two 'subject' categories.

Curriculum level 7 (NCEA L2)

- apply drawing and design knowledge and techniques to visually communicate design ideas during the ongoing development and analysis of a conceptual outcome to address a brief, through informed generation, testing, and evaluation of design ideas.

Curriculum level 8 (NCEA L3)

- apply drawing and design knowledge and techniques to visually communicate the ongoing development and critical analysis of a conceptual outcome to address a brief, through informed generation, testing, and critical evaluation of design ideas.

DRAWING

Knowledge and skills associated with increasingly sophisticated multi-dimensional drawing techniques and media usage, including understandings of relevant codes of practice, conventions, and underpinning concepts. This aspect also focuses on synthesising and organising visual information for effective presentation.

Curriculum level 6 (NCEA L1)

- gain knowledge and skills in fundamental drawing techniques.

Curriculum level 7 (NCEA L2)

- gain knowledge and skills in complex drawing techniques and in presenting visual information.

Curriculum level 8 (NCEA L3)

- gain knowledge and skills in synthesising and organising visual information for effective presentation.

DESIGN

Knowledge about design principles and approaches and the nature of design in the world.

Curriculum level 6 (NCEA L1)

- gain knowledge of visual communication and design principles and approaches and influential designers.

Curriculum level 7 (NCEA L2)

- gain knowledge of design heritage and specialist fields.

Curriculum level 8 (NCEA L3)

- gain knowledge of the nature of design.

Pathways to Tertiary and Industry

The purpose of schooling is to educate students for future employment, study and engagement with their community. For technology education this means supporting students' technological literacy to the point where they exit schooling. For most students exit points exist after completion of year 11. Those entering further training will generally seek to build an increasingly specific set of skills and knowledge across a range of learning areas (notably science and mathematics).

Feedback collected from the tertiary sector indicates that most study options are not seeking the delivery of large amounts of discipline-specific knowledge. However there is a desire to see generic skills delivered in a relevant context which is motivating to the student. A small amount of specific knowledge is helpful, but not essential to successful tertiary study in many disciplines. For students who expect to exit secondary education directly into employment or training there is value in providing more context specific skill development and experience.

It is of vital importance that technology programmes in secondary schools support as many pathways as resources and student aspiration allow. Regardless of which pathway students select technology education provides a key way of viewing and interacting in the world that will enhance citizenship and general literacy.

Questions for Schools, the Tertiary Sector and Industry

1. Within each of the three 'subject' categories proposed (which may become the future subjects of technology), is there a coherent body of knowledge and set of skills that can form the basis for good quality learning programmes and assessment across the subject?

2. It could be argued that the three category model is just a splitting off of digital technologies from a generic technology subject. If this is the case, many schools may not try to teach a comprehensive learning programme across 'technology' as a subject, and a plethora of localised sub-subjects would arise, as at present. Is this envisaged as a problem? If so, would the four subject model with an expectation that students are exposed to the whole of the relevant body of knowledge across the whole subject (as occurs in subjects in other learning areas) be a better option?

3. Focussing particularly on material and processing technologies, does the three or four overall future subject model better meet the needs of the tertiary sector and of industry (noting that some students also may have the option of moving into a trades academy)?

4. Are there particular knowledge or skills that the tertiary sector is seeking from students seeking to move on to specialised tertiary study not included in any of the three 'subject' categories?

5. Would schools have any preference for, or any difficulty in, implementing either of the proposed future subject models

6. The tertiary and industry feedback suggested design should be taught across the whole learning area and not just in the context of the graphics category – do you agree with the narrower or more generic approach?

Feedback

Please send responses to this paper and the questions above to feedback@teched.net.nz by 4 pm 10 July 2009. For any general enquiries about technology education please contact Niall Dinning, National Coordinator Technology Education, 07 333 1551, niall@teched.net.nz.

Note: Consultation on the detail within each 'subject' category can be accessed through Techlink from late June 2009