Development of Technology Education in New Zealand Schools 1985-2008

Don Ferguson

MINISTRY OF EDUCATION
Te Tāhuhu o te Mātauranga

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ABSTRACT

This paper provides an overview of the development of technology education in New Zealand from the early 1980s, when a few teachers, particularly those with strong science interests, were experimenting with including technology in the curriculum, up until late 2008 before the change of government. From the outset technology was seen as something distinct from technical education, eg. workshop craft and home economics. Now technology is established as a learning area in *The New Zealand Curriculum* which sets the direction for learning for all students from years 1 -13 and is compulsory up to year 10.

The paper begins by identifying the range of technology education projects from the late 1980s and early 1990s, including the development of technology education discussion papers and the policy papers that led the then Minister of Education, Dr Lockwood Smith, to decide to include technology as a compulsory learning area in the curriculum.

A draft technology curriculum was developed in 1993, founded on research undertaken at the Centre for Science and Mathematics Education Research (CSMER) at the University of Waikato. Based on further research and feedback, the 1995 Technology Curriculum Statement was developed. The three strands were: Technological Knowledge and Understanding; Technological Capability; and Technology and Society. The curriculum was not implemented until 1999, allowing time for teacher professional development and the development of a range of supporting resources, which included the *Know How* video series (also shown on national television).

The paper then outlines the various technology education research and development projects in the period 1999-2003 leading up to the curriculum stocktake in 2001-2003. Following the stocktake, the New Zealand Curriculum Marautanga Project (NZCMP) was established to revise the New Zealand curriculum. As part of the NZCMP writing groups were established for each of the curriculum learning areas. A technology writing group worked to develop a revised framework for the technology curriculum based on information from the stocktake and from various technology education research projects. They made the decision to retain the aim of developing technological literacy but to restructure technology around three new strands: technological practice, the nature of technology; and technological knowledge.

The New Zealand Curriculum Draft was distributed to schools in 2006, and based on feedback *The New Zealand Curriculum* was developed and issued to schools late in 2007. It is scheduled for full implementation from February 2010.

The involvement of interested groups such as the Royal Society of New Zealand (RSNZ) and Institution of Professional Engineers New Zealand (IPENZ) is discussed and the support of related technology teacher associations (TENZ, NZGTTA and HETTANZ)[1] is commented on.

The second to last section of the paper outlines the current vision for technology education and suggests possible future developments if this vision is to be realised. The most important of these is further extensive teacher professional development.

The final section of the paper discusses a range of issues, both historical and current, that have arisen over the 20 years of the development. They include principals' and senior managers' understandings of technology and support, the accommodating of technology into the school curriculum, retraining of manual and technical teachers, school facilities, salary negotiations and the G3+ issue, recruitment of teachers, and the theory versus skills debate.

[1] TENZ Technology Education New Zealand, NZGTTA New Zealand Graphics & Technology Teachers Assn, Inc., HETTANZ Home Economics and Technology Teachers' Association.

PART 1A: Pre 1990 Developments

INTRODUCTION – THE VISION FOR TECHNOLOGY EDUCATION

Overseas developments in Technology Education, together with enthusiasm sparked by the Science and Technology Development Conference held at Massey University in 1985, resulted in business and industry leaders, education policy makers and numbers of teachers, particularly those with strong science interests, embracing the inclusion of technology in the curriculum. They saw the need for young people to be technologically literate, able to be flexible, resourceful, enterprising and inventive if these young people were going to be able to respond to the technological and social changes in the years ahead.

From the mid 1980s to the mid 1990s numbers of teachers across several disciplines developed innovative technology education programmes for their students. Curriculum policy makers in education and college of education teachers attended technology education focused conferences (IOSTE, WOCATE, ITEA)[2] in Europe and North America, and studied and visited programmes in schools in these countries. Both teachers and policy makers interested in technology education called on Government to include technology in the curriculum. It was envisaged it would be taught by teams of teachers comprising science, social science, design technology, technical and home economics teachers as there were no specialist technology trained graduates at that time.

Further catalysts were the establishment of the Ministry of Research Science and Technology in 1989, the introduction of a Bachelor of Technology degree at Massey University, which was designed to educate graduates to a high level in a particular branch of technology such as food technology, biotechnology and product development, and the establishment of a Bachelor of Science (Technology) at the University of Waikato.

INTERNATIONAL DEVELOPMENTS

In educational conferences in the late 1970s and early 1980s UNESCO was emphasising the inclusion of technology education within the curriculum.

"An initiation to technology should be an essential component of general education without which this education is incomplete…"UNESCO 1974

"Technology, as a means to extend man's biological capabilities, is universal. Hence technology education is a sine qua non, both to understand the scientific bases of techniques and devices and also to acquire the requisite skills for productive work and efficient living in different societies…." UNESCO 1981

Sweden was the first country, in 1982, to introduce a subject called technology in the curriculum. It was not clearly defined (Fensham 1991) which allowed variation in the way it developed and flexibility in the way it was taught. It developed into a subject with high status leading to careers in technology and engineering[3]. Other European countries soon followed this lead and included technology within their curricula.

Britain was also a leader in the development of technology education. In 1984 Professor Paul Black, a prominent science educator, and Professor Geoffrey Harrison, a former engineer, produced an important discussion paper entitled *In Place of Confusion* in which they presented a task-action-capability model of technology education. Their ideas influenced particularly the development of the English National Curriculum Statement for Technology published in 1990.

During the 1980s there was considerable debate over the definition of technology and technology education but by the beginning of the 1990s many countries had settled on a definition of technology, and most countries definitions were similar. Many were really a restatement of the 1985 UNESCO definition below:

"Technology is the know how and creative process that may use tools, systems and resources to solve problems and enhance control over the natural and man-made environment in an endeavour to improve the human condition."

[2] IOSTE Internationanal Organisation for Science and Technology Education, WOCATE World Council of Associations for Technology Education, PATT Pupils Attitudes to Technology, ITEA International Technology Education Association

[3] During the 1990s Don Ferguson, Senior Education Officer, Ministry of Education worked closely with Thomas Ginner of Linkoping University. Ginner was providing input regarding technology education to The Swedish National Agency for Education, Skolverket. He was interested in New Zealand technology education thinking and developments in terms of further developments of the Swedish technology curriculum.

Layton (1988) suggested that all the definitions of technology should involve the preparation of a product (which could include processes and systems) in response to a perceived need. Medway (1989) saw design also as inherent in the definitions and essential to technology. His view was that it was the critical feature which distinguished technology from science.

While there was similarity in the definitions of technology across countries, discussion about the specific nature of technology education is still going on in 2008. In schools there has been considerable variation in the ways technology education was implemented by teachers. Differences were related to teachers' experiences of technology and their subject backgrounds. McCormack (1992), a British researcher, noted there were distinct differences in practice both across and within countries. Some programmes were largely craft focused with design, others more like applied science, and still others focused on general technological literacy.

Black (1994) discussed the approaches taken by countries already implementing technology education as falling into five different categories that reflect the differing perspectives on technology. He discusses the differences both in terms of the definition of technology and its educational purpose. The five perspectives, as summarised from Black (1994) by Compton[4] (1995), are presented as Appendix 1.

Also there was considerable international debate about whether technology should be introduced as a separate subject or should be linked with science. Most countries decided it should be given separate subject status, but some countries such as Canada initially introduced it (in most provinces) in the context of science, technology and society. There was also much interest in the Science, Technology and Society (STS) approach in countries such as Malaysia and Indonesia at this time.

NEW ZEALAND SCIENCE AND TECHNOLOGY DEVELOPMENT CONFERENCE

The Science and Technology Development Conference supported by the Department of Scientific and Industrial Research (DSIR) and Massey University, and attended by business and industry leaders in 1985, stimulated widespread interest in the role of technology in New Zealand's economic growth and social development. The conference attracted wide media attention. The importance of developing and using technologies was stressed by the conference speakers and the conference was the stimulus to ongoing debate in business and industry about technology and the need for technology education.

Important publications during the next five years included:

- *CERTECH: The Supply of Technological Skills to a Changing Economy,* September 1986, Massey University.
- *Key to Prosperity (Beattie Report)*, Report of the Ministerial Working Party, November 1986.
- *Tomorrow's Skills*, The New Zealand Planning Council, July 1989.

These reports highlighted the concern in New Zealand about the shortage of skilled and qualified people in science and technology. They sounded warnings that unless something was done soon the economic viability of New Zealand could be under threat.

SCIENCE AND TECHNOLOGY ADVISORY COMMITTEE (STAC)

This Government Committee was chaired by Ron Arbuckle, a former head of the subsidiary in New Zealand of the chemical giant ICI. The Department of Education Officer responsible for the technology area was a member of the Science Education/Workskills Retraining Task Sub Group of STAC. The two reports produced by STAC were in constant demand by business, industry and tertiary institutions. The reports were:

- *Science and Technology Review*, Science and Technology Advisory Committee, 1988.
- *Ten Year Technology*, Science and Technology Advisory Committee, July 1989.

Recommendations in these reports included stressing the need for high quality science and technology education in the schooling system.

[4] Previously Mather

The interest and enthusiasm for the development of technological knowledge and skills generated in the period 1985-1990 provided the background and stimulus for further developments in the 1990s and beyond.

TECHNOLOGY IN THE SCHOOL CURRICULUM

Aspects of technology have been part of school programmes in New Zealand, particularly in the science and technical areas, since the introduction of compulsory education in 1877 and the introduction of technical education in 1890. However, technology had not been presented in a comprehensive and coherent way and there was no syllabus or national curriculum statement specifically for technology.

An outcome of the Science and Technology Development Conference in 1985, and the discussion papers developed following the conference, was that it stimulated interest amongst some teachers and educators to discuss and think about the role of technology education in preparing young people for a world of change.

In a paper to Bill Renwick, the Director General of Education in 1985, Curriculum Officers for Science, Social Studies, Technical subjects and Home Economics raised issues concerning the inclusion of technology within the curriculum. There was no immediate response to the paper. In 1986 the publication of the School Certificate workshop technology guide for teachers, *Design and Technology*, generated interest in technology from numbers of technical teachers and resulted in an increased focus on design and the use of a wider range of materials in student projects. Some Home Economics 'clothing' teachers also began to introduce design into their work with students.

In 1986 the Curriculum Officer for Science, Dr Beverley Bell, prepared a discussion paper on technology following a conversation with Mark Cosgrove, Head of Science at Hamilton Teachers College. Around the same time Don Ferguson, a Senior Education Officer with the Department of Education wrote to inspectors and advisers asking them to identify any schools involved in technology education initiatives.

Both Don Ferguson and Mark Cosgrove had an interest in technology education related to their science backgrounds, and had opportunities to see technology education in action both within New Zealand and overseas. In 1987 they attended the International Organisation for Science and Technology Education (IOSTE) Conference in Kiel, Germany. At the conference they observed the speed with which technology was being introduced as a separate subject in European countries – often as a response to the view that science teachers had failed to incorporate technology successfully within their teaching programmes. Many sessions focused on debating how technology should be introduced into the curriculum. Many science educators supported its inclusion through a Science, Technology and Society (STS) approach. Canadian provinces and Malaysia later introduced an STS approach to technology education in the curriculum. The Science and Technology Regional Organisations (SATROs) in England also advocated this approach.

Following the IOSTE conference Mark Cosgrove promoted the idea of learning science through technology and developed a resource for teachers called *Searching for Solutions: Developing an Approach to Learning Science from Technology*. A number of science teachers trialed the resource and found it very useful in making science more relevant and interesting to students. Don Ferguson developed several papers[5] for the Department of Education, and for presentation at courses and seminars on international developments in technology education. These papers discussed reasons for the inclusion of technology in a growing number of countries' national curriculum statements.

In 1987 Officers of the Department of Education organised a feasibility study for a *Focus on Science and Technology Week* to be held in April 1988. The response was very positive and the Ministers of Education and Science gave their support. BP New Zealand sponsored the event and it was successful in raising awareness of the importance and roles of science and technology in society. Most primary and secondary schools took part and it was estimated that not less than 250,000 and perhaps 300,000 students were involved.

Throughout the late 1980s and in the early 1990s Professor Bill Monteith of Massey University provided support and encouragement to Ministry of Education officials[6] and to teachers and students with an interest in technology education. He visited numbers of schools and spoke to teachers and students about his vision for technology education.

[5] Technology Education – Its Importance and Growth; Technology Learning Activities.

[6] Department of Education disestablished in September 1989. Ministry of Education established in October 1989.

THE 1988 NATIONAL CURRICULUM DISCUSSIONS

Following a major public consultation on the curriculum in the mid 1980s (the Curriculum Review, commissioned by the then Minister of Education, Hon. Russell Marshall) the Department of Education began work on an overall framework for a revised school curriculum. However, the work did not proceed beyond a draft document - published in 1988 as *National Curriculum Statement: A Discussion Document for Primary and Secondary Schools (Draft)*. The framework promoted the following principles: focus on the learner, promotion of a sense of cultural identity, promotion of equity, balance and coherence, and accountability. Instead of **subjects**, the framework proposed eight curriculum **aspects**: culture and heritage; language; creative and aesthetic development; mathematics; practical abilities; living in society; science, technology and the environment; and health and wellbeing.

This document was an attempt to move to a more integrated curriculum, shifting the emphasis towards development of the whole person. While not made clear, the implications were that technical and/or technology education could be incorporated into the following aspects: creative and aesthetic development; practical abilities; living in society; and science, technology and the environment. However, the document was sidelined by the reform of the administration of education in 1989 and by a change of government in late 1990.

TECHNOLOGY EDUCATION PROJECT

In April 1988, an exploratory Technology Education Project was established within the Curriculum Development Division of the Department of Education. The aims of the project were to:

- raise teachers' awareness of the value and role of technology education;
- survey students' attitudes to technology and their concepts of technology;
- survey what was happening in schools in technology;
- encourage local initiatives in technology;
- advise government on the need for a policy in technology education and to prepare policy options.

National residential courses entitled *Technology Education across the Curriculum* were held at the Lopdell House Education Centre in Auckland in July and November 1988. Teachers with an interest in technology from a range of disciplines were invited to attend. A draft statement defining technology, listing principles for technology education, outlining the content of technology education and discussing the importance of integrating it into the curriculum, was produced. Draft units of work were also developed. All this material was sent to schools in a newsletter and feedback invited.

In March 1989 a policy paper was submitted to the then Minister of Education, Hon. David Lange, asking for support for developmental work in technology education. The paper noted that Dr Lockwood Smith (then the opposition spokesman for education) had visited Britain in 1988 and met with Professor Paul Black to discuss technology education developments. The policy paper was subsequently approved in April 1989.

PUPILS ATTITUDES TO TECHNOLOGY (PATT) CONFERENCE AND NZ PATT PROJECT

Early in 1988 Don Ferguson attended a PATT conference in the Netherlands at the Eindhoven University of Technology. Jan Raat and Marc de Vries, researchers at Eindhoven University, started PATT in 1986 with the purpose of developing an instrument that could be used internationally to measure pupils' attitudes towards technology. Researchers in 11 countries conducted pilot studies with translated questionnaires. From these results, an instrument was developed that was proven to be reliable and valid in the Western countries. This second PATT conference included reports from 25 countries on the results of a PATT survey of pupils' attitudes to technology and concepts of technology.

In 1989, as part of the Technology Education Project, the Department of Education in New Zealand also commissioned a research project to explore young peoples' concepts of technology and attitudes to technology. The questionnaire used for the survey was the *Pupils Attitudes to Technology (PATT)* instrument developed as described above. A national survey of 2000 students aged 13 – 14 was undertaken. The questionnaire was supplemented by interviews. Dr Janet Burns, then with the Department of Education, supervised the survey. She later transferred to Massey University and in 1990 was employed by the new Ministry of Education, under contract to Massey University, to write the survey report.

DISESTABLISHMENT OF THE DEPARTMENT OF EDUCATION

A further Lopdell House course was held in August 1989 and a tentative draft technology curriculum statement was developed by course members. The statement was edited by the Curriculum Development Division but was never circulated for comment as the Curriculum Development Division was disbanded when the Department of Education was disestablished and replaced by a new smaller, policy focused, Ministry of Education in October 1989.

PART 1B: 1990 - 1991 - A Time of Change

With the disestablishment of the Department of Education in September 1989, work on the technology education curriculum project came to a virtual standstill. Other work related to the establishment of directions for the new policy focused Ministry of Education took priority. During this period a report was received by the Ministry of Education from Dr Janet Burns on the findings of the research project on New Zealand students' attitudes to technology and concepts of technology (PATT survey). The major finding was that New Zealand students had positive attitudes to technology but poorly developed concepts. Concepts were positively related to attitudes and boys had generally better concepts than girls, though girls were less likely to gender-stereotype technology.

The main focus of the curriculum work in the Ministry of Education was on the development of a draft national curriculum framework. A topic of debate at the time was whether technology should be included in the draft framework as a new and separate curriculum learning area, or should be linked to science or craft-based subjects.

ACHIEVEMENT INITIATIVE

Late in 1990 the National Party published its manifesto for the forthcoming election. It announced as one of its key education policies the 'Achievement Initiative (AI).' The AI was to focus on developing clear statements of essential learning objectives to be achieved by children at 10 (later reduced to 8) different levels in English, mathematics, science and technology. At this stage it was not clear whether technology was to be a separate subject or combined with science.

The National Government was elected in November 1990 and in 1991 work started in the Learning and Assessment section of the Ministry of Education on the Achievement Initiative. It was decided that work on technology would proceed at a slower pace than mathematics and science, as further background work needed to be undertaken if it was to be developed as a separate essential learning area. During 1991, Don Ferguson, now a senior policy analyst in the Ministry of Education, undertook an extensive literature search on technology education and, based on the findings, prepared a series of seven discussion papers for circulation within the Ministry and beyond. The titles of the papers were:

Definitions of Technology
Definitions of Technology Education
The Growth of Technology Education
The Purpose of Technology Education
The Relationship between Technology and Science
The Implementation of Technology Education
The Content of Technology Education Programmes

Meetings were held within the Ministry with interested officers and the Secretary for Education, Dr Maris O'Rourke, to discuss the literature findings. Papers were developed for the Minister of Education, Dr Lockwood Smith, expressing the Ministry views. Dr Smith was visionary in his outlook for education, and technology was part of that vision. He agreed that technology should be a separate area of the curriculum rather than linked to science in, for example, a Science, Technology and Society (STS) approach.

In August 1991 the Ministry invited individuals and groups to make submissions about technology education. Over 150 submissions were received. These were collated and a summary report prepared. The majority of submissions supported the development of technology as a separate subject within the curriculum.

THE NATIONAL CURRICULUM OF NEW ZEALAND (1991)

The National Curriculum of New Zealand - A Discussion Document was distributed to all schools and interested parties late in 1991. This document included technology as an essential learning area and stated it was "included because of its increasing importance in today's life and economy and because it was part of the curricula of almost all OECD member countries". Over 2000 responses from individuals and groups were received. Most respondents were supportive of the inclusion of technology as a new curriculum area, but some secondary teachers questioned how it would be implemented as they considered the curriculum to be already crowded. This was not raised as a concern of primary teachers at this time.

SCIENCE AND TECHNOLOGY TASK GROUP

Also in 1991 a task group to review science and technology education at all levels was set up by the Minister of Research Science and Technology and the Minister of Education, at the request of the Minister of Research Science and Technology. The task group included educationalists and people with backgrounds in business, industry and technology. Recommendations in the Task Group report *Charting the Course* (February 1992), relating to the development of technology education were that:

- technology be an area of study in its own right rather than a subset of other areas such as science or social studies;
- practical skills should be recognised as valuable in terms of academic achievement;
- the area should encompass a broad range of knowledge and skills.

PART 1C: 1992 - Action

Early in 1992 it was decided within the Ministry of Education that:

- there needed to be a communication strategy to stimulate debate in schools, business and industry about the nature and scope of technology education;
- policy papers should be developed to provide a framework for the technology curriculum;
- policy work should be undertaken to prepare a case for funding teacher professional development and supporting resources for the implementation of technology education in schools;
- research should be undertaken into teachers' perceptions of technology and how students develop technological capability.

As with other Achievement Initiative work these developments were to proceed in association with the development of the framework for the New Zealand curriculum.

COMMUNICATION STRATEGY

A communications strategy was developed which included: meetings with business and industry; meetings with education sector representatives; newsletters; publications to schools designed to generate discussion about technology education; and a national eTV series about technology education (*Know How*).

Learning Media, on behalf of the Ministry of Education, produced a discussion booklet for schools entitled *So this is Technology*. The booklet, published in 1992, was developed in collaboration with a group of teachers and reflected their questions about the scope and importance of technology. A video (the first of the *Know How* series) was also distributed showing best practice in schools at that time. Both items generated discussion in schools as teachers and principals wrestled with the idea of the inclusion of a new subject area in the curriculum.

DEVELOPMENT OF POLICY PAPERS

A contract was let to the Centre for Science and Mathematics Education Research[7] (CSMER) at the University of Waikato to develop policy papers for the technology curriculum project. Dr Alister Jones was to be responsible for this work. He had an interest in technology and had worked with Professor Paul Black at King's College, University of London, on aspects of technology education. During the development of these papers Alister Jones worked closely with Don Ferguson in the Ministry of Education.

The titles of the policy papers were:

- *Rationale for technology education*
- *General aims and expected outcomes of technology education*
- *Achievement aims for technology education*
- *Strategies for the implementation at the school level*
- *Approaches to teaching and learning technology at the classroom level*
- *Access to technology education.*

The content and suggestions in the policy papers regarding the possible nature and scope of technology education in the New Zealand context were endorsed by the Ministry of Education and provided a sound basis for later developments, including the development of the 1993 draft technology curriculum statement.

A further paper on *Resources and facilities for technology education* was developed by technical education consultant Terry Guy. Guy stated that "the most important resource if this subject is to prosper will be a knowledgeable and skilled teacher of technology education".

RESEARCH

In 1992 a further contract was let to the CSMER to undertake a three-year research project into teachers' perceptions of technology and how students develop technological capability. The research was initially undertaken by Alister Jones, Malcolm Carr and Ernie Verbowski. Several months later Vicki Compton, who in later years was to do considerable research into aspects of technology education, joined the team after Ernie Verbowski left.

Over the period 1993-1995 several research papers were published and these were to provide valuable background later for the development of the national curriculum statement for technology. The papers were:

- *Paper 502 Teachers' perceptions of technology education*
- *Paper 503 Development and management of technological activities*
- *Paper 504 Analysis of student technological capability*
- *Paper 505 Working with teachers to enhance student technological capability*
- *Paper 506 Revisiting developing and managing student technological capability.*

These papers were published later in various educational journals.

PART 1D: 1993 – Development of *Technology in the New Zealand Curriculum Draft*

Early in 1993 Ministry of Education work related to technology focused on policy specifications for a draft technology curriculum statement. In mid 1993 a booklet *Technology in Schools*, suggesting the nature and scope of technology education in the New Zealand context, was published and distributed to all schools. The information and suggestions in this booklet were based on the framework for technology education put forward in the policy papers developed in 1992.

THE NEW ZEALAND CURRICULUM FRAMEWORK

In April 1993 *The New Zealand Curriculum Framework* was published. The document was to provide the framework for the development of the essential learning area statements over the next few years and set overall policy direction for curriculum and assessment. The framework included a set of key principles, seven essential learning areas and eight sets of generic essential skills. A section highlighting the importance of attitudes and values was also included. In the document technology was confirmed as one of the seven essential learning areas.

DEVELOPMENT OF THE DRAFT NATIONAL CURRICULUM STATEMENT FOR TECHNOLOGY

Proposals were sought on a contestable basis and in June 1993 a contract was let to CSMER for the development of the *Technology in the New Zealand Curriculum Draft*. The statement was to be based on the framework for technology education put forward in the policy papers developed in 1992 and was to be ready for distribution to schools by October 1993. More than 200 teachers were involved in the development process which was overseen by Alister Jones of the University of Waikato and Eleanor

[7] The CSMER was formed in 1989. It grew out of the Science Education Research Unit, which was started in 1981 by Dr Roger Osborne and Professor Peter Freyberg. The Centre is an interdisciplinary centre jointly administered by the School of Science & Technology and School of Education.

Hawe of the Auckland College of Education. During the development of the draft technology curriculum statement, Steve Benson, from the Curriculum and Contracts Division of the Ministry of Education, worked closely with Alister Jones and his team[8].

The draft curriculum proposed three general aims:

- technological knowledge and understanding;
- technological capability; and
- understanding and awareness of the relationship between technology and society.

The proposed strands were:

- technological knowledge and understanding;
- identification of needs and opportunities;
- implementation and production of technological solutions;
- communication and presentation of strategies and outcomes;
- reflection and evaluation;
- technology and society.

These strands were to be developed through seven technological areas:

- Materials technology
- Information and Communication technology
- Electronic and Control technology
- Biotechnology
- Process technology
- Design and Graphics
- Food technology

and through a variety of contexts such as personal, recreation, business, industry, home and community.

The *Technology in the New Zealand Curriculum Draft* listed achievement objectives, possible learning experiences and assessment examples, and was distributed to schools in December 1993. The progressions in the achievement objectives were not based on research as there had not been time to undertake the classroom research needed to verify the suggested progressions. They were based on best practice, which at the time was very limited, and on the expert views of the many people involved in the writing of the document.

THE MINISTER OF EDUCATION'S TECHNOLOGY ADVISORY GROUP

The Minister's Technology Advisory Group (TAG) was appointed in June 1993. The TAG comprised teachers, college of education and university representatives, and people from business and industry. The TAG was chaired by Dr Geoff Page, CEO of Industrial Research Ltd, one of the Crown Research Institutes. The tasks of the TAG were to:

- consider working drafts of the *Technology in the New Zealand Curriculum Draft*;
- consider submissions arising from the consultation process on the *Technology in the New Zealand Curriculum Draft*;
- make recommendations to the Minister of Education and Ministry about the scope and structure of the final version of the technology curriculum statement;
- advise the Minister about the support required for the successful implementation of technology education.

The TAG met first in July 1993, and on three further occasions, to review working drafts before the published version of the *Technology in the New Zealand Curriculum Draft* was released.

The TAG had some reservations about the eight levels of learning objectives and with the plain, rather austere, presentation format being used by the Ministry for the draft curriculum statements. They were supportive of the framework for technology education but they would have liked a more dynamic presentation style to generate enthusiasm for the new area of learning.

GENDER INCLUSIVE ADVISORY GROUP

At this time there was also a Gender Inclusive Advisory Group in the Ministry of Education reporting to the Minister of Education. They critiqued all publications from the Ministry, including the *Technology in the New Zealand Curriculum Draft*, to ensure they were gender inclusive.

POLICY WORK FOR FUNDING SUPPORT OF TECHNOLOGY EDUCATION

Policy work in this curriculum area was directed towards the provision of support for the implementation of the technology curriculum through funding for teacher professional development and additional funding

[8] Team Leaders: Eleanor Hawe, Terry Guy, Frances Rowntree, Bev Farmer, Mike Forret, Heather Mather, Paul Keown, Nola Campbell, Gray Clayton, Mihi Roberts, Roger Edwards, Vicki Mather. For a full list of the development teams see: Ministry of Education, (1993) Technology in the New Zealand Curriculum Draft. Wellington, Learning Media, pp 125 – 127.

for inclusion in schools' 'Operations Grants' for the implementation of technology education. This work was in preparation for the 1994 Budget.

Research undertaken in New Zealand (Jones and Carr 1993) showed that teachers' concepts of technology and technology education showed great variety and differed significantly from those portrayed in the *Technology in the New Zealand Curriculum Draft*. Teachers also brought many pedagogical understandings from their subject sub-cultures and/or schooling sector experiences that often focused on issues that only related to discrete aspects of technology. This finding highlighted the importance of professional development programmes to support teachers' conceptual and pedagogical understandings in technology.

TECHNOLOGY DEVELOPMENT SCHOOLS

In a parallel initiative in 1993, secondary schools were invited to put in proposals to the Ministry of Education to become technology development schools. Approximately 100 proposals were received and four schools were selected. Each school received $400,000 and was expected to develop innovative programmes in technology and provide leadership in the implementation of technology education. The schools were Papanui High School, Christchurch; Tikipunga High School, Whangarei; Aorere College, Auckland; and Stratford High School, Taranaki.

The schools were expected to:

- provide enhanced opportunities for students to use 'technologies' both in their regular studies and in problem solving work in technology and science
- place increased emphasis on technology and science in their programmes, in comparison to regular schools
- provide technology enhancement programmes for other local schools and the community
- encourage students to pursue careers in science, engineering and technology - fields where there were likely to be shortages by the year 2000
- provide a central point where education and industry could work together for the benefit of teachers and students.

The four schools reported to the Ministry at the end of each term on progress in implementing their technology plans. Their progress was also independently monitored and evaluated through a contract, let by the Ministry's Research Division, to the Education Research and Development Centre at Massey University. The evaluator noted the following:

- the schools gave considerable emphasis to information and communications technology, with one school allocating most of its budget to upgrade its ICT facilities. To enable students to access and use technologies across the curriculum, three of the schools developed their libraries as information centers
- other technological areas, (e.g. biotechnology, materials technology, food technology, graphics and design) were considered to be strong in most of the schools and many of these were further developed in the senior programmes in all the schools
- from the outset of the project all the schools attempted to work with their local primary schools including providing professional development support for teachers. However, in the longer term, schools found it difficult to sustain the links as well as providing access and training for their own students and staff
- one of the schools placed particular emphasis on integrating science and technology above any other learning area
- all schools had success establishing links with industries in the areas of 'work experience' and 'job shadowing programmes'.

There was some debate, both beyond and within the Ministry of Education, about the usefulness of this initiative because in the contracts with schools strong links with the technology curriculum development work were not made clear as the curriculum document and the new directions for technology education were not as yet established.

BP TECHNOLOGY CHALLENGES

Throughout the early 1990s the BP Technology Challenges involved many thousands of students throughout New Zealand working in teams to produce solutions to technological challenges[9]. The aims of these Challenges were to:

- encourage and develop problem solving skills using simple problems and common materials within performance goals and constraints of time and materials
- encourage co-operative group effort and effective utilisation of individual skills and knowledge
- develop skills in applying scientific and technological principles and knowledge

[9] In 1996, 135,000 students took part in school and regional events.

- introduce elements of fun into problem solving in technology.

A very positive outcome of the BP Technology Challenges was to stimulate student, teacher and community interest in technology and develop some understanding of the role of technology in everyday life. A negative outcome was that in some primary schools, involvement in the Challenges became the sole mechanism for implementing technology in their school. A revised version of these challenges still exists, but now only involves primary school students and 'Technology' has been dropped from the title (known as BP Challenges).

PART 1E: 1994-1995 Finalisation of the National Curriculum Statement for Technology

During 1994 and 1995 there were four major activities:

- the production and screening of the *Know How* eTV series about technology education
- initiatives arising from the 1994 Budget provision for funding teacher professional development and resources for schools to implement technology education
- a survey of schools responses to the *Technology in the New Zealand Curriculum Draft*
- finalisation of the *Technology in the New Zealand Curriculum*, national curriculum statement.

During this period Steve Benson, of the Curriculum and Contracts Division of the Ministry of Education, was responsible for the implementation aspects of technology education. He worked closely with the producers of the eTV series, with groups contracted to deliver teacher education programmes, and with various groups involved in the finalisation of the national curriculum statement for technology.

The process of collating feedback received relating to Technology in the *New Zealand Curriculum Draft* and the subsequent revision, was not fully contracted out but managed within the Ministry. However, guidance was sought from members of the team responsible for writing the draft technology curriculum, by the letting of short term consultancy contracts on a needs basis.

During this period Steve Benson made presentations to a wide range of business and industry groups about the development of the technology curriculum.

THE 'KNOW HOW' eTV SERIES

This series of ten half-hour programmes first screened from May to August 1994 on Television One. The series was made by Kotuku Productions (David Copeland and Jill Wilson, producers, working closely with Alister Jones and Steve Benson) for TVNZ on contract to the Ministry of Education. Feedback received on the series was very positive and the programmes helped to give teachers, boards of trustees and parents an understanding of the nature and scope of technology education and the range of activities students might undertake in the classroom. The programmes were rescreened in mid 1995 with new 'Update' segments. The titles of the programmes were:

1. The Call for Technology Education
2. The Aims of Technology Education
3. The Technology Curriculum
4. The Curriculum in Action I
5. The Curriculum in Action II
6. The Curriculum in Action III
7. The Question of Assessment
8. Implementing Technology Education
9. Resources and Facilities I
10. Resources and Facilities II.

Schools were invited to obtain the series on videotape and 2500 copies were distributed in late 1994.

FUNDING FOR TEACHER PROFESSIONAL DEVELOPMENT AND IMPLEMENTATION

In the 1994 Budget, funding of just over $11 million was approved for teacher development in technology education for the period 1995-1997 and ongoing funding of $6 million was added to schools Operational Funding for the implementation of the technology curriculum. However, the increase to funding was not tagged specifically for the implementation of the technology curriculum and many schools used the funding for a wide variety of purposes. (Schools didn't necessarily know it had been added for this purpose and/or there was confusion between 'technology' and ICT.)

Five contracts were let for teacher professional development programmes in 1995 and 13 contracts programmes were let in the 1996 school year. Included in these contracts were programmes for professional development in technology education to be delivered largely on a regional basis, although one employed a distance education model.

The professional development programmes had three foci:

- school based programmes to develop implementation strategies at the school wide and classroom levels;
- programmes focusing on teacher knowledge in the technological areas, especially in the less familiar ones such as biotechnology and electronics;
- facilitator training.

The contracts were let to a mix of universities and private providers. Although variety was considered important, during delivery it became apparent there was a lack of national consistency in the presentation of the programmes. While many primary school teachers took up these opportunities, secondary teachers did not due to the delay in gazetting the technology curriculum document and industrial issues of the time that restricted involvement in Ministry related curriculum initiatives. These factors significantly slowed initial implementation and impeded the uptake of technology education by technical and other teachers in secondary schools - see Issues section.

SURVEY OF SCHOOLS RESPONSES TO THE DRAFT NATIONAL CURRICULUM STATEMENT FOR TECHNOLOGY

The aim of this research conducted by the Research Section of the Ministry of Education was to obtain feedback from schools on the 1993 document *Technology in the New Zealand Curriculum Draft* to contribute to the writing of the final document. The objectives were as follows:

- to determine support for the concept of structuring the curriculum into the three aims and six strands
- to find out whether the achievements were clearly specified from one another, and appropriate for the level specified
- to determine whether the suggested learning experiences and assessment examples were useful
- to establish whether it was easy for teachers to come to grips with the document as a guide for planning, assessment and classroom practice
- to determine support for the various sections of the document.

A random sample of schools was sent a questionnaire – 116 primary schools and 67 secondary schools responded. Schools were generally supportive of the technology curriculum document. As with other curriculum statements, adequate resourcing, including funding to schools, and teacher professional development were identified as important for satisfactory implementation of the technology curriculum.

FINALISATION OF THE TECHNOLOGY CURRICULUM STATEMENT – THE PPTA "FRAMEWORKS FREEZE"

On the basis of responses, submissions and the reports of trials, work began in early 1995 on the text of the final curriculum statement. This work was undertaken by a working party of teachers, university and teachers college representatives, and Ministry officers. There were few responses to the draft technology curriculum statement from secondary school teachers, partly due to the Post Primary Teachers' Association (PPTA) Frameworks freeze. At the time, progress on settlement of the secondary teachers' pay agreement had stalled so the PPTA had asked secondary teachers not to provide comment/evaluation on the various essential learning area draft curriculum documents. This served to continue a climate of minimal engagement with technology education by the secondary sector during this formative phase.

On the basis of the feedback it was decided to have one overall aim for technology education. This aim was to enable students to achieve technological literacy through the three strands of;

- technological knowledge and understanding
- technological capability
- understanding and awareness of the relationship between technology and society.

A simplified structure (from three aims to one, and from six strands down to three) also enabled the number of achievement objectives at each of the eight levels to be reduced considerably.

The technological areas in the final technology curriculum also showed a number of changes. Firstly, while design and graphics was perceived as a separate technological area in the policy papers and in the draft technology curriculum, in the final statement 'design' was positioned as an integral part of all technological areas rather than being a technological area in its own right.

Similarly 'graphics' was also seen to be an integral part of technological activity in terms of a communication tool. Another change was the addition of a technological area called 'Structures and Mechanisms'. The way in which each of the areas had been defined was reworked in order to broaden the nature of these areas and provide more opportunities for students at every level in each area.

The final curriculum statement included the six contexts (but 'domestic' was changed back to 'home') from the draft and included an additional three contexts: 'school', 'environmental', and 'energy production and supply'.

The 'Implementation of Technology' section was more comprehensive in the final statement and included more guidance to teachers regarding teaching and learning in technology. A much larger section on assessment and evaluation in the final document included 'indicators of progression' as based on the levelled achievement objectives.

In October 1995 Technology in the New Zealand Curriculum was launched by the Minister of Education and distributed to schools. The Ministry vision for the inclusion of technology as an essential learning area in the curriculum was to:

- provide exciting opportunities for all students to develop and extend their technological ideas and to explore creative solutions to practical problems
- enable students to gain skills, knowledge, and competencies that would equip them for further (tertiary) training, or employment in technological areas and to contribute to New Zealand's social and economic development
- provide students with opportunities for interactions with business and industry that would help students understand and adapt to a rapidly changing world and to take a confident part in shaping the future.

PART 2A: 1995 - 1999 Implementation of the Technology Curriculum Statement

INTRODUCTION

This section of the paper details major events following the introduction of the curriculum statement for technology towards the end of 1995 until the curriculum stocktake in 2001-2002.

This was a period when, both in New Zealand and internationally, there was considerable research into various aspects of technology education. New Zealand technology educators and researchers during these years attended a range of international technology education conferences (WOCATE, PATT, ITEA and IDATER)[10] where they presented papers and findings related to the development of technology education in the New Zealand context.

The 1995 Ministerial Reference Group (MRG) report on teacher staffing generated concerns amongst manual training teachers and impacted on their interest and willingness to engage in professional development opportunities focused on the new curriculum in technology.

Other significant events during this period were:

- delay in gazetting the technology curriculum statement
- refocusing of teacher professional development programmes
- establishment of further research projects in technology education
- introduction of a Technology Education facilitator training programme
- support from the Royal Society of New Zealand (RSNZ)
- establishment of Technology Education New Zealand (TENZ).
- implementation of curriculum support projects and publications.
- Ministry of Education and Education Review Office (ERO) surveys of technology education in schools.
- broader political and economic influences.

INTERNATIONAL INTEREST

At the time of its publication the 1995 New Zealand technology curriculum was regarded as a world leader and attracted attention from educators and officials in other countries including Russia, the UK, Ireland, the USA and South Africa. The key people associated with the development of the New Zealand technology curriculum statement presented papers to interested audiences at international conferences in Slovakia, Sweden, England, Israel, the USA, Canada and Taiwan. Finland also based its technology curriculum on New Zealand's.

Particularly influential was the Second Jerusalem International Science and Technology Conference (JISTEC) held in Jerusalem in January 1996. The conference brought together a wide range of people interested in technology education including philosophers of technology, curriculum theorists and developers, teaching and learning educationalists, and government officials. The book arising from the conference on Concepts and Processes in Technology was seen as being very influential. New Zealand had three people attending, Steve Benson from the Ministry of Education, Bev France from Auckland College of Education (now Faculty of Education, University of Auckland), and Alister Jones, University of Waikato. Steve Benson and Alister Jones presented a joint paper on development of the technology curriculum in New Zealand.

The distinguishing features of the New Zealand technology curriculum were:

- its overarching aim of technological literacy
- its emphasis on authenticity, ie that student technological practice related closely to technological practice in the 'outside world'
- the identification of technological knowledge as distinct from applied science for example, and a focus on technologies that were increasingly important to New Zealand such as biotechnology and electronics
- the inclusion of a strand examining the relationship between technology and society.

These features were not always found in other international technology curricula to the same extent. For example, the United Kingdom and Australian curricula

[10] WOCATE World Council of Associations for Technology Education, PATT Pupils Attitudes to Technology, ITEA International Technology Education Association, IDATER International Design and Technology Education Research (UK).

tended to focus more narrowly on the aim of 'capability' and therefore the development of practical skills through activities usually described as 'design-make-appraise'. Canada chose to take a Science, Technology and Society (STS) approach to implementing technology education.

MINISTERIAL REFERENCE GROUP ON SCHOOL STAFFING (MRG) AND THE UNRESOLVED SITUATION REGARDING MANUAL TEACHERS

In 1995 the Ministerial Reference Group (MRG) recommended that:

- for 1996, for years 7 and 8, schools providing Manual Training be resourced on the basis of 1 specialist teacher to 120 students, including those from other schools, for manual training, and 1 teacher to 29 students for all other areas of the curriculum
- the specialist designations of the teachers be removed
- from 1997, the two ratios be combined to one of 1:23.36, with this staffing entitlement going to the schools where the students were enrolled.

The removal of the specialist designations of 'manual teachers' as a consequence of the MRG recommendations was widely interpreted by these teachers as an indication that their skills were not required for the new curriculum. Considerable confusion and misinformation was generated largely by the media, summed up by a typical headline: '*Manual teachers to be axed*' (Southland Times, 21 March 1995).

At the same time several manual teachers' action groups were established and they were vocal in their condemnation of the MRG report on staffing.

The Ministry developed a communications strategy to counter the misinformation. The significant elements of the strategy were:

- the new MRG staffing system would give schools the flexibility they needed, and had been requesting for some time, to deliver the curriculum in the most appropriate way for that school
- the teachers' jobs would be re-designated, not abolished
- where teachers had specialist knowledge and skills, in technology and home economics, these would continue to be of value to a school.

The MRG envisaged that schools would be able to contribute staffing to a central facility. This could be described as an 'opt in' model involving mechanisms for staffing transfer. The MRG envisaged arrangements being made at the local level between schools. It did not consider that such arrangements would be sanctioned or managed at the Ministry level. Such mechanisms didn't have to be limited to technology.

The 1995 MRG recommendations related to staffing entitlement have never been fully implemented and staffing remains with the interim 1:120 provision for approved provider schools. Subsequent staffing reviews have recommended leaving the interim staffing arrangements in place.

As a result of this, large numbers of year 7 and 8 students continued to receive their technology education away from their home school at a technology centre, at an intermediate school or in a high school. This has meant that technology education for these students may be disconnected from the rest of the curriculum especially where there is little dialogue between on and off-site teachers. While this situation provided students' access to specialist teaching and facilities, **the learning opportunities often reflected technical education rather than technology education.**

DELAY IN GAZETTING THE CURRICULUM STATEMENT

The curriculum statement was to have been 'gazetted' in December 1996 for full implementation from the start of the 1997 school year. However, in May 1996 the new Minister of Education, Hon. Wyatt Creech, announced the easing of curriculum timelines in response to concerns about teacher workloads and the pace and scale of change.

This delay had a significant impact on the introduction of technology education in schools, slowing down its acceptance and implementation. The perception of many, including some principals and teachers, was that technology had been 'Lockwood Smith's Dream' and would shortly disappear. This unsettling environment also had an effect on the entry of people into technology teacher education.

MINISTERIAL CONSULTATIVE GROUP

Between September 1996 and July 1997 a Ministerial Consultative Group considered a range of teacher workload issues. New curriculum development and implementation timelines were developed including a further transition year for technology in 1998 at the end of which the curriculum statement would be gazetted for mandatory implementation from the beginning of the 1999 school year. The existing *Workshop Craft* syllabus was to be revoked at the end of 1997. In addition, the *Home Economics* syllabus was to be revoked at the end of 1998 after the Health and Physical Education curriculum statement was published in its final form. The revoking of these two syllabi, along with the MRG recommendations regarding re-designation of manual training teachers, continued to send mixed messages to the teachers involved in technical education. Were they being replaced? Were they being 'renamed'? Or were they needing to become something other? The last of these was probably closer to the truth. That is, teachers trained as technical educators would have to *become* technology educators. The original intent was that technology teachers would be drawn from a wide range of backgrounds – none of which would provide all the requirements needed to teach technology without professional development support. For example, technical teachers, comfortable with many aspects of the capability strand, would need to extend their understandings of the knowledge and society strands to offer programmes of learning that integrated all three strands. Science teachers, comfortable with many aspects of the knowledge strand, would need to extend their understandings of the society strand and develop capability skills. Social science teachers, comfortable with many aspects of the society strand, would need to extend their understandings of the knowledge strand and develop capability skills. Alternatively, a range of teachers would combine their expertise and share in the teaching of technology.

However, industrial and teacher supply issues complicated the whole situation, resulting in the narrowing of the potential pool of teachers by an almost nationwide 'renaming' of technical teachers as technology teachers irrespective of their interest and/or capability in teaching technology based on the 1995 technology curriculum.

KNOW HOW 2 PROFESSIONAL DEVELOPMENT PACKAGE

A new approach to teacher professional development was begun with the development of *Towards Teaching Technology: Know How 2*. Even with the substantial investment over three years (1995-97) in professional development, it was acknowledged that it would be extremely difficult to provide all teachers in all schools with the level of teacher development that had been provided in the pilot courses in 1995.

To address this issue the Ministry accepted a proposal from a consortium of University of Waikato, Auckland College of Education and Copeland, Wilson and Associates to devise a video-based package, supported by print material, which could be used across all schools for in-school professional development - with internal and/or external facilitation. The package was developed so teachers could gain a shared understanding of the philosophy of the technology curriculum, and of the concepts of technology, technological practice and technology education. It also sought to help schools to develop an implementation plan suited to their circumstances considering their staff strengths and interests, student needs, community expectations, resources and facilities.

The *Towards Teaching Technology: Know How 2* package was published in June 1997 and was accompanied by a further national television broadcasting of the video elements. This time the focus of five of the eight half-hour programmes was technological practice. Five educator/presenters familiar from the first *Know How* series introduced viewers to the practice of technology in New Zealand in very different contexts. They illustrated the strands of the curriculum: technological knowledge, technological capability and technology and society. The programmes were:

- *Main Street (redeveloping provincial town centres)*
- *Building 'The Master Builder' (a Circa Theatre production)*
- *Mighty Milk (milk powder for an Asian market)*
- *Noise Annoys (combating noise pollution)*
- *Smart Drive (an innovative Fisher & Paykel washing machine design).*

The other three programmes looked at how technological practice can occur in the context of a school, sharing the experience of three teachers trying technology activities for the first time.

- *Tuakau College (packaging and marketing passionfruit to export to Japan)*
- *Hora Hora Primary School, Cambridge (gaining skills and understandings in electronics and control)*
- *Mangere East Primary School (developing resources for a Samoan language nest).*

This package was widely disseminated to schools, technology centres, and teacher educators. However, the expected facilitation support never eventuated and the potential impact of this professional development resource went largely unrealised.

LEARNING IN TECHNOLOGY EDUCATION PROJECTS (LITE)

The LITE research projects, funded by the Ministry of Education, were undertaken by the Centre for Science and Mathematics Education Research (CSMER) at the University of Waikato. The 1992-1995 LITE projects were carried out to inform both curriculum development for technology and professional development for teachers in the implementation of the technology curriculum.

The projects provided:

- critical analysis of what was happening in other countries regarding the introduction of technology education. This information assisted researchers and writers to decide on the overall aim, and what aspects would be appropriate for a technology education focus in New Zealand
- research on teachers' perceptions of technology. The researchers found that teachers' existing subcultures influenced the way they perceived technology and how they would implement the technology curriculum. The researchers found that teachers' initial constructs can change with the experience of planning and teaching technology. They also found that the most critical factors impeding teachers' personal professional development were a lack of appropriate technological language, unfamiliarity with the technology curriculum statement, and the lack of easy access to collegial conversation
- classroom investigations exploring the way in which students carried out technological activities in the classroom. The researchers concluded classroom culture and student expectations appeared to strongly influence the way in which students carried out their technological activities (Jones, Mather and Carr, 1995).

The later LITE research reported on a series of interventions in New Zealand schools in order to enhance the teaching of, and learning in, technology as a new learning area. It detailed the way in which researchers worked with teachers to introduce technological activities into the classroom, the teachers' reflections on this process and the subsequent development of activities. These activities were undertaken in 14 classrooms (8 primary and 6 secondary).

The research took into account past experiences of school-based teacher development and recommendations related to teacher change. Extensive use was made of case studies from earlier phases of the LITE research, and of the draft technology curriculum, in order to develop teachers' concepts of technology and technology education. Teachers then worked from these concepts to develop technological activities and classroom strategies. The researchers also introduced a model that outlined factors contributing to school technological literacy, and suggested that teacher development models would need to allow teachers to develop technological knowledge and an understanding of technological practice, as well as concepts of technology and technology education, if the teachers were to become effective in the teaching of technology. This model was later used in training technology education facilitators.

The project was also important in generating professional debate amongst teachers, teacher educators and curriculum developers in New Zealand. The LITE research was held in high regard by international technology educationalists.

FACILITATOR TRAINING

In 1995 the Centre for Science and Mathematics Education Research (CSMER) at the University of Waikato was contracted by the Ministry of Education to train facilitators. In 1995 15 people were selected to participate in a year long national professional development programme.

This programme included a post-graduate module in technology education. The programme was based on a model developed from the earlier Learning in Technology Education (LITE) research.

The key aspects of the model employed in this programme focused on the importance of the facilitators developing:

- a robust concept of technology and technology education in keeping with the national technology curriculum statement
- their own technological knowledge in a number of technological areas – including those outlined in the national technology curriculum statement
- their own technological skills in a number of technological areas - including those outlined in the national technology curriculum statement
- an understanding of technological practice in a variety of contexts
- an understanding of the way in which peoples' past experiences both within and outside education, impacted on their conceptualization of key principles in technology education
- an understanding of the way in which technology education could become part of the school and classroom curriculum. This was to be based on a sound pedagogical base in keeping with the concept of technology education as supported by the national technology curriculum statement.

This programme also acknowledged the strengths of the ongoing school-based model of teacher development, and the importance of facilitators developing facilitation skills appropriate for technology education.

Following the training, the facilitators began training teachers in their own or selected schools to implement technology education and later set up regional clusters of schools/teachers for professional development.

A further group of 15 people was selected for training in 1996. These facilitators also trialled aspects of the *Know How 2* professional development package as part of its development.

A major set-back was that in 1997 the remaining budget funding for the facilitators working in schools was withdrawn by the Ministry of Education. The reason for this was re-prioritisation of funding to other projects. This effectively meant that the skills of the 30 facilitators were not available to teachers and schools, and as indicated above, the final *Know How 2* package was sent out with no accompanying targeted facilitation.

POST GRADUATE COURSES IN TECHNOLOGY

In 1993 the University of Waikato took the lead in developing postgraduate courses in technology education. A postgraduate diploma was established later and this proved to be a very successful qualification with many going on to complete Masters degrees. Later on Massey University and the University of Auckland also offered technology education papers as part of their post graduate programmes.

Postgraduate qualifications have been crucial in developing a professional knowledge base in technology education in New Zealand, and building a research culture in this country. Some of the people who completed these early courses have gone on to become leaders in technology education in schools and in various technology education related organisations.

ROYAL SOCIETY OF NEW ZEALAND (RSNZ) CONFERENCE ON TECHNOLOGY

With its strong networks in the scientific and technological communities, the Royal Society has been able to play a unique role in education and promotion of science and technology.

The Royal Society has contributed to ensuring the provision of New Zealand's future human capacity in research, science and technology by:

- encouraging young people to engage in scientific and technological practice;
- encouraging students to enter scientific and technological careers and supporting them in the early stages;
- demonstrating the value of sciences and technology in other careers;
- identifying promising individuals and providing opportunities to foster their growth and development in sciences and technology.

It still has a broad perspective on science and technology education through the maintenance of a Science and Technology Education Advisory Committee and close links with the New Zealand Association of Science Educators (NZASE) and Technology Education New Zealand (TENZ).

From the early stages of the development of the draft technology curriculum in 1993 the Royal Society had shown considerable interest. In April 1997 the

Royal Society convened a Technology Education and Technology Enterprise forum which reinforced the strong links between the development of the technology curriculum and New Zealand's overall technology policy. The proceedings of the forum were published in December 1997.

TECHNOLOGY EDUCATION NEW ZEALAND (TENZ)

Another positive development in 1997 was the establishment of a professional association for all those with an interest in technology education. TENZ was set up at the end of the facilitator training mentioned earlier. Glynn McGregor, a former science teacher and one of the people who completed the facilitator training, worked to establish a trust board for TENZ and set up the membership structure.

TENZ is a network which:

- fosters the development of technology education in the New Zealand;
- develops and maintains national and international links between those working in technology education and with the wider technological community;
- supports professional, curriculum, and resource development in technology education;
- encourages research in technology education;
- organises a national technology education conference every two years.

TENZ has gained membership across primary, secondary and tertiary education and also acquired support from technology-based industries. More than 230 schools (with approximately three teachers per school) and over 50 individuals, are members. It is now administered by a National Council comprising 9 persons.

Members are kept informed through the (now electronic) newsletter *t-news* (www.tenz.org.nz/t-news/), a twice a school term publication focusing on professional matters relating to technology education. TENZ also has a website which includes a range of materials and information for technology teachers and individuals and organisations interested in technology education.

Telecom New Zealand Ltd was the major sponsor of the inaugural TENZ conference held at Christchurch College of Education in October 1997 attracting 440 delegates. This was a larger number than attend most well established subject association conferences and augured well for the future of the curriculum. The theme for the conference was "From Curriculum to Classroom Practice". Keynote presentations included a presentation on assessment in technology education from Dr Richard Kimbell from Goldsmiths College, University of London. The conference included two afternoons of technology visits to emphasise the connections between technology education and technological practice within the workplace.

Conferences have been held every two years since 1997. The themes of the conferences have been:

1999	Pathways to technological literacy
2001	A celebration, a challenge and the future
2003	Enhancing technological literacy
2005	Technology Education - A future in technology
2007	Leading the way - nature of technology, technological knowledge, technological practice.

The theme for the 2009 conference is: 'Students at the centre of learning in technology education'.

The TENZ website is: www.tenz.org.nz

DELTA TECHNOLOGY PROJECT

TENZ worked with the Royal Society and IPENZ in the *Delta* Technology Education Project to produce a series of case studies of technology education practice in schools. The Delta Tec hnology project set up in 1998 was initiated to provide students and teachers with access to examples of current technology practice and up to date technological knowledge. Angela Christie of the Royal Society worked with Gabrielle O'Connor from IPENZ as part of a Royal Society Science and Technology Fellowship to generate a number of case studies of school-enterprise links which were set up to support classroom technology programmes in a number of Wellington schools. With the support of their schools and companies, enthusiastic teachers were linked with willing engineers and technologists to develop opportunities for students to experience working as technologists on their classroom projects. The resources broadened the professional experience of teachers and the technologists involved, and widened the range of experiences offered to students. The basic structure of the '*Deltas*' can be seen in some current case studies on 'Techlink' (www.techlink.org.nz).

MINISTRY OF EDUCATION CURRICULUM SUPPORT

Since the 1995 technology curriculum statement was finalised the Ministry, besides implementing teacher professional development programmes, developed a number of materials to support its implementation:

- *Technology Updates*: a series of leaflets included in the Education Gazette (1994-1998). During 1998 the leaflets were subtitled *Countdown* to '99 and focussed on implementation at different levels.
- *Implementing Technology in New Zealand Schools: Years 1-8* (1998): a handbook for principals and teachers concerned with school-wide implementation planning.
- *Safety and Technology Education - a Guidance Manual for New Zealand Schools* (1998): information for teachers and boards to establish sound health and safety policies and procedures in technology education.
- *Materials Technology - Classroom Practice in Years 1-8* (1999).
- *Information & Communication Technology - Classroom Practice in Years 1-8* (1999).
- *Biotechnology - Classroom Practice in Years 1-8* (1999).
- *Food Technology - Classroom Practice in Years 1-8* (1999).
- *Electronics and Control Technology - Classroom Practice in Years 1-8* (1999).
- *Production and Process Technology - Classroom Practice in Years 1-8* (1999).
- *Structures & Mechanisms Technology - Classroom Practice in Years 1-8* (1999).
- *Materials Technology - Classroom Practice in Years 1-8* (1999).
- *Design & Graphics in Technology in Years 1-8* (1999).
- *Graphics Education – Guidelines for Years 9–13* (2001).
- *Planning and assessment in technology education.* This resource built on the work done through two assessment research and professional development programmes undertaken by the University of Waikato and Massey University/Auckland College of Education. www.tki.org.nz/r/technology/tech_research/index_e.php
- *Technology: Online Materials 2000/1* www.tki.org.nz/r/technology/curriculum/rsnz/index_e.php

TKI WEBSITE

Throughout the late 1990s and early 2000s information about developments in technology education was to be found on the Ministry of Education's *Te Kete Ipurangi* (TKI) website (www.tki.org.nz). TKI provided bi-lingual quality-assured educational material for New Zealand teachers, school managers, and the wider education community.

MINISTRY OF EDUCATION AND EDUCATION REVIEW OFFICE SURVEYS

Two surveys in 1998 provided information about the readiness of schools to implement the technology curriculum in 1999.

The first, undertaken by the Ministry of Education, surveyed 452 schools of which 77% responded. Overall 74% of schools reported they had a written plan or partially completed plan for implementation. Only 5% had not undertaken any planning. In general, all types of schools reported similar levels of readiness.

Schools also reported how ready they were to provide learning experiences in the seven technological learning areas. On the whole they reported they were ready to access all areas. However, Biotechnology and Electronics and Control were areas about which schools felt less confident.

In the survey, schools identified things that were going well with their implementation processes, as well as barriers they were experiencing. The fact that a high proportion made positive comments compared with the smaller numbers who listed barriers to implementation, was encouraging.

Lack of funding and resources were reported as the main barriers to effective implementation. Time pressures and teachers' own technological knowledge were also mentioned as barriers.

The second report was prepared by the Education Review Office (ERO) based on an analysis of 181 schools. Overall ERO found that 52% of schools had made good progress towards implementing the new curriculum and 11% were fully ready, or already implementing the curriculum. There was strong correlation between readiness and involvement in Ministry contracted professional development programmes. The report also noted that there was some confusion (mainly amongst school trustees) between ICT and the technology curriculum. This resulted in ICT across the curriculum needs often being considered, but technology as a learning area was overlooked.

BROADER POLITICAL AND ECONOMIC INFLUENCES

National discussions about New Zealand's future economic and social directions during the 1990s increased interest in and support for technology and the role it would play in economic growth, caring for the environment and improving the quality of life of New Zealanders.

Several major initiatives or events occurred during this period. They were: *Science and Innovation Advisory Council (SIAC) Challenges, the Knowledge Wave Conferences, the Bright Futures initiative, and the Growth and Innovation Framework (GIF).*

SCIENCE AND INNOVATION ADVISORY COUNCIL (SIAC)

The Science and Innovation Advisory Council was appointed by government in 1990 to provide advice on how to best position New Zealand as a knowledge-driven economy and society. In its report published 1991 the SIAC came up with a proposal for a New Zealand Innovation Framework based around what it saw as New Zealand's seven 'critical challenges' to our attitudes, behaviours, infrastructure and investments. For each challenge the report suggested possible 'indicators' to measure our success in meeting that challenge, and the goals to monitor our progress. The challenges were:

- rewarding 'can do', risk taking and success
- educate for a knowledge economy
- become a magnet nation for talent
- generate wealth from ideas and knowledge
- excel globally
- network, collaborate and cluster
- take an investment-driven approach to government.

The 'Educate for a Knowledge Economy' challenge stated "the money we spend on education is the best long-term investment we can make and that skills and knowledge are the building blocks of our individual and collective fortunes". There are successes in our present education system, but the report says there are gaps. Schools must foster students' ability to think for themselves, to access knowledge and information directly, and to manage their own learning. The secondary system needs to give much more support to technology, entrepreneurialism and wealth creation, and tertiary education must become more aligned with our economic and social development needs.

Suggestions included:

- making sure principals and teachers are trained up in subject areas like maths, science and technology
- incorporating thinking skills, creativity, and innovation into students' learning at all levels
- encouraging young entrepreneurs. Programmes for recognising top entrepreneurial achievers should be developed alongside existing programmes for recognising top academic achievers
- ensuring that young people are familiar with ICT.

KNOWLEDGE WAVE PROJECT

The New Zealand Government, in partnership with the University of Auckland and supported by business, in 1991 launched the "Catching the Knowledge Wave" Project. The Knowledge Wave conferences of the 1990s raised national awareness of the need for economic performance to improve if New Zealand was to return to the top half of the OECD. They generated a new willingness amongst private and corporate citizens to take responsibility for making that happen. The aim was for achieving a "prosperous, cohesive society". Core themes for the conferences included:

- fostering learning, innovation and creativity
- macroeconomic policy and growth
- entrepreneurship in the Knowledge Economy
- people and capability
- social cohesion and cultural transformation
- environmental sustainability.

BRIGHT FUTURES

The Bright Future scholarships scheme administered by the Tertiary Education Commission supported people to conduct research in science and technology. Bright Future included two types of scholarships: Top Achiever Doctoral Scholarships and Enterprise Scholarships. They have continued to be awarded each year.

GROWTH AND INNOVATION FRAMEWORK (GIF)

These initiatives contributed to the most recent governmental initiative, the Government's Growth and Innovation Framework (GIF). Released in 2002, GIF was developed by the Ministry of Economic Development after widespread consultation. It was designed to deliver the long-term sustainable growth necessary to improve the quality of life of all New Zealanders.

It was a strategy based on a vision of New Zealand as:

- a land where diversity is valued and reflected in our national identity
- a great place to live, learn, work and do business
- a birthplace of world-changing people and ideas
- a place where people invest in the future;
- an environment people cherish and are committed to protect for future generations.

Four areas were identified for Government action initially. These were:

- strengthening the innovation system
- developing skills and talents
- increasing international connection
- engaging with sectors.

Although the Government's Growth and Innovation Framework (GIF) linked most strongly to tertiary education it also linked to technology, mathematics and science in schools, especially at senior secondary levels. The first four taskforces established under the GIF were in biotechnology, ICT, design, and screen production. These were all areas of relevance to technology education.

New Zealand Trade and Enterprise co-ordinated the work of the four taskforces, with support from other government agencies. Each taskforce sought to highlight bottlenecks and identify ways to remove them, and produce a report recommending to Government possible future directions.

Officials across a range of departments and agencies worked to finalise Government responses to the taskforces' recommendations. As part of this work, proposals were developed for use of GIF funding and the proposals included initiatives designed to support the implementation of the technology curriculum.

At the time (and this continues today) there was a widely held perception that senior secondary school students were turning away from mathematics and science subjects. The reality was that while the percentage within yearly cohorts was falling, the actual numbers of students taking the subjects were growing, in some cases substantially, as the curriculum broadened. The main drop-off in numbers occurred, as it does now, between school and tertiary education.

PART 2B: 1999 – 2004 Work in Technology

Between 1999 and 2004, there was a large amount of 'behind the scenes' work undertaken in technology education. The Hangarau (Māori technology) curriculum was published. There was a number of classroom-based research projects established. The National Certificate of Educational Achievement (NCEA) replaced traditional senior secondary qualifications and included achievement standards in technology. Information from the curriculum stocktake was analysed and resulted in publication of the Curriculum Stocktake report in April 2003. In 2004 the National Educational Monitoring Project (NEMP) investigated the achievement of students in technology and the attitude of students to technology at year 4 and year 8, and the Education Review Office (ERO) evaluated the quality of the teaching of technology at year 4 and year 8.

HANGARAU CURRICULUM

After two years of research and development and six months trialling, Hangarau, the Māori technology curriculum, was completed in April 1999 and sent to all kura kaupapa and schools with bilingual and immersion units. The aim of Hangarau was to develop Māori students' technological literacy by prioritising Māori knowledge and values in the understanding and undertaking of technological practice. It was built on similar aims and concepts as the English medium technology curriculum.

However, Hangarau differed from the English medium technology curriculum in that it only had two strands, Marautanga Hangarau and Hangarau a Iwi. Marautanga Hangarau incorporated aspects from the technological knowledge and technological capability strands. Hangarau a Iwi reflected the aspects of the technology and society strand. The learning experiences and assessment examples provided within Hangarau attempted to exemplify how traditional Māori knowledge and practices resulted in traditional and contemporary technological endeavours and artefacts.

RESEARCH PROJECTS

Technology Education Assessment in Lower Secondary (TEALS)

The Technology Education Assessment in Lower Secondary (TEALS) was a joint project between Massey University College of Education and the Auckland College of Education (ACE) funded by the Ministry of Education. Vicki Compton (ACE) and Cliff Harwood (Massey) were the researchers involved.

In 1999, this project focused on exploratory research with 10 teachers in year 9 and 10 classrooms to investigate how student learning in technology can be enhanced through the development of valid, explicit, and reliable assessment practices. The initial research primarily focused on students' perceptions of technology education, and on ascertaining what assessment practices teachers were using and how effective they were at identifying and supporting student learning. The results of this phase of the research led to the development of a Technology Assessment Framework (TAF) designed to enhance learning through clearly identified learning outcomes, formative assessment practices, and the development of valid judgments about students' technological practice. The research also attempted to address the mismatch found between teacher and student perceptions of assessment by making more explicit the purpose of assessment and learning experiences as a whole. It also sought to clearly show how learning outcomes focused on context specific skill and knowledge were critical for students to successfully achieve technological practice learning outcomes.

The TAF was trialled and evaluated during another six-month phase of classroom research. The information from this phase of the research resulted in a refinement of the TAF. Data from classrooms showed the impact of the TAF in practice.

In 2000, the TEALS research was extended for a further year in order to increase the range of year groups involved (the TAF was used with students from years 1 to 13) and to begin to look more closely at the nature of student progression in learning within the technology curriculum. These findings showed the TAF to be effective in enhancing the delivery of technology units that provided students with the opportunity to undertake technological practice.

Gateways[11] were important planning and management structures of the TAF bringing together learning outcomes, assessment criteria, and assessment strategies to better identify and support student learning. They also provided links to the achievement objectives of the curriculum showing how these could be integrated to support technological practice. They provided a structure for teachers to **formatively interact** with student learning throughout their technological practice. Through such interactions the learning experiences offered could be adapted to better address student learning needs. Gateways also provided a focus for making **summative judgments** of student learning at the exit point of a technology unit/programme. In this way they allowed for the ongoing development of technology education programmes that reflected both the needs of the student and the aim of the technology curriculum.

TEALS 2000 also identified the need for further research to establish 'key features' of technology which could be nationally accepted and understood.

Further research in 2001 explored the nature of progression in technological practice. Findings from the 2001 research allowed for the identification of key features of technology education that are relevant across all age groups, contexts and technological areas. These key features were collectively termed **components of practice**. The three **components of practice** established were **brief development, planning for practice**, and **outcome development and evaluation**. This research from 2002-2004 also led to the development of progression matrices for each of these components and provided illustrative examples of student work levelled against the matrix indicators of progression for brief development.

These components provided the basis of the components of technological practice that would be developed as part of the 2007 technology curriculum – see Part 3.

[11] The web link www.tki.org.nz/r/technology/tech_research/glossary_e.php lists a number of glossaries including Gateways, Formatively Interact and Summative Judgments.

LITE Assessment

The LITE (Learning in Technology Education) Assessment project was undertaken by the Centre for Science and Technology Education Research, University of Waikato, and funded by the Ministry of Education. The researchers were: Judy Moreland, Alister Jones, Ann Northover, and Megan Chambers. LITE (Assessment) took place from 1998-2001. It continued in 2002-2003 examining school-wide change but this research was internally funded by the University of Waikato. The Classroom InSiTE project then extended LITE from 2005 until 2008.

In 1999, the LITE project explored classroom-based intervention strategies to enhance teachers' formative assessment practices in primary classrooms (years 1–8). This research built on the findings of Judy Moreland's earlier primary technology research work in 1998.

In 2000, intervention strategies were further developed to enhance teaching, learning, and assessment practices. Of particular focus was the interrelationship between formative and summative assessment strategies and summative assessment reporting. These assessment strategies were trialled with 15 primary school teachers from 5 schools in 1999 and 2000.

During the LITE research, a planning template was developed and trialled. This planning template helped teachers to identify concisely the technological learning that students were to undertake in units of work. The template encouraged teachers to define the task clearly and to consider how the students would need to bring together different aspects of technology to complete the task.

Teachers were prompted to supply appropriate information under the following headings:

- task definition
- technological area/s
- overall student technological practice (the operationalisation of the conceptual, procedural, societal and technical aspects in student technological practice – integrating all four aspects in undertaking and completing the technology task)
- conceptual learning outcomes (knowledge and understanding of relevant technological concepts and procedures)
- procedural learning outcomes (knowing how to do something, what to do and when to do it)
- societal learning outcomes (aspects related to the interrelationship between technology and groups of people).
- Technical learning outcomes. (Skills related to manual/practical techniques.)

Technology Education Assessment National Professional Development Programme (TEANPD)

In 2000 a national professional development contract, also funded by the Ministry of Education, was awarded jointly to Auckland College of Education (ACE) and Massey University to provide assessment guidance to technology education teacher educators. The project was known as the Technology Education Assessment National Professional Development Programme (TEANPD). Vicki Compton of ACE and Cliff Harwood of Massey University led the project. They also worked with Ann Northover (now of ACE) who had previously worked on the LITE Assessment research. This programme was developed to ensure the findings of the TEALS and LITE research were made available to lead teachers and pre- and in-service teacher educators throughout New Zealand.

With a focus on regional meetings the TEANPD programme allowed for shared professional learning in technology to occur across institutions. This resulted in the opportunity for discussion of the implications of the research findings and encouraged an increase in national consistency across pre- and in-service teacher education programmes. It also provided case study material that was later made available to teachers.

National Exemplar Project

The National Assessment Strategy (www.tki.org.nz/r/assessment/parents/nat-strategy_e.php) was launched in 1999 and focused on:

- setting specific and challenging goals with students
- fostering partnerships in learning
- using information to improve learning
- developing high-quality assessment tools
- developing teachers' assessment literacy
- informing strategic planning.

In August 2000 the Minister of Education, Hon. Trevor Mallard, announced the development of the National Exemplars project as part of the broader National Assessment Strategy. Exemplars of student work were to be developed in both English and Māori for Levels 1 to 5 of the New Zealand curriculum. An exemplar was to be an authentic example of student work annotated to illustrate learning achievement and quality in relation to the levels described in the relevant national statement.

Each exemplar was to highlight significant features of that work and important aspects of student learning.

In 2001 a contract was let to Auckland College of Education (directed by Jill Parfitt) for the development of technology exemplars. Sub contracts were let to the University of Waikato for the development of the exemplars for years 1-8 (Alister Jones and team) and Auckland College of Education/Massey University for the development of the exemplars for years 9-13 (Cliff Harwood from Massey University and Vicki Compton from Auckland College of Education).

A progression matrix was developed including a range of exemplars for the technology essential learning area and made available in 2003. The committee reviewing the matrix had divided views about some aspects of the matrix and some committee members withdrew as a result. At the end of 2001 Auckland College of Education/Massey University withdrew from the exemplar project and Cliff Harwood and Vicki Compton continued with their own research project. They later made the following statement about the matrix which was developed as part of the Exemplar project.

> "It is our considered opinion that the draft matrix, and the rationale to support it, undermines both the intent of Technology in the New Zealand Curriculum and much of the work that is currently being undertaken by teachers of technology inside New Zealand classrooms. The characteristics of technology identified in the matrix are not characteristics that are the 'key' to students' learning (and hence progression) in technology education. The levelled descriptors are unsupported as indicators of progression by contemporary research undertaken within New Zealand classrooms. As such they will provide little to no guidance to teachers on student progression both within and across technology units."

This was a turbulent period for technology education. Frequent changes of Ministry of Education technology education personnel during the period 1999-2003 resulted in a lack of clear direction and stable leadership. There were considerable differences of views between the exemplar team, the researchers and Ministry staff. The 2003 exemplar progression matrix was not considered useful by teachers as the levels were not technologically differentiated. The exemplar matrix was finally withdrawn in 2005 by the Ministry of Education. This created further tension, with many members of the technology community concerned at the Ministry's handling of the exemplar process and the progression matrix withdrawal.

Subsequently the exemplars were reworked to reposition them back within the technology curriculum. As they were based on actual student work, it was considered they still had a role to play when supported by other resources and/or facilitation.

The introduction of National Certificate of Educational Achievement (NCEA) and support for NCEA Technology - Teacher Professional Development

The National Certificate of Educational Achievement (NCEA) was developed from 1998-2002 to replace the existing qualifications of School Certificate, Sixth Form Certificate and University Bursary/Scholarship.

It was designed to be a flexible, dynamic qualification with three levels and Scholarship. Over the period 2001-2005 Achievement Standards were developed in all subjects for all levels. These continue to be regularly reviewed and modified where necessary.

The Technology Achievement Standards (and Unit Standards[12]) for NCEA at Levels 1-3 were developed by Ministry-led teams of teachers with input from tertiary and industry representatives.

The TEALS 1999 research informed the development of the Level 1 Technology Achievement Standards and a selection of these standards were trialled and evaluated in the TEALS 2000 research. This resulted in their modification and provided insight into how achievement standards could be used effectively within technology programmes. TEALS ongoing research also informed the development of the Levels 2 and 3 Technology Achievement Standards.

The Implementation of the NCEA took the technology curriculum into the senior secondary school from 2002. Professional development programmes were developed from 2001 to provide teachers with the knowledge and confidence to deliver and assess courses based on Levels 6 to 8 of the technology curriculum for students being assessed for NCEA Levels 1, 2 and 3. These programmes also served as technology curriculum professional development for the majority of secondary teachers. That is, the teachers were not simply learning about new assessment procedures in their subject but were being challenged by a whole new view of technology as a subject in terms of purpose, content, and pedagogy.

[12] MoE and NZQA developed a large suite of Unit Standards for general education in the late 90s including technology related. The Unit Standard resources for the NCEA were developed in association with the Ministry of Education. A wide range of other Unit Standards were developed by Industry Training Organisations (ITOs).

The professional development programmes, provided through contracts with the Royal Society of New Zealand (Levels 1 and 2) and Massey University (Level 3 and Scholarship), involved facilitators in:

- using information provided by advisers in School Support Services to identify schools where teachers required professional development so that they could plan courses
- identifying the professional development needs of these teachers and providing regional cluster workshops, meetings with principals and/or members of the senior management teams and follow-up visits to meet these needs
- assisting teachers to develop courses, and to produce schedules to assist assessment and reporting
- assisting them to develop student work exemplars and to moderate and assess these exemplars
- sharing ideas regionally through links with School Support Services advisers
- sharing ideas regionally and nationally through the Technology Education New Zealand (TENZ) network.

The introduction of technology in the senior secondary school paved the way for teachers to fully implement technology in years 9 and 10. No longer could secondary teachers avoid technology due to there being no curriculum specific assessments which credentialed students at senior secondary. The development of technology standards for NCEA qualifications was a far more powerful driver for implementation of the technology curriculum than the 1999 mandating of that curriculum (years 1-10).

A limited number of resources were provided during this time to support teachers to help them develop a shared understanding of assessment judgments with regards to the technology standards.

Curriculum Stocktake and National Schools Sampling Study

Alongside the introduction of new curriculum timelines in 1997 came a promise that, following the publication of the full set of curriculum statements, a time of consolidation and reflection would occur. The last document produced was the arts curriculum in September 2000. The objective was not to rush into revision of the curriculum, but to take stock of the previous decade's developments and their implications for teaching and learning, and to consider what they indicated for future curriculum directions. A review of the curriculum was undertaken in the years 2001-2003.

The key outcomes of the curriculum review/stocktake were to be:

- an assurance of, and increased confidence in, the quality of the New Zealand curriculum as policy
- a higher likelihood of effective implementation of the New Zealand curriculum and therefore of improved outcomes for students
- an agreed direction and process for the ongoing development of the New Zealand curriculum
- in each case applying to the curriculum in both English and in te Reo Māori.

The curriculum stocktake investigated a number of problems and issues associated with the New Zealand curriculum and its development which had been raised in and outside the educational sector.

The stocktake made 11 recommendations on how the curriculum should be shaped to better meet the diverse needs of students.

In summary the stocktake recommended that:

- essential learning areas be reviewed and refined and outcomes be clarified
- the essential skills, attitudes, and values be revised so they were better integrated into the essential learning areas
- more opportunities be provided for students to learn another language in years 7-10
- there be a focus on supporting quality teaching and strengthening school ownership of the curriculum
- material be developed for parents and communities so that they knew what students were learning at school and why
- curriculum materials be developed to assist teachers to better meet the diverse needs of students
- the links between outcomes, pedagogy, and assessment be more explicit in curriculum materials and professional development programmes.

A contract was let to the University of Waikato in 2001 as part of the *Curriculum Stocktake: National Schools Sampling Study* to undertake a national study to investigate teachers' experiences in the implementation of the technology curriculum in New Zealand schools from years 1–13. This investigation, which asked teachers to self report on their implementation of the technology curriculum, was part of a larger study being undertaken nationally in all curriculum areas to explore how effective the curriculum was in practice and how the results could inform future developments.

National focus groups, questionnaires and case studies were used to explore how the curriculum was being implemented. The questionnaires were distributed to over 10% of New Zealand schools. The key findings indicated that most primary school teachers were aiming for curriculum coverage, had moderate levels of confidence but were concerned about curriculum overcrowding. Years 7 and 8 teachers were mainly concerned about assessment, whereas secondary school teachers stated they were constrained by existing structures in schools.

Teachers were satisfied with the usefulness of the technology curriculum statement to guide planning but assessment was a problematic area. Nearly three-quarters of the teachers indicated they had taken part in professional development to prepare them for teaching technology. It was noted that technology teachers have had to adapt more than in any other curriculum area to new ways of teaching. For many teachers, particularly manual training teachers in intermediate schools and technical teachers in secondary schools, this had not been easy (see Issues section).

The *New Zealand Curriculum Stocktake Report* was published in April 2003. Following publication of the report the New Zealand Curriculum Marautanga Project was established to re-develop the New Zealand curriculum.

National Education Monitoring Project (NEMP) and Technology Results

The NEMP reports were, and are, commissioned by the Ministry of Education to inform development of the Ministry's strategy to raise educational standards in this country. The project is managed by Otago University's education research unit.

The annual national educational achievement assessments cover a broad range of content included in the New Zealand school curriculum on four-yearly cycles of learning areas and skills. The assessments focus on students at two levels, four years apart: year 4 (age 8-9) and year 8 (age 12-13).

Each year about 3,000 students in 260 schools are randomly selected to take part in the national monitoring project. The focus is on growth in educational achievement across time.

They provide the Ministry of Education and schools with system-wide information on student achievement across all areas of primary education on a regular cycle. They are part of a range of education assessment studies that monitor and evaluate educational progress.

Information collected gives a 'raw' image of what our children know and can do. Reports are published annually on the NEMP assessment from the previous year. The NEMP data sets provide a wealth of information on student learning and needs to be considered more widely. Technology was reported on in 2000 and 2004. A further report is due in 2009.

In comparing the NEMP 2004 results with the NEMP 2000 results, it was found that:

Year 4 and 8 students continue to enjoy technology, with 81% of year 4 and 93% of year 8 students rating it positively. Year 8 students ranked it their second favourite subject, with most saying they learn 'heaps' or 'quite a lot' from technology. Nearly half of year 4 and year 8 students would like to do more. And they are confident: 72% of year 4 students and 83% of year 8 students rate their technology learning positively. Students consider that they are exposed to a variety of different aspects of technology.

There was evidence of general technological progress between year 4 and year 8. This was particularly notable in detail given in explanations, increased level of technological product knowledge and knowledge of devices. Year 8 students also tended to be able to identify and combine a greater number of variables in technology activities, and the representation of their technological ideas had become more sophisticated since year 4.

Year 4 students show improvement as a group, performing slightly better in 2004 than they did in 2000, while year 8 students had maintained their ground. Year 8 students showed a reasonable grasp of the nature of technology, with close competition between those who view it in terms of 'high technology' (computers and so forth) and those who saw a link with designing and making things.

Generally, type and size of school had little impact upon technological performance; however, there was a marked, comparative drop in performance among students from low-decile schools, first identified in the technology assessments of 1996, and still very evident. Also bearing out previous trends, Pakeha students were performing moderately better than Māori students and substantially better than Pasifika students. These differences seemed less pronounced when undertaking tasks which dealt with technological capability (that is analysing, designing and making solutions). There were only small differences in achievement between girls and boys at both levels for technology.

The project researchers concluded that student learning could be assisted by placing greater emphasis on technological knowledge, particularly in terms of device and system knowledge, and by placing greater emphasis on the nature of technology. They considered students needed help to think beyond the immediate in finding solutions to problems.

Education Review Office Reports on Technology

ERO evaluated the quality of teaching of technology at year 4 and year 8 during Term 4, 2004 and Term 1, 2005. They also published three case studies based on 2006 surveys. They made the following observations in the 2005 report.

Examples of good practice showed that:

- many students were enthusiastic about and enjoyed their learning in technology
- many teachers gave students interesting and challenging learning experiences in technology
- in most schools, a range of high quality teaching and learning resources supported the technology programme
- the employment of specialist teachers of technology increased the range of learning opportunities and experiences for students, particularly year 8 students
- many students were being taught the skills needed to evaluate their progress and that of their peers in technology
- positive and supportive relationships among students and between students and teachers were evident in the technology programmes in most schools.

Recommendations for improvement were provision of:

- progressive and sequential programmes for learning in technology that builds on prior learning, rather than basing a technology programme on a series of 'one-off' activities
- the organising and management of the teaching of the curriculum through an integrated approach that adequately addresses the objectives of the technology curriculum
- improved communication about students' learning needs and progress in technology between the students' home school and their off-site providers of technology at years 7 and 8.

Based on the findings of this evaluation, ERO recommended focusing on the following areas for continued development:

- increasing teacher confidence and competence
- increasing the range of technological areas and in the use of equipment and resources that support the technology curriculum
- using teaching strategies that are student-centred rather than a prescriptive, teacher-directed teaching of technological skills
- identifying the different learning needs of all students within classes and adapting programmes and teaching strategies to meet these needs.

ERO stated "Overall the introduction in 1999 of the technology curriculum into schools appears to have been largely successful. ERO reviews generally show that about 80 percent[13] of schools implement the technology curriculum successfully. Information from recent reviews of primary, intermediate and secondary schools show that 71, 74 and 57 percent respectively of these schools are including technology programmes satisfactorily into their overall curriculum. Similarly, most teachers in most primary, intermediate and secondary schools have undertaken adequate training and been provided with sufficient teaching and learning resources to enable them to deliver the curriculum satisfactorily. Composite schools have had less success in implementing the new curriculum, with 60 percent of those included in this study having inadequate programmes in at least part of the school. This is likely to be a result of the difficulties of covering an extensive curriculum over a small school with a wide range of student ages."

[13] There is some skepticism about this figure amongst technology educators, researchers and Ministry of Education officials, as anecdotal evidence through advisory points to little consistency of understandings of technology and to weak programmes in many schools.

PART 3: Technology Education Research and the Development of the Revised New Zealand Curriculum 2004-2008

INTRODUCTION

The period 2004 to 2008 was an exciting time with the development of *The New Zealand Curriculum Draft* for Consultation 2006 and The New Zealand Curriculum published 2007. As part of the New Zealand Curriculum Marautanga Project (NZCMP), writing groups were established in each of the learning areas. Significant changes were to occur for technology within this period. The Technology Writing Group worked to redefine the aim and revise the constructs of the technology curriculum within the New Zealand curriculum. A research project (Technological Knowledge and Nature of Technology - TKNoT) was undertaken to inform the writing group. This decision was based on findings from the earlier TEALS and LITE research, NEMP findings, ERO reports, early results in NCEA Technology.

Other initiatives with significance for technology during this period were:

- GIF Technology Education Initiative
- Beacon Practice Technology
- Techlink website (www.techlink.org.nz)
- Biotechnology Learning Hub - Ministry of Research, Science and Technology (MoRST)
- inclusion of technology to the New Zealand Universities canon of agreed university entrance subjects
- development of *Futureintech* through IPENZ
- classroom Interactions in Science and Technology Education (InSiTE) research project.

This section details the above and concludes with a discussion regarding international trends in technology education and the contribution New Zealand research and the New Zealand Technology Curriculum have made to the international scene.

THE CURRICULUM DEVELOPMENT PROCESS

Between 2004 and 2007 more than 15,000 students, teachers, principals, advisers, and academics contributed to developing the draft New Zealand curriculum as part of the New Zealand Curriculum Marautanga Project (NZCMP). The revision built on the recommendations from the *New Zealand Curriculum Stocktake Report*, published in April 2003.

People contributed by participating in working groups, providing input online, or taking part in focus groups. The draft revision of the curriculum, *The New Zealand Curriculum: Draft for Consultation 2006*, was enriched by the knowledge, experience, and different perspectives of all those involved. The participatory process also led to the creation or growth of professional communities and the forging of new connections between teachers, educators, business and industry.

TKNoT Research (Technological Knowledge and Nature of Technology)

A two year research contract funded jointly by the Ministry of Education and GIF - Technology Education Initiative (see later for details) was let to the University of Auckland in 2004 in order to define the Technological Knowledge and Nature of Technology strands proposed for the *The New Zealand Curriculum: Draft for Consultation 2006*. Vicki Compton directed this project, undertaking the research with Bev France and Ann McGlashan. An overview of this research is provided below, for details see Compton and France, (2007a); Compton and France, (2007b); Compton and France, (2007c).

The questions underpinning this research were:

- What components of technological knowledge and the nature of technology are essential for technology education in New Zealand?
- How does technological knowledge progress across the New Zealand Curriculum Framework (NZCF) Levels 1-8?
- How does the nature of technology progress across NZCF Levels 1-8?

The major aim of the TKNoT research was to provide a sound understanding of technological knowledge and the nature of technology to ensure a strong foundation for the New Zealand Technology Curriculum to be released in 2007.

The TKNoT research established the key components of technological knowledge and the nature of technology, and provided initial indicators of how these might progress. These were established from exploration of the philosophy of technology internationally and the technological knowledge located in New Zealand technology communities of practice. Key technology networks were approached and individuals within these communities identified as research participants. International experts were also involved. Contemporary technology education literature was also explored and a number of teachers and teacher educators were approached for comment and feedback as the research progressed.

A further aspect of the TKNoT research was to explore students' intuitive ideas with regards to two components of the nature of technology strand - the characteristics of technology and the characteristics of technological outcomes. Students were asked about their concept of technology and its purpose, their understandings of the physical and functional nature of technological outcomes, how and why technological outcomes might be developed. The research consisted of 220 students completing a written questionnaire and this was followed by structured interviews.

These findings showed:

- students' ideas of the nature of technology were largely bound by their school experiences of technology education. few students were able to articulate generic understandings of technology or locate their understandings in a global or historical context.
- many students recognised technology as a purposeful activity aimed at improving life but the examples they gave were high-tech products with no awareness of how these products have been developed.
- there was a clear tendency when describing a technological outcome for students to focus on its physical nature and there is little evidence of any understanding of the relationship between the physical and functional nature of technological outcomes.

THE TECHNOLOGY WRITING GROUP AND THE REVISION OF TECHNOLOGY IN THE NEW ZEALAND CURRICULUM

The Technology Writing Group (TWG)[14] was established in 2004 and mediated the wide range of views provided through the NZCMP consultation process. The TWG sought to redefine the aim of technology education and the curriculum constructs for how this could be expressed. An introductory "essence statement" was developed which identified technological literacy as the overall aim for technology education. The TWG upheld the view that technology is at the heart of an increasingly changing world. Toffler likened technology to "the growling engine of change". Technology has shaped our past and it will shape the future at an ever increasing pace. Internationally many educators and leaders in business and industry believe that in the 21st century it is vital that students develop **technological literacy** to be able to participate in society as responsible and informed citizens.

The aim of *Technology in the New Zealand Curriculum* (1995) was to develop students' technological literacy. This literacy was argued as reliant on students undertaking their own technological practice and analysing both this and the practice of others. Technological practice was viewed as the vehicle by which students developed technological literacy. This was achieved by students being involved in activities that inter-linked the three strands of technological knowledge and understanding, technological capability and technology and society.

In an endeavour to provide guidance for teachers to support their students developing technological literacy, classroom based research became focused on developing a better understanding of technological practice. Technological practice was defined as that resulting activity that students could engage in when learning opportunities were based on all three strands of the 1995 technology curriculum - technological knowledge and understanding, technological capability and technology and society.

As a result of 10 years of research data on the implementation of the 1995 technology curriculum, the *New Zealand Curriculum Framework Stocktake* information and information coming from an analysis of NCEA technology results, it had became increasingly evident that the nature of technological literacy being developed by students was somewhat limited in breadth

[14] Members of the Technology Writing Group were: Alister Jones, Bev France, Cheryl Pym, Cliff Harwood, Dave Kennedy, Glynn McGregor, Grant Miles, Heather Bell, Heather McIntyre, Kay Collins, Geoff Keith, Kendra Greenwood, Mike Forret, Niall Dinning, Rebecca Waugh, Vicki Compton.

and depth. It also lacked the level of informed critical analysis behind decision making. It was considered this was largely due to the focus on developing students' understandings of and about technology from within the context of their own technological practice – students spent all their time learning 'in' technology and little if any time learning 'about' technology.

As a consequence of these findings the TWG sought to redefine the aim of the technology curriculum and revise its constructs as part of the New Zealand Curriculum Marautanga Project (NZCMP). The realisation that teaching technological practice on its own could not support the development of a broad, deep and critical technological literacy led to an argument to provide opportunities for increasing students' understanding at a philosophical level, and for developing their understanding of more clearly defined technological knowledge (Compton 2004, Compton and Jones 2004). This resulted in a decision to restructure technology education in the New Zealand curriculum around three new strands: technological practice, the nature of technology; and technological knowledge.

Vicki Compton and Cliff Harwood were approached by the Ministry of Education to develop initial drafts of potential levelled achievement objectives for the technological practice strand. This was to be based on their earlier TEALS Indicators of progression for Brief Development, Planning for Practice and Outcome Development and Evaluation. These were provided to the TWG to debate and develop further.

The TKNoT research findings with regard to the components of the 'technological knowledge' and 'nature of technology' strands were also provided to the TWG, to develop into achievement objectives.

THE NEW ZEALAND CURRICULUM: DRAFT FOR CONSULTATION 2006

The New Zealand Curriculum: Draft for Consultation issued to schools in June 2006 contained a vision, principles, values and key competencies. The vision supported the development of young people who were confident, connected, lifelong learners actively involved in a range of lifelong contexts. It positioned students at the centre of their education and strived to ensure each student was provided with the opportunity to reach their potential.

The focus of the document was on continuing to raise levels of achievement in the early years of schooling. Foundation skills of literacy and numeracy continued to be at the heart of the curriculum. Eight learning areas were provided for, each with an introductory statement and levelled achievement objectives.

Within this Draft, the Technology Learning Area contained an introductory statement and levelled achievement objectives for the technological practice strand only, with space shown for the two new strands. This reflected the fact the research on the components for these strands was still in progress. As a result, the achievement objectives for 'technological knowledge' and 'nature of technology' strands, were published separately in October 2006, along with a reprint of technological practice. This was to cause some confusion within the consultation process and in the analysis of responses.

DESCRIPTION OF THE THREE STRANDS PUBLISHED FOR CONSULTATION IN OCTOBER 2006

The *Technological Practice* strand was to provide opportunity for students to examine the practice of others and undertake their own technological practice to design and develop outcomes. Technological practice included identifying and investigating issues and existing outcomes to ensure their own practice was informed by that of the past and from different cultural and ideological perspectives. It also included consideration of ethics, legal requirements, protocols, codes of practice, and the needs of and potential impacts on stakeholders and the environment. Through technological practice, students would design, develop and communicate a range of outcomes, including concepts, plans, briefs, technological models and fully implemented technological outcomes.

The curriculum components identified for this strand were:

- brief development
- planning for practice
- outcome development and evaluation.

the technological practice strand may be referred to as dealing with the *Know How* aspects of technology.

The *Nature of Technology* strand was to provide opportunity for students to develop a philosophical understanding of technology, including how it was different from other domains of human activity. This strand supported the development of an understanding of technology that was critical in nature, and allowed for informed debate of historical and contemporary issues and future scenarios.

The curriculum components identified for this strand were:

- characteristics of technology
- characteristics of technological outcomes
- the nature of technology strand may be referred to as dealing with the *Know Why* aspects of technology.

The *Technological Knowledge* strand was to provide opportunity for students to develop understandings of 'how things work' and develop technological knowledge specific to technological endeavours and environments. Key ideas that cross all technological contexts included in this strand were: technological modelling; product development including materials use and development; and the components of technological systems and how they interact.

The curriculum components identified for this strand were:

- technological modeling
- technological products
- technological systems.

The technological knowledge strand may be referred to as dealing with the *Know What* aspects of technology.

Feedback on the Technology Learning Area in The New Zealand Curriculum: Draft for Consultation 2006

There was widespread feedback on the *Draft New Zealand Curriculum* following one of the most comprehensive consultation processes undertaken by the Ministry of Education. The Ministry received more than 10,000 submissions in response. These were collated and analysed and were taken into consideration in the development of the final New Zealand Curriculum. There was feedback from teachers, schools, tertiary education institutions, business and industry on *The New Zealand Curriculum: Draft for Consultation 2006.*

A total of 4328 questionnaires referring specifically to the Technology Introductory Statement and 1677 referring specifically to the Technology Achievement Objectives were received. As indicated above, there was some confusion as to whether the comments referred to the incomplete July 2006 version, or the complete October 2006 version. The responses were re-analysed in an attempt to establish to which version they were referring. However, this was not always possible as many submissions were not dated and comments were very general.

A total of 52 short submissions (3 pages or less) that included some reference to technology were received. In total 174 long submissions were received. Thirty-one long submissions with sections related to the Technology Introductory Statement, and 12 long submissions with sections related to the Technology Achievement Objectives were collated. Again, these submissions were re-analysed to ascertain whether they were related to the July 2006 version or the October 2006 version.

Two international reviews were sought and completed (Le Matais, 2007; Ferguson, 2007) and an additional four reports (Flockton, 2007; Aitken, 2007; Patara, 2007; Doig, 2007) were commissioned by the Ministry of Education to gain different perspectives and recommendations from the data. These reviews and reports included an analysis of the feedback on technology. Some rather critical comments on technology in these reports were however based on the incomplete July version, specifically referring to its 'incomplete' nature.

An analysis of the feedback showed that the two new strands generally received good support. The main criticisms were focused around the concern that technology was not 'practical' enough, the 'jargon' used made it difficult for teachers to interact with the ideas being presented, and the lack of explanation or detail for the new components – particularly those within the technological knowledge strand. Many respondents expressed a strong need for second tier support. In particular, comments showed a need and desire for targeted professional development support. These comments were from all sectors and came from those commenting positively and negatively.

Based on the reports and feedback, the TWG revised the introductory learning area statement and achievement objectives. It also recommended the Ministry of Education prioritise the development of professional development programmes and resources.

THE NEW ZEALAND CURRICULUM (2007)

The New Zealand Curriculum (NZC) was published in its final form in late 2007. Like the Draft, the *NZC* places learners at the centre of the learning process and emphasises the importance of literacy and numeracy and of a broad education across a number of learning areas including technology. It describes the key competencies needed in order to live, learn, work and contribute as active members of society. The *NZC* states succinctly what each learning area is about and how its learning is structured. The sets of achievement objectives were carefully revised by teams of academics and teachers to ensure that they were current, relevant, and well-defined outcomes for students. The *NZC* gives schools the flexibility to actively involve students in what they learn, how it is taught and how the learning is assessed. It invites schools to embrace the challenge of designing relevant and meaningful learning programmes that motivate and engage all students.

The technology learning area in the *NZC* maintained the structure, focus and intent of the October 2006 Draft, but attempted to communicate this more effectively. It clearly emphasised the importance of students knowing **how** to develop products and systems themselves, understanding **what** knowledge and techniques are involved in the development of technologies generally, and knowing **why** technology is so important in today's world.

The learning area statement recommends that while teaching and learning programmes should integrate all three strands, specific units of work might focus on one or two strands at a time. This sought to increase manageability for teachers and ensure students were provided with learning experiences that progressed their context specific knowledge, skills and knowledge and practice. It was also suggested that the current requirement for schools to deliver a specified number of technological areas be replaced with the expectation that students experience a broad range of technology-related contexts. This would give schools the flexibility to develop innovative programmes that reflected their unique communities.

THE GIF - TECHNOLOGY EDUCATION INITIATIVE

A proposal requesting support from the Growth and Innovation Framework (GIF) for Technology Education was developed and approved in 2004. Funding for the initiative came from the Ministry of Economic Development (MED) and was allocated to the Ministry of Education. The funding was for a ten year period from July 2003 to June 2013.

The *GIF – Technology Education Initiative* was launched in April 2005 to help raise the quality and effectiveness of teaching and learning in senior secondary school technology courses - and so increase student participation. It aimed to build teacher capability in technology education through a focus on quality teaching, inunovative environments and supportive relationships. It also aimed to improve the alignment between secondary and tertiary technology education, and encourage more interaction with the 'enterprise' community.

A reference group was established to guide the initiative. The initiative is ongoing and is managed, under contract, to the Ministry of Education. The project manager, Niall Dinning, is contracted as National Coordinator for Technology Education to manage technology related projects, communicate with the sector and develop the strategic direction for technology education. The initiative is positioned within the Ministry of Education's Secondary Outcomes team in the Schooling Group.

A number of GIF - Technology projects are underway. Key projects established to date include:

- Technology Beacon Practice Project (now completed)
- materials development
- curriculum leader support
- research
- curriculum support package
- promotion of technology education
- National Technology Professional Development Manager
- Techlink website (www.techlink.org.nz)

BEACON PRACTICE TECHNOLOGY (BPT) PROJECT

The framework for Beacon Practice Technology Project was developed following analysis of the evaluations from the Beacon Schools initiative in England and similar initiatives in Australia. The project aimed to build teacher capability in technology education. It provided support to teachers who demonstrated best practice in technology education and showed a willingness to further progress this. Participating schools were provided with funding (20% of a fulltime equivalent) over a two-year period to release teachers from the classroom. Outside facilitation and support was provided to teachers through the Project's Professional Support Facilitation www.techlink.org.nz/GIF-tech-education/beacon-practice/prof-support.htm. The support personnel included:

- professional support facilitators
- researchers
- writers
- tertiary and industry technologists.

The project was interventionist in nature. Facilitators undertook research to identify what teachers and their students were doing well and determined areas for further development. On the basis of their findings, facilitators effectively supported and mentored teachers to thoroughly embed and extend technological practice in technology programmes and to provide a basis for materials development.

The first phase of the project began in 2005 and involved 7 initiatives in 13 schools; in Hamilton, Katikati, Pahiatua, Tauranga, Gisborne, Havelock North, Wellington and Christchurch (www.techlink.org.nz/GIF-tech-education/). The second phase of the project began in 2006 with the addition of a further 9 schools in Auckland, Waikato and Nelson.

Professional writers were employed to develop a range of teacher and student resources and, as a result, case studies from these schools were published between 2006 and 2009.

The case studies focused on such things as:

- individual and/or class learning outcomes achieved as a result of participation
- teaching programmes that enable student learning to be identified
- the establishment of school industry partnerships
- examples of the benefits of having students mentored by professional technologists
- strategies for assessing student learning.

The project concluded at the end of 2007 but case studies based on this initiative are still being developed.

Materials Development

This project sources material directly from the Technology Beacon Practice Project and from a range of other schools and develops a range of materials designed to support technology teachers, which are then made available on the Techlink website. Student showcases that highlight the achievements of students in technology are also being developed by the materials development team. These showcases are being drawn from the Beacon Practice projects as well as from students outside of this initiative.

Curriculum Leader Support

Curriculum Leader workshops have been conducted throughout the country since 2006. These workshops have been well received. The aim of these is to support technology middle managers (Heads of Department/Faculty in the secondary sector or Leaders of Technology in the primary sector) in schools. The project is working closely with the local school support services.

Research and Curriculum Support

As mentioned earlier the GIF - Technology Education Initiative contributed funding for the Curriculum Project TKNoT research in partnership with the Ministry of Education. The Initiative also provided funding for the Technological Knowledge and the Nature of Technology: Implications for teaching and learning (TKNoT: Imps) research 2008 – 2010.

In recognition of the need to provide teachers with in-depth support, the Initiative provided funding for a Technology Curriculum Support Package which was developed and published at the release of the 2007 curriculum. This package will be revised as required.

Promotion of Technology Education

A communications person is employed as part of the Materials Development contract to liaise with key stakeholder groups. A series of promotional materials have also been developed and disseminated to schools, parents and wide community interest groups. PDFs of these brochures are available for download off the Techlink website.

National Technology Professional Development Manager

In 2007 a National Technology Professional Development Manager role was developed, and Cliff Harwood was appointed. This role is to provide leadership in teacher professional development including working with technology advisers and pre-service lecturers attached to the schools of education at the universities. The main aims of this work is to establish a sustainable self-managing professional learning community across pre-service and in-service technology education, to develop consistency of understandings within this community, and to support regional teacher professional development programmes.

Techlink Website

The Techlink Website (www.techlink.org.nz) was established by the Institution of Professional Engineers New Zealand (IPENZ) in 2003, with support from New Zealand Trade and Enterprise, through the Enterprise Culture & Skills Activities Fund. IPENZ has been very supportive of technology education in schools particularly since the current CEO Andrew Cleland became involved. It has been particularly concerned that technology based programmes at the senior secondary school should link with those in the tertiary sector, and created the position of Director-Schools, currently held by Angela Christie. IPENZ membership has provided thoughtful comment on technology curriculum statements and has provided ongoing support and interest in curriculum initiatives in technology.

In 2005 a partnership between the Ministry of Education and IPENZ resulted in the continued development of Techlink to provide resource material to support the planning and implementation of programmes in technology education, and case studies of classroom practice. Techlink showcases examples of contemporary teaching and learning in technology, and provides support for teachers in their planning and implementation of classroom programmes. On average it receives over 1000 hits a month. Techlink has a Project Coordinator, Glynn McGregor, who works with writers and web developers to identify best practice stories, write them up and present them on the website.

The case studies on the Techlink site are divided into four main areas - Technological Practice; Beacon Practice; Enterprise Links; and Classroom Practice.

Technological Practice case studies (www.techlink.org.nz/Case-studies/Technological-practice/index.htm) tell the stories of industry technological projects from throughout New Zealand and provide an excellent classroom resource for Technology teachers to use as examples of product, process and problem-solving in technological practice, and to celebrate the excellence of innovative New Zealanders. These case studies provide examples of the three components of technological practice. In the future these will also exemplify the five components of the two new strands.

Case studies have been developed from the experience gained in the Beacon Practice project and these are presented in a range of formats, including case studies of classroom work and of specific teacher practice.

Enterprise links case studies (www.techlink.org.nz/Case-studies/enterprise/) show how teachers initiated, maintained and benefited from interactions between their students and organisations or industries, and illustrate how technological skills are relevant in careers and business practice.

Classroom Practice case studies (www.techlink.org.nz/Case-studies/Classroom-practice/index.htm) provide examples of how teachers from a range of schools have worked with technologists to plan and implement quality technology units. They include projects from all levels of teaching - from year 1 to year 13.

The site also has material to support curriculum leaders in promoting their subject within schools and to their local communities, and provides current news about technology and technology education.

MORST BIOTECHNOLOGY LEARNING HUB

Biotechnology was one of the technological areas specified in the 1995 technology curriculum. It was an area where there was little support material for teachers. In 2004 MoRST contracted the University of Waikato to set up the Biotechnology Learning Hub. Alister Jones led the project. The aim of the hub was to support the flow of quality resources from the biotechnology sector to schools in a way that met the needs of teachers and students. It was one of the key actions signalled in the New Zealand Biotechnology Strategy. The cross fertilisation of the science and technology curriculum is encouraged by the Hub. This is a successful initiative judged by responses of particularly science teachers who have made use of the resources.

InSiTE (Classroom Interactions in Science and Technology Education) Research

This was a three-year study from 2005 to 2008 based at the University of Waikato and funded through the Teaching and Learning Research Initiative. The goal of this three-year collaborative research project was to develop a more robust understanding of the interactions between teachers, students, the important ideas and attitudes of science and technology, and the tools and knowledge that teachers use to support student learning. This longitudinal study was carried out in 6 schools with groups of teachers and their students (years 1-8).

The researchers reported that for teachers, undertaking assessment for learning is demanding and complex. To assess and respond to student learning, teachers needed a detailed understanding of possible student learning pathways, along with the ability to develop and deploy pedagogical strategies to ascertain students' current understandings and to move their learning forward. The blending of teacher content knowledge and pedagogical knowledge to a form appropriate for their particular students is commonly referred to as pedagogical content knowledge (PCK) (Shulman, 1987). New Zealand primary teachers indicated that they can lack confidence in their ability to teach science and technology and that they are interested in developing their practice in these areas (McGee et al., 2003). This project built on that interest.

The project involved working with teachers and cohorts of students in years 1–8 classrooms to investigate and to identify over time:

- subject ideas that teachers perceive as important for student learning in science and technology
- pertinent teacher pedagogical content knowledge, its sources, development, and the ways it is embodied in teacher–student interactions

- the structure of interactions around science and technology ideas, the factors that afford and constrain interactions and the implications of this for the construction/ constitution of what it means to know, do, and understand science and technology
- student and teacher perspectives of interactions that support learning
- the temporal aspects of the teaching and learning of science and technology as these play out for student learning (including conceptual, procedural and attitudinal outcomes)
- student understandings.

The InSiTE project has made more explicit some of the subject-specific pedagogical content knowledge teachers need to interact with students in ways that support and enhance student understanding of diverse groups of students.

MINISTRY OF EDUCATION IMPLEMENTATION SUPPORT FOR THE TECHNOLOGY CURRICULUM

Support Package

A package to support schools and teachers with the implementation of the technology curriculum in *The New Zealand Curriculum* (2007) was (and still is) available on the Techlink website and some papers are available on the TKI website. The package was developed in response to teachers' concerns expressed in feedback on the draft technology curriculum. The high level of interest shown in the web-based materials is reflected in the Techlink web statistics which show an average of 1,000 hits a month with well over 1,000 downloads of the whole document to date in PDF format.

The papers included in this package were developed by Vicki Compton during 2007, under contract to the Ministry of Education, to explain and exemplify the underpinning ideas within the technology learning area in *The New Zealand Curriculum (2007)*. They reflect a significant body of New Zealand and overseas research and classroom practice in technology education.

The contents of the package included:

- Ministry of Education Overview
- Ministry of Education Guidance
- Explanation of Terms
- A New Technological Literacy
- Explanatory Papers
    - The Technological Practice Strand: Brief Development
    - The Technological Practice Strand: Planning for Practice
    - The Technological Practice Strand: Outcome Development and Evaluation
    - The Nature of Technology Strand: Characteristics of Technological Outcomes
    - The Nature of Technology Strand: Characteristics of Technology
    - The Technological Knowledge Strand: Technological Modelling
    - The Technological Knowledge Strand: Technological Products
    - The Technological Knowledge Strand: Technological Systems
- Technology Indicators of Progression
- Technology Programme Design
    - Discussion ideas for future programme development
- Technology and Values:
    - Initial discussion of the relationship
- Technology and Key Competencies
    - Initial discussion of the relationship

The indicators of progression for technological practice have also been made available as part of this package by Vicki Compton and Cliff Harwood.

Research

The University of Auckland is currently working under contract to the Ministry of Education to undertake classroom-based research in a three-year project called the Technological Knowledge and Nature of Technology: Implications for teaching and learning (TKNoT: Imps). This project is funded from the GIF - Technology Initiative. The focus of this research is on developing understandings and illustrative examples of the five components within the two new strands of the revised technology curriculum – Technological Knowledge (TK) and Nature of Technology (NoT). The Project Director and senior researcher is Vicki Compton. The professional development facilitator and researcher is Ange Compton.

Classroom research will be undertaken in schools throughout New Zealand across a range of deciles and school types. The research will determine students' current understandings of these components, to explore pedagogical strategies that would enhance student understandings of these, and capture illustrative examples of student attainment that can validate indicators of progressions for the achievement objectives of these components across Levels 1-8 of *The New Zealand Curriculum* (2007). Effective pedagogical strategies will be documented in the form of case studies to provide material for future resource development.

The set-up phase of the research is progressing as planned and a total of 39 teachers have been selected as teacher participants.

The overarching Ministry of Education purpose of the TKNoT: Imps project is:

> "… to provide an understanding of appropriate and effective pedagogical strategies and content to support the reviewed technology curriculum. The purpose of the materials development is to support teachers and inform practice across the sector."

INTERNATIONAL TRENDS

In the last few years there has been considerable international research related to the philosophy of technology, defining technological literacy and establishing the nature of technology education. New Zealand research has contributed to this background. The philosophy of technology is a fairly young discipline compared to, for example, the philosophy of science.

A useful publication in this area is *Defining Technological Literacy*, (2006) John R Dakers, Palgrave McMillan, England. The 20 contributors are all well known researchers in the technology education field.

> The researchers and educators in the technology education field believe that we must guide young peoples' learning towards developing a critical awareness of what it is to live in a technologically mediated world. They state that "Technology education needs to engage young people in the discourse surrounding technology. Young people need to see the benefits of technology as well as the potential dangers it can harbour" (Dakers 2006 pg 2).

Professor Marc de Vries, who has been actively involved within the international technology education community over a long period of time, visited New Zealand recently and had discussions with educators, researchers and the Minister of Education. He was the assistant professor in philosophy of technology at Eindhoven University of Technology, and an affiliate professor for reformational philosophy at Delft University of Technology. He now holds the position of Professor of Science and Technology Education at Delft University of Technology. De Vries is the editor of the *International Journal of Technology and Design Education* and one of the founders of the PATT conferences mentioned earlier. In the discussions in New Zealand he stated that "Technology education has now been introduced as a new learning area across a very large number of countries. In many other countries this already existing curriculum area has undergone drastic revision." De Vries observed that the common aim of technology education is now, "to provide future citizens with the necessary knowledge, skills and attitudes to live in a technological society and to stimulate technological careers as a contribution to economic development". "This means" he said, "that technology education is primarily a contribution to general education, but it also can be regarded as preparatory for 'engineering' education."

De Vries was able to reflect on the success that New Zealand has had in incorporating experience from other countries in its development of a technology curriculum in which there is a balance across the learning of concepts and processes related to technology. He pointed out that, "What is fairly unique in the New Zealand approach is the combination of curriculum development, teacher education and educational research".

De Vries emphasised his view that, for the future of technology education, it is extremely important that a research and development culture is maintained that supports the learning area. He stated that "This is currently the case in New Zealand and for that reason the rest of the world's 'technology education eyes' are now on New Zealand. In New Zealand there is a unique opportunity to set an example internationally of how to develop a sustainable learning area that in the course of time will prove to have measurable benefits."

A concern is that there is little current research related to the implementation of technology education in schools in the OECD countries. A most useful reference is the International *Handbook of Technology Education - Reviewing the Past Twenty Years* (2006) edited by Marc de Vries and Ilja Mottier, Sense Publications, The Netherlands. This publication discusses the implementation of technology education in USA, Canada, Australia, New Zealand, England, Scotland, Japan, Hong Kong, Czech Republic, Germany, Finland and Malta.

De Vries, in the introduction to this publication, lists six areas of progress in technology education internationally in the last 20 years:

> "The first area of progress is in the philosophical basis for technology education. Two types of progress are visible here - the first is in the evolution of the philosophy of technology as a disciplinary field and the second related area is that technology educators have become interested in studying the philosophy of technology education.
>
> The second area of progress is the scope and content of technology education in the school curriculum. Here a movement has taken place from a position in which technology education has a narrow focus, being mainly about craft skills, towards a situation in which teaching about technology also takes into account the social aspects of technology and the more cognitive, conceptual and epistemic aspects of technology.
>
> The third area of progress is in pedagogical development. Nowadays students are expected to develop their own ideas about technology starting from intuitive ideas and progressing towards ideas that have been learnt in authentic situations.
>
> A fourth area of progress in the overall development of technology education worldwide is in educational research – several countries have undertaken a range of research projects and there are now several scholarly journals publishing research findings in technology education.
>
> The fifth area of progress is in the assessment of technology education. (However, this is an area where de Vries considers there is still work to be done.)
>
> The sixth area is in the international communication and cooperation in technology education. The past two decades have seen the emergence of a number of international conferences and projects (PATT, WOCATE, ITEA)."

SUMMARY

Technology education is a relatively new area of learning in all countries. There has been a great deal of progress over the last 20 years. There are large numbers of teachers and students enthusiastic about technology education. In some countries there are threats to technology education but these are more than balanced by success stories in other countries. Success is firstly dependent on having knowledgeable and enthusiastic teachers supported by funding from governments for research, teacher professional development and resources. Secondly, it is dependent on having strong links with practising technologists who can share their knowledge and experience with researchers, educators, teachers and students.

PART 4: Issues - Historical and Current

A major constraining factor facing almost all countries in introducing technology education was that they were working from a position of limited provision and experience. This was in contrast to most other curriculum developments where there was not only a sound research base but also a tradition with definitions, a content base and teaching strategies already developed.

The following sections discuss some of the issues and concerns that have arisen during the introduction and implementation of technology education in New Zealand schools.

PRINCIPALS' UNDERSTANDING AND SUPPORT

The success of any curriculum initiative depends to a large extent on principals having sufficient understanding of the aims, objectives and goals of an initiative to be able to lead the implementation of the initiative in their schools. Some school principals and school trustees in the 1990s appeared to have only a partial understanding of the new curriculum and/or considered it was a short-term politically-driven initiative which would not proceed to full implementation. Even in the late 2000s there is weak support from some principals who would prefer to see 'technology' disappear or remain as a technicraft subject.

When funding for professional development in technology was approved in the 1994 budget, discussions were held regarding professional development for principals. Principals at the time stated they were too busy with the implementation of other curriculum initiatives to have the time to attend in-service courses in technology education. In hindsight the Ministry of Education should still have provided courses as the implementation of technology education, a new essential learning area, would have been more successful if all principals had understood the intent of the new curriculum and how it differed in nature and delivery from traditional technical education. They needed to understand and appreciate that successful implementation would be enhanced by a team teaching approach involving particularly science, social science and technical teachers as there were no New Zealand trained technology graduates at that time.

ACCOMMODATING TECHNOLOGY INTO EXISTING CURRICULUM STRUCTURES

There was initial resistance to the introduction of technology in many secondary schools. The main difficulty was that other curriculum changes were more easily accommodated into existing curriculum structures (eg. timetable) but technology required new arrangements. This was sometimes perceived as a threat to established subjects/ departments and the teachers themselves.

Many secondary schools continued to characterise the junior curriculum as having 'core' and 'options' subjects despite the removal of this distinction from the Curriculum Framework in 1993 and from regulations in 1998. It appeared then that a significant number of secondary schools were non-compliant with the revised regulations in that they did not ensure that all year 9 and 10 students had technology education as part of their core curriculum. They sought to cover the requirement with a range of options or short courses leading, in many cases, to an uncoordinated smorgasbord of one-off units in technology rather than a coherent programme of learning.

Because of industrial and resourcing issues, mentioned later, only a very small proportion of secondary teachers were involved in the wide-scale technology teacher professional development programmes offered during 1995-99. This, alongside a lack of senior secondary qualifications being available for technology at that time, accounts for the poor uptake of technology by secondary schools. An ERO report prepared in 1998 to inform the decision to 'gazette' the technology curriculum concluded that teacher readiness to implement the curriculum was closely related to their participation in national professional development programmes.

Due to the non-availability of qualifications in senior secondary for technology prior to the introduction of the NCEA teachers and school management perceived that junior technology programmes had nowhere to go in the senior school. They therefore used this situation as an excuse to justify their non-adoption of technology into the secondary school curriculum. The Ministry of Education's withdrawal of focused professional development support for secondary schools in 1997 was also considered by many secondary principals as a signal that technology was not all that important.

This situation was compounded where the technology teachers who were formerly responsible for workshop subjects were charged with implementing the whole range of technological areas in the new curriculum. Those who were willing to take on this responsibility often lacked the background knowledge in some technological areas (eg, biotechnology, electronics). The relevant knowledge may have been held by science teachers but was not made available to technology, and/or the technology teachers remained committed to teaching a technical skills-based course to students.

There was also some confusion about the resourcing requirements of technology versus the need for computers/ICT for use across the curriculum. To many people in the wider community, technology education still meant computers – that is, technology for learning rather than learning in and about technology.

SCHOOL FACILITIES

At the time of the introduction of the 1995 technology curriculum there were concerns regarding the upgrading of facilities in secondary schools and in former 'manual training centres', to make them more suited to the delivery of the practical aspects of technology education - the development of students' technological capability in the various technological areas.

This was addressed through the Ministry's policies involving close liaison between property and curriculum staff and technology teachers. It resulted in the development of architectural guidelines for technology education facilities. These were published in 1998 to assist schools in designing and planning new or refurbished facilities, and were well received by the sector as their focus on flexibility of use through the recommended design supported implementation of technology but did not inhibit practical work spaces. The guidelines were field tested by Ministry District Property Officers. Some impressive new facilities have been built in recent years, eg. at Tauranga Intermediate School and at several girls' high schools which formerly had no 'workshops'.

EDUCATION FORUM REPORTS

From 1994 the Education Forum, a lobby group with links to the New Zealand Business Round Table, published a series of critical reviews of the New Zealand curriculum draft and final essential learning areas statements beginning with English, followed by Mathematics and, thirdly, Science and Technology.

The Science and Technology report stated that "science and technology were related in a number of complex ways, and working out these relationships and their implications was essential to the establishment of a respected place for technology education in New Zealand schools".

It suggested "the technology curriculum needed a narrower and more sharply focussed set of objectives, learning and assessment activities". The report concluded that "a respected place for technology within school curricula was more likely to be secured if the aims and nature of technology education were widely shared amongst all involved – teachers from subject disciplines likely to contribute, parents, students, and potential employers".

The fourth critique published was a highly critical response to the *Technology in the New Zealand Curriculum Draft*. Although critical of the content of the technology curriculum statement, the Education Forum commended the New Zealand Government for including technology as one of the seven essential learning areas. Many of the Education Forum's concerns were related to who would teach technology. They were concerned that most technical teachers did not have the background to teach the requirements of the technology curriculum, particularly the more academic aspects. The Forum considered teachers would need far more specific guidance about what should be taught than was given in the draft curriculum statement. They also advised against cross curricular implementation partly because of the need for widespread teacher training and difficulties of getting teachers to work together.

The Forum described the curriculum as over ambitious – an ideal curriculum but beyond the average teacher to deliver – and unfocused – too open to local interpretation. They advocated a narrower technical and vocational approach with only two strands - Technological Knowledge and Designing and Making, rather than the six strands in the New Zealand draft curriculum statement. They were critical that design was not a major focus in the 1993 New Zealand draft technology curriculum statement.

The Forum considered that in the interests of enhancing the status of technology as a curriculum subject it would, as had happened in England and Wales, become overly intellectualised "emphasising problem solving skills, design and evaluation in complex or highly generalised contexts" (Bierhoff and Prais, 1992). It was suggested that this could fail to provide the academically inclined students with the opportunity to develop practical skills at a high level, and disadvantage and de-motivate the less able for whom the route to higher education might be through training associated with practical work.

More recently the position of the Education Forum is that the current technology curriculum needs scoping with a more 'practical focus'. The scoping group should include teachers, heads of departments, government officials, curriculum/technology experts and representatives from business and industry.

TRAINING OF TEACHERS/ RETRAINING FORMER MANUAL TEACHERS

For traditional workshop craft, text and information management, computing and home economics teachers, the change to being technology teachers has meant upskilling and a considerable shift in teaching approach. Some welcomed this as a career boost and an opportunity for technology education and themselves to gain in status. Others saw it as a threat to their traditional role in teaching skills related to trades, and in some cases, a threat to their continued employment. Some were thrust into the role of being responsible for technology education by principals who did not understand the need for a team approach to technology education as there were few specialised technology education trained graduates at that time. These teachers were often overwhelmed with the need to upskill personally, combined with a heavy teaching load and leadership role.

From 1995 to 1997 there was a major professional development programme. It was, however, a disappointment to the Ministry that few manual training and technical teachers chose to take up the professional development opportunities offered in the 1990s. Some reasons for this were principals' lack of understanding of technology, and some principals' and technical teachers' hopes that the technology was a 'nine-day wonder' that would disappear from the curriculum. Industrial issues including the G3+ salary issue mentioned below also discouraged technical trained teachers from embracing technology education.

It has been suggested that teaching technology should not have been too difficult for teachers who had already made the transition from teaching traditional technical education to teaching design technology under a technical education framework. (Harwood, 2002). These teachers had already begun to shift away from teaching knowledge and skills for their own sake, to teaching knowledge and skills to enable students to undertake informed and high quality technological practice, and begin to develop more generic technological understandings. For many technical teachers however, these shifts had not previously been made, and the requirement to do so was not clearly explained and/or accepted (Harwood, 2002). This resulted in many technical teachers feeling increasingly disempowered within the technology education community, with many choosing to focus on industry training programmes rather than general education technology.

Just as contemporary technological practice requires collaboration between numbers of experts from different backgrounds, the successful implementation of technology education also requires collaboration between a range of teachers with diverse backgrounds. Teachers from technical backgrounds are an important part of a successful technology team. They bring the domain specific knowledge and skills to support the practical aspects that are central to a well rounded technology education Harwood and Compton (2006).

Traditionally schools recruited technical teachers with workshop craft and home economics backgrounds. In the past there was an adequate supply of people with a trades background to meet schools' staffing needs. With the introduction of the technology curriculum, principals and boards of trustees came to realise that the knowledge required to teach technology was broader than what was required to teach workshop craft and home economics. Schools needed to teach technology either:

- using a team teaching approach involving science, social science and technical teachers (this also meant providing release time for teachers, particularly technical teachers, to attend teacher professional development courses); or
- by employing people with a technological practice background recruited out of industry. However, it was difficult to recruit practising technologists because of pay differentials and the need for them to undertake teacher training.

SALARY NEGOTIATIONS – THE G3 ISSUE

Unfortunately, the situation mentioned above was exacerbated by a growing industrial dispute about salaries in relation to qualifications. Many technology teachers were accepted into one-year secondary teacher education courses on the basis of their trade qualifications (eg. Advanced Trade Certificates - ATCs). This also placed them in the G3 qualifications band for salary purposes. An outcome of the PPTA (Post Primary Teachers' Association) secondary teachers pay contract settlement in 2002 was the creation of a new step/band - referred to as G3+ - for teachers with a substantive degree and a teaching qualification. Immediately after the contract was ratified it became clear that the teachers with qualifications such as ATCs were not eligible for the extra step. These teachers who had previously believed that their qualifications were regarded as 'degree equivalent' in the past were now aggrieved by the decision, and an industrial campaign was built with PPTA supporting their case. Some teachers talked about taking action against their employers (school boards of trustees) over the situation and also action against the PPTA and the Ministry as parties to the collective contract.

The outcome of this situation was that some teachers have undertaken further study to upgrade their qualifications so as to be paid at the G3+ rate while others have decided not to study to upgrade and continue to be unhappy that ATCs are not accepted for G3+.

TECHNOLOGY AND THE NCEA

The achievement standards developed for technology for the NCEA at Levels 1-3 effectively took the technology curriculum into the senior secondary school from 2002. Teacher professional development to support assessment against these achievement standards became, by default, curriculum professional development in technology for many secondary teachers. Few teachers of 'technology' had previously taught at Bursary level unless they taught Graphics or thought to offer design based technology through Art Design. The teachers were not simply learning about new assessment procedures in their subject but a whole new approach to the subject in terms of content, purpose and pedagogy. For many teachers it was the first time they had taught a year 13 class and/or prepared students for assessment at this level.

Some technology teachers were unhappy about the NCEA achievement standards in technology as they did not see them as providing sufficient focus on the practical skill that had traditionally been a focus of design technology/workshop technology for School Certificate and 6th Form Certificate. For this reason some teachers decided that the Technology Achievement Standards provided the excuse they had been seeking to use Industry Training Organisation (ITO) Unit Standards such as Automotive Engineering, Furniture and Carpentry instead of the Technology Achievement Standards as the basis for teaching, learning and assessment.

Disappointing NCEA Level 1 results in technology in its first year caused more teachers to revert to familiar courses focused on design and manufacture which could be assessed using ITO developed unit standards. These teachers were unlikely to offer courses based on Level 3 achievement standards in future years or to offer students courses leading to assessment for NZ Scholarship. This had the effect of discouraging students with both academic abilities and practical skills from studying technology in the senior secondary school.

Some technology teachers claimed the Achievement Standards were too academic and required students to do too much written work. However, this view has been challenged by Harwood who claims that in his experience as a teacher and moderator of School Certificate workshop technology, students often submitted at least as much, if not more, written work for their final assessments under this subject than that expected from Technology Achievement Standards.

The achievement standards were written, as was the curriculum, understanding that technology was a part of general education and therefore appropriate for students of all abilities. This was distinct from technical education which many people traditionally viewed as a subject for less academic students. Ongoing contestation around how best to provide for less academic students continues to impact on decision making about, and critique of, technology education. While the provision of learning opportunities and pathways for less academic students is a real issue – it should have no more to do with technology than any other learning area within general education. Current work is taking place to explore alternative pathways that will meet the needs of all students.

UNIVERSITY ENTRANCE

Up until 2005, Technology was not included in the list of approved subjects for University Entrance. This had the effect of some teachers, deans and career advisers discouraging students from taking senior technology courses, and some schools from even offering them. It also played a part in some teachers not up-skilling in order to be able to implement the requirements of the technology curriculum. In 2006 Technology was added to the list of approved subjects. Work is now underway to get technology listed as a desirable subject for university technology related programmes.

THE 'THEORETICAL VERSUS PRACTICAL' DEBATE

International recognition of the importance of the dynamic relationship between the theoretical and the practical within all learning has been particularly important to developments in technology education. The traditional separation of these aspects of learning in schools has, however, led to a perception of academic subjects being theoretical in nature and suitable for able students, while practical subjects are viewed as non-academic and suitable for less able students. Technology directly challenges this view as it combines **both** practical and theoretical and claims its space as an **academic** subject suitable for **all** students.

This continues to cause ongoing issues for technology education as different groups in the community seek to position technology back into the traditional separation, and thus focus only on its practical dimension and claim its theoretical dimension has no validity. This is further complicated by the additional view that less motivated or engaged students are by 'definition' practical. Technology is then not only critiqued in terms of having an irrelevant theoretical dimension, but also accused of failing to provide a place for these students.

Interestingly, many technology teachers would argue that the theoretical dimension was also important in earlier subjects such as Engineering Shopwork and Woodwork; that to be good with your hands has always required significant mental ability – you do not think with your hands!

Cliff Harwood, a researcher in technology education, a former technology adviser at Massey University, and a past moderator for Workshop Technology and Design Technology, argues in several papers that the 'academic' requirements on students studying technology education are no more demanding than those in the days of School Certificate. He states "Technology is a subject that should engage students in actively seeking to resolve authentic problems. It is not a textbook bound subject that can be taught in a theory room, nor is it a skills only subject where teachers 'instruct' students to follow steps and/or recipes. Rather, technology education requires that teachers provide opportunities within well supported learning environments for students to undertake technological practice whereby they will develop and demonstrate 'understanding' of technological knowledge and capability in skills."

However, some technology teachers are still concerned that students who are not academically inclined are neglected or discouraged by what they see as the overly theoretical requirements of the technology curriculum. As mentioned earlier, this has resulted in some teachers, particularly in the senior secondary school, offering courses largely based on ITO Unit Standards rather than the technology achievement objectives. Other teachers have developed courses using a mix of achievement standards and unit standards. Discussions are ongoing with ITOs to revise some of the unit standards to achieve a better alignment with the technology achievement standards. Shortly, work will commence to revise the achievement standards so they align with the achievement objectives in the technology learning area in *The New Zealand Curriculum* (2007). Together with teacher professional development this may lead to more teachers basing their technology education courses for students on the achievement objectives.

Understanding and undertaking technological practice is fundamental to student learning in technology education in New Zealand as is developing technological knowledge and a philosophical understanding of the nature of technology as a discipline. These three aspects support the enhancement of student technological literacy. The implementation of technology into New Zealand's core curriculum has reached the stage where it is essential that learning programmes are based on student progression to allow for a seamless education in technology from early primary to senior secondary. For this to occur teachers and students need to focus learning on the key features of technology education – that is the components of technological practice, technological knowledge and nature of technology.

POST PRIMARY TEACHERS' ASSOCIATION (PPTA) - CURRENT VIEWS

The PPTA stated its current view about the technology curriculum in a Submission on the Skills Strategy, June 2008.

> "Technology is a curriculum that provides the ideal opportunity for students to combine practical and theoretical learning. The curriculum actively encourages problem solving and innovation. However, the technology curriculum is a relatively new curriculum area and has been seriously under-resourced by the Ministry of Education as highlighted in the PPTA report *Technology: theory without practice* (2006) – (The recommendations of this report are attached as Appendix 2). It is not enough for the Ministry of Education to promote initiatives such as Youth Apprenticeships. They must also commit to resourcing technology delivery in secondary schools and technology centres to allow all students the opportunity to build a skills base in this curriculum area."

PART 5: Looking to the Future

INTRODUCTION

There is already ample evidence that, once they have overcome natural qualms about engaging with a whole new area of learning, students and teachers alike find technology education a rewarding experience for its own sake as well as for any useful outcomes that may be achieved.

In technology programmes, teachers and students are engaged in new kinds of learning, where they are usually not searching for the single right answer but rather developing appropriate solutions from multiple options. Teachers from different backgrounds can collaborate to plan and deliver units of work. Expertise from the community can be incorporated and learning can be situated within a range of authentic contexts in the school or wider community. Their technological solutions are often developed in response to authentic needs or opportunities and so their learning will be seen to connect very directly with life and work outside and beyond the school gate. Creativity, innovation and risk-taking are encouraged and technology provides rich opportunities for values to be explored and developed.

Experiences over the last ten years indicate that technology is a powerful learning area which supports integration of learning from a broad range of curricula and contexts. It has a strong focus on community and environmental links. The newly defined technological literacy can play an important role in relation to values education. It provides opportunity to both learn about values and to develop values related capability.

VISION FOR TECHNOLOGY

The technology learning area within *The New Zealand Curriculum* (2007) is a dynamic and future focused framework for teaching and learning in technology. It gives students challenging and exciting opportunities to build their skills and knowledge as they develop a range of outcomes through technological practice and develop technological knowledge and a greater understanding of technology in the world. They bring together practical and intellectual resources in creative, critical and informed ways to engage with the many technological challenges of today's world and of those in the possible future.

Technology education in New Zealand has a strong research foundation and the technology curriculum in *The New Zealand Curriculum* (2007) is internationally recognised as 'leading the way' when it comes to clearly describing the knowledge, skills and practices required for students to develop a comprehensive technological literacy. It allows teachers great flexibility, breadth and depth to develop learning opportunities that meet the needs and potential of their school communities and students.

The overarching vision is for seamless quality technology education programmes for all New Zealand students as part of their compulsory schooling and to further support technology programmes in Years 11-13. This sets challenges and opportunities for the whole technology education community, pre- and in-service educators, classroom teachers and the wider technology community. They are required in *The New Zealand Curriculum* to consider the needs of each individual student in their care and develop suitable programmes to meet these needs.

Three stages of literacy have been described as end points of key transition stages in New Zealand's Education System (Keith 2006). These are described as follows:

- as a compulsory learning area technology education helps all students develop a technological literacy for general citizenship. This includes students coming to an understanding of how technologies work, how technology impacts on people and also how to undertake technological practice
- initially post compulsory education in technology education helps students to extend this literacy to gain knowledge and skills that might prepare them for trade apprenticeships, service professions and for possible careers in technology related industries
- technology education in the senior secondary school provides a more specialised technological literacy, where students gain knowledge and skills that prepare them for tertiary courses and future professional careers in technology. These students may become future leaders of excellence through innovative technological practice.

CURRENT CONCERNS

Informal teacher reports (and a recent statement from National Education Monitoring Project (NEMP) co-director Terry Crooks) indicates that the strong emphasis on literacy and numeracy in primary schools means that subjects like science, social science and technology are being marginalized or given minimal time, and in some cases have disappeared from classroom programmes. This is a cause for concern and there is a need for teacher professional development related to helping teachers to use technology contexts to teach literacy and numeracy.

Technology education researchers and technology education advisers have suggested there needs to be a Technology Beacon Practice Project for the Primary sector. The project would aim to build teacher capability in technology education and would help to address the issue mentioned above. As the GIF - Technology funding is legally appropriated for Senior Secondary further funding would need to be sought for a Beacon Primary project.

A further concern is the level of Ministry of Education funding for teacher professional development directly related to the implementation of *The New Zealand Curriculum* and in particular the technology learning area. There is an ongoing need for policy work to analyse and address this issue.

Another concern is the level of technology in-service teacher education. At present there are only 6.5 full-time equivalent technology adviser positions and this is insufficient to meet the support needs of teachers and schools across New Zealand. Yet another concern is in the area of pre-service teacher education. There has been a significant reduction in time provided within initial primary teacher education for learning areas - including technology. The most common initial teacher education for secondary teachers is still a one year graduate course. All these teacher education issues lead to capability issues in the teacher workforce. Successful implementation of *The New Zealand Curriculum* is dependent on having knowledgeable and capable teachers.

Finally, teacher supply in the secondary sector is a major concern. Attempts are being made to address this through improved teacher recruitment scholarships. The impact of shortages of specialised technology staff in intermediate and secondary schools is a significant barrier to establishing seamless technology education, based on the 2007 curriculum, across the country.

Developing ongoing partnerships with the business, industry and tertiary sectors is one strategy being explored to address some of these concerns. For example, working with different organisations to sponsor/promote opportunities such as:

- resource development
- teacher training scholarships
- technology education events, e.g. science and technology weeks and technology challenges to highlight the importance of science and technology education for all and for economic growth.

ONGOING ROLE OF THE MINISTRY

For further progress in technology to occur it is likely that the Ministry of Education will need to encourage and support technology education in schools through developing policy for and/or implementation of:

- provision of teacher professional development based on research and best practice
- ongoing provision of teacher resources especially in Technological Knowledge and Nature of Technology curriculum strands
- research based evaluation into technology classrooms and specialist facilities in primary, intermediate and secondary schools
- research into the nature of current pedagogical practices and programme design and how this impacts on student learning.

It is likely that the Ministry of Education will need to continue to encourage partnerships that bring together the work of various technology education stakeholders. Groups can achieve far greater synergy by working together rather than working in isolation. Collaborative ventures need to be supported in ways which don't compromise each group's unique purpose, status and identity or create unnecessary tensions.

Work is already underway, initiated by the key technology related teacher associations (TENZ, NZGTTA, HETTANZ)[15] to coordinate their efforts with regard to support for technology teachers. They need to be encouraged to:

- share communication regarding successful technology education programmes
- contribute to each others' conferences; and
- develop opportunities through the technology curriculum for specific skill and knowledge sets to be supported and delivered through integrated technology programmes.

Partnerships that link the practicing technology sector with schools are encouraged by the Ministry of Education. Particularly in the senior secondary school, teachers and students need the opportunity of linking with practicing technologists.

TEACHER PROFESSIONAL DEVELOPMENT

The success of the new technology curriculum will be very dependent on:

- school principals and senior management teams having an understanding of technology education
- teachers who are knowledgeable, passionate and excited about technology education.

As described by Keith (2006) a Ministry of Education vision statement for this is to:

- "develop technology teachers who can teach in line with the principles of New Zealand's general education in ways that improve learning outcomes for all New Zealand students;
- develop a general teaching skill set for technology teachers similar to that required for a good teacher in any learning area that is in line with contemporary New Zealand practice; and
- develop a specialist skill set for technology teachers that is appropriate for the delivery of the special requirements of curriculum based technology across a range of contexts."

Appendix 3 lists desirable qualities of technology teachers. The material comes from a presentation Alister Jones (University of Waikato) made to a recent APEC meeting in Chile.

Technology Advisers

Technology advisers are employed through regional organisations that are part of the major universities. Though they are few in number they have a vital role to play in supporting teachers. Currently there are 6.5 equivalent full-time technology adviser positions spread over 14 people for the approximately 2570 primary, intermediate and secondary schools. This number is considered by technology educators insufficient to meet the support needs of teachers in a relatively new area of the curriculum.

The major future focus of the advisers' work is to continue to build teacher capability to develop, deliver and monitor quality learning programmes in technology education, with the aim of raising achievement levels of all students.

[15] Technology Education New Zealand (TENZ), the New Zealand Graphics and Technology Teachers Association (NZGTTA), and the Home Economics and Technology Teachers' Association (HETTANZ)

Ministry of Education guidance to ERO and Technology Advisers is that during 2008/09 particular emphasis needs to be on the technological practice strand with support being offered to ensure that student progression is assessed and reported against the new technological practice achievement objectives. Exploration of the concepts underpinning the Nature of Technology and Technological Knowledge will be encouraged but teachers have been advised it should not be the focus of assessment or reporting students' progress until the 2007 New Zealand Curriculum is implemented. Implementation will take place in 2010 for all students of years 1-10, and from 2011 for all students of years 11-13. From these dates schools will be expected to develop programmes for their students in technology that cover all three strands of the curriculum.

Work to support professional learning communities within and across schools needs to continue with an emphasis on building curriculum leaders' understandings of the technology curriculum and the technological literacy it aims to develop and enhancing their abilities to translate this into authentic learning opportunities for students under their management.

As part of the GIF - Technology Initiative as mentioned earlier, the Ministry of Education appointed a National Technology Professional Development Manager, Cliff Harwood. This role is particularly important for providing leadership in technology education and to ensure overall consistent national professional development.

CURRICULUM SUPPORT MATERIALS

Future initiatives proposed to provide curriculum support include:

- research on the implementation of the technology curriculum
- further classroom based research on *Te Kete Ipurangi (TKI)* – The Ministry of Education's Online Learning Centre
- further teacher print/web-based resources
- support for technology curriculum leaders
- a database of New Zealand research in technology.

There is a need to provide support materials related to the achievement objectives for each of the three strands for technology in *The New Zealand Curriculum* (2007). A concern expressed by some teachers is that these achievement objectives are expressed in 'academic' language – they are not teacher-friendly[16]. At present there is only classroom based support material for the technological practice strand. The achievement objectives for this strand are supported by indicators of progression that are far more teacher-friendly.

The current TKNoT: Imps research will provide indicators of progression for Technological Knowledge and Nature of Technology and in so doing will make them more teacher-friendly. This research will also provide illustrative examples of what student achievement looks like in these strands and what pedagogical practices have been useful in enhancing student learning within the five new components.

NCEA DEVELOPMENTS

The NCEA (National Certificate of Educational Achievement) has now been in place six years and many of the teething problems have been eliminated. The recent NCEA results show an increase in students achieving credit for technology achievement standards. However, this increase is almost entirely for internally assessed standards. There has also been a steady increase in the number of students receiving merit or excellence awards.

A concern is few teachers are entering students for the external standards because the teachers lack an understanding of the standards and therefore the confidence to prepare students for them. They are concerned of their reputation being damaged if the students do not achieve the standards. The current revision of the standards may serve to reduce this apprehension. The inclusion of technology within the list of University Entrance subjects in 2006 has also resulted in an increase in the numbers of students studying technology at the senior school level. Exemplar material is available on the Techlink website and new material is being added regularly.

A contract is likely to be let to Teacher Associations to revise the current NCEA Levels 1-3 Technology Achievement Standards so that they align with the Technology Achievement Objectives in *The New Zealand Curriculum* (2007). Technology Education New Zealand (TENZ), the Graphics and Technology Teachers Association (NZGTTA), and the Home Economics and Technology Teachers' Association (HETTANZ) are currently working together to put a proposal to the Ministry of Education to develop the new NCEA Achievement Standards for Technology. This is a very positive step to see the teachers' associations working together.

[16] This is partly due to the fact that over the last 20 years technology education has developed its own 'language' as does every other curriculum area.

RECRUITMENT AND RETENTION OF TEACHERS

The recruitment of capable and appropriately qualified technology teachers is an international concern. At the present time in New Zealand some schools are having difficulty in attracting suitably trained technology teachers. The Ministry of Education has begun to explore in depth these supply and capability issues in a more coherent and integrated way and over fifty 'TeachNZ Scholarships' have been awarded in technology for this year, 2008.

Some potential recruits from industry are being discouraged from entering teacher training by a qualifications bar imposed in 2003 as part of an industrial agreement. In response to this, a new degree qualification programme for technology was implemented at the University of Waikato in 2008. Other universities are also currently exploring opportunities to develop similar programmes. The Waikato qualification involves a flexible multiple entry and exit programme, and is being offered conjointly by the university and a polytechnic to meet the full range of technology teacher requirements; academically and in terms of teaching practice, and also for context specific skills and knowledge.

Currently all major teacher training institutions offer courses in technology education as part of the primary B.Ed (teaching) programme. A concern recently has been that most of these institutions have reduced the time given to technology education. This is partly because teacher education courses have been reduced from four years to three years, but also due to the six Colleges of Education each amalgamating with their respective universities and the extra focus that has gone on to lecturers being involved in research activities, alongside an increased emphasis on more 'generic' aspects of teaching.

Primary teaching degree technology education courses are reported as being between 20 and 30 hours in duration. This is cause for considerable concern amongst technology educators and technology interest groups such as Institution of Professional Engineers New Zealand (IPENZ) as they consider this time allocation is insufficient to give trainees the skills and knowledge to teach technology.

ROLE OF AGENCIES THAT SUPPORT TECHNOLOGY EDUCATION – RSNZ, IPENZ

The Royal Society of New Zealand (RSNZ) and the Institution of Professional Engineers New Zealand (IPENZ) have already played an important role in the development of technology education in New Zealand.

Royal Society of New Zealand

The Royal Society believes that technology education, both at the primary and secondary school level, is critically important to New Zealand's future, and it is through education we can develop a scientifically and technologically literate society able to utilise knowledge, skills and opportunities for our social, environmental and economic betterment. The Society, in its unique position as the interface between scientific and technological practice and education, is involved in a variety of initiatives with these as their ultimate goals. Examples of Royal Society programmes to achieve these goals are:

NZ Science, Mathematics and Technology Teacher Fellowships

A scheme by which teachers of science, mathematics, social sciences or technology are able to be released from school for up to one year to work on projects of their choice, hosted by industry or institutions such as tertiary institutions, local or territorial authorities, community groups or research institutes.

Realise the Dream

This is a national event that rewards and celebrates students who have demonstrated excellence in science and/or technology. With Genesis Energy as its major sponsor, Realise the Dream brings together students who have carried out excellent pieces of technological or scientific practice throughout New Zealand. These students engage in a programme of lectures, workshops, visits and presentations for a week in December, hosted by Victoria University of Wellington. Participants are selected from regional science and technology fairs, CREST Award scheme, Young Historians competition, Bright Sparks, Geography Problem-solving and Decision-making competitions, Invention NZ and a variety of other such activities.

CREST

CREST is a national awards programme for students in years 6 – 13 which provides a framework to support and enhance the quality of students' educational experience in science and technology within New Zealand. It encourages creativity and problem-solving. Undertaking a CREST Award gives students authentic experience in scientific investigation or technological practice of their own choice, working with an outside consultant/expert to investigate issues of real significance in their lives.

Institution of Professional Engineers New Zealand (IPENZ)

IPENZ works in schools under the brands *Transpower Neighbourhood Engineers'* and *Futureintech*. The features of the *Neighbourhood Engineers'* programme include the development and management of a relationship between engineers and schools to provide classroom-based assistance in teaching technology, and a national competition for the best technology project.

Futureintech has been funded by New Zealand Trade and Enterprise as one of a range of initiatives to significantly lift enrolments for tertiary study in technology, engineering and science over the medium to long term. Launched in 2003, *Futureintech* works directly with schools, industries and universities to help ensure that technology, maths and science teachers have the right resources to inform school students and inspire them to continue their study through to tertiary level. The approach is hands-on. Eight *Futureintech Regional Facilitators* work to engage industry support, and work with classroom teachers, careers advisers, students and their caregivers, within primary, intermediate and secondary schools throughout New Zealand.

Futureintech Ambassadors play a major role as industry role models in primary and secondary schools. Ambassadors are technologists, scientists, and engineers who are trained as volunteers to visit classrooms and work alongside students and teachers to support the curriculum. They are involved in highly successful initiatives throughout the country, helping students work on projects or towards NCEA standards, facilitating individual and class access to working environments and contributing to careers evenings.

Futureintech's website, www.futureintech.org.nz, is a key promotional tool for careers in technology, engineering and science, and a resource base for teachers, careers advisers, caregivers and students.

Other IPENZ community activities include:

- the development of resource material such as 'Matters of Principle'
- the development of case studies
- provision of engineering careers material for use in schools
- issuing 'Informatory Notes' on significant national issues from an engineering perspective. Recent notes cover issues such as school governance of the technology curriculum and managing innovation.

Techlink

The Techlink website www.techlink.org.nz is jointly funded by IPENZ and the Ministry of Education and hosted by IPENZ. It represents the best from IPENZ's long-term commitment to technology education and all the new developments and resources for technology educators. IPENZ brings a wealth of knowledge and experience in professional technology to the partnership and the Ministry's input ensures a quality collection of resources for technology education is available for New Zealand teachers.

The Techlink website is a very valuable resource for technology educators. The case studies provide examples of technology education in action. New case studies are added regularly as are updates on technology education developments. This initiative needs continued support. The Ministry of Education currently demonstrates a strong commitment to the development of resources for New Zealand technology teachers, and to the Techlink website.

Future roles of RSNZ and IPENZ

It is crucial that the support of these two organisations continues through:

- promotion of the importance of quality technology education – with the public, business and industry and government
- supporting dialogue and collaboration between industry, tertiary and the education sector
- supporting innovative projects in schools
- linking students and teachers with technologists in industry
- providing scholarships and programmes to give teachers opportunity to have experience in industry

- providing support materials for teachers and students
- encouraging members with an interest in passing on their skills to become technology teachers
- creating synergies with technology education in the ministry of education to further develop resources and other support for teachers of technology
- supporting science and technology fairs and similar events designed to provide opportunities for young people to be actively involved in research and innovation
- providing pathways for students with a flair for technology to enter professional careers in technology. these students, through innovative technological practice, may be crucial to the development of the Government goal, the transformation of New Zealand into a knowledge based economy and society.

Support in these areas will be important to the successful implementation of technology in schools.

Role of Tertiary Institutions

Massey, Auckland and Waikato Universities currently offer post graduate papers in technology education for teachers wishing to upgrade their knowledge and qualifications. They have also contributed to research in the technology area through tendering for contracts related to analysing what is happening in technology classrooms and developing models for teacher professional development.

Good quality teacher education needs to develop a general teaching skill set for technology teachers similar to that required in any learning area. They also need to develop a specialist skill set for technology teachers that is appropriate for the delivery of the special requirements of curriculum based technology across a range of programme contexts.

Successful implementation of the technology learning area of *The New Zealand Curriculum* wholly depends on having knowledgeable, capable and enthusiastic teachers.

The *Centre for Science & Technology Education Research* at the University of Waikato, was the early leader in New Zealand research into technology education under the direction of Alister Jones. The Centre has been continually involved in a variety of research projects in technology education since first developing the policy papers for technology education in 1992. This year, 2008, University of Waikato is also offering a four year flexible conjoint degree qualification for technology. Massey University and Auckland College of Education in the early 2000s, and more recently the University of Auckland, have played an important role in technology education research and in encouraging people to train as technology teachers. University of Canterbury is currently reconfiguring their teacher education programmes for technology – particularly with the aim of reintroducing a secondary programme and a four year multiple entry and exit undergraduate and post graduate programme in technology education.

There are opportunities for universities to explore links across their colleges/schools (ie teacher education and colleges/schools of engineering and/or science) and with polytechnics in the technology education areas to perhaps offer combined courses linking the academic and practical aspects of technology such as the new Waikato qualification mentioned earlier. This could help in addressing the current shortage of technology teachers in schools.

There are opportunities for tertiary institutions to encourage young people to undertake technology projects such as the CREST scheme which Massey University sponsored from 1988 to 1998. CREST is now facilitated by the Royal Society.

Both universities and polytechnics have an important role to play in preparing young people for future professional careers in technology.

Role of the Subject Teacher Associations

In Appendix 4 information is given about the three teacher associations that have shown a particular interest in technology education. It is important that these associations work together in the interests of technology education. They need to develop and share teacher resources, provide opportunity for members to participate in each other's conferences and encourage their teachers to work together in the school setting to provide coherent and challenging programmes for students.

Growth and Innovation Framework (GIF)

The GIF - Technology Initiative is a very significant project supporting technology education in New Zealand. GIF funding of $2.2 million per annum for technology education initiatives continues until 2013. The funding is managed within the Ministry of Education's secondary team, supported by a national reference group with the work delivered by contractors. The current scope of the initiative is targeted at senior secondary school.

However, the Ministry of Education recognises that success in technology education in the senior secondary school is almost entirely dependent on quality programmes both in primary schools and in secondary schools. The Ministry is now targeting some of this funding to programmes in the compulsory schooling area in line with the vision for seamless quality technology education from early childhood through to senior secondary. However, there is a risk of spreading the resource too thinly so further funding is being sought to address the needs of the primary sector.

An increase of funding should result in students having greater access to technological worlds, and through quality teaching, developing a deeper, broader and critical technological literacy.

Summary

In order to progress, New Zealand must continue to create wealth from products and services. This need is set in an increasingly competitive and globalised society and its currency is that of ideas and knowledge which together can produce innovation. New Zealanders live in an increasingly technological society and must be able to make sound decisions in relation to technology. These things can only happen if New Zealanders are technologically literate.

The development of technology education in New Zealand has been informed by continuing research initially about the nature of the subject, teacher and student perceptions of technology, and the professional development of teachers. Now a much greater focus is on classroom-based research related to students' development of technological knowledge and understandings of the nature of technology. The research field continues to grow both in New Zealand and internationally with an increased number of researchers and larger teams.

Technology education has become a compulsory component in all pre-service teacher education, and post graduate programmes in technology education are offered in three universities (University of Auckland, University of Waikato and Massey University). Increasing numbers of technology education trained graduates are entering the teaching profession.

Up until recently there have been extensive programmes of teacher professional development and 75% of teachers have reported they have been helpful (Curriculum Stocktake 2003). Across all school types two-thirds of teachers expressed a medium level of confidence in teaching technology and about one fifth a high level of confidence. Teachers have increasingly gained confidence in teaching technology although there is still some way to go. Teacher professional development needs to be the major focus for Ministry of Education support in the next few years – to bring the vision for technology education in *The New Zealand Curriculum* to fruition.

A wide range of resources for teachers have been made available either in print form or published on the Techlink website.

Through studying technology, students are encouraged to be innovative, creative and show initiative. They are excited about engaging in learning where they are not usually searching for a single right answer but developing appropriate solutions. A range of examples of excellent student work is featured on the Techlink website. Increasing numbers of students are studying technology in the senior secondary school. Not only does technology education provide the technological literacy necessary for informed participation in today's world but it also provides knowledge and skills useful in a variety of tertiary courses and paves the way to exciting career opportunities.

Links with industry and professional technologists have been developed and organisations such as the Royal Society and IPENZ have provided valuable support for both teachers and students. This support is continuing. Many business, industry and tertiary organisations are becoming increasingly supportive of technology education, both in terms of the need for technological literacy for all students and the need to meet future labour market requirements for technologists and other technology-related careers.

Technology education over the last 20 years has found a place in research, teacher education and classroom practice. Students are excited about technology education programmes and the opportunity to solve technological problems in innovative ways. However, there is a need for increased public understanding of the importance of technology education. It is vital that all New Zealand students develop a broad technological literacy that will equip them to participate in society as informed citizens and give them access to technology related careers. Technology education will also contribute directly and indirectly to New Zealand's future productivity and economic growth.

Conclusion - Looking Back and Looking Forward

LOOKING BACK

More than 30 years ago UNESCO challenged countries to introduce a new subject, technology, into the curriculum. The speed of technological change together with the need for young people to understand both the benefits and dangers of technology, led to this challenge. In the 1980s at national and international conferences, many scientists, engineers and educationalists campaigned for the introduction of technology education in schools. They believed young people needed an understanding of technology and the opportunities to develop technological capability.

A number of countries, including New Zealand, rose to the challenge. It was not to prove an easy challenge, partly because there was no philosophical basis for technology education and little international research regarding the critical elements of technology education. While countries had similar definitions of technology education, and agreed regarding the need for all students to develop technological literacy, there was wide variation in practice in countries, and within countries, in its implementation - see Appendix 1.

New Zealand benefited by not rushing to introduce technology into the curriculum. First there was a large amount of background work including visits to other countries already implementing technology education, discussions with universities and technologists, and the setting up of a strong research base prior to the development of the curriculum. A range of written materials and videos were distributed to all schools to generate discussion. Luckily for New Zealand there were teachers, policy makers, politicians, university personnel, practicing technologists, scientists and engineers who had the knowledge and enthusiasm to encourage the development. The introduction of the 1995 technology curriculum was a major step forward but it was recognised that there was much more to be done, including research into better defining the critical elements of technological literacy and technology education.

At that time it was also recognised that, as with the introduction of any new initiative, there was a need for extensive, ongoing and targeted teacher professional development to enable all teachers to adjust to the broader and more flexible approaches suggested in the technology curriculum, or develop specific knowledge and skills. It was disappointing that in the early years following the introduction of technology education many technical and manual training teachers decided not to take up the training offered because of industrial issues. However, some did, and this group has been providing leadership in this area for some years now. This group is growing in number as more teachers, and people coming in from industry, take up technology teacher training opportunities offered by various tertiary institutions, and TeachNZ scholarships offered by the Ministry of Education.

Also of importance is that there has been continuing research both here in New Zealand and overseas into the components of technological education including better defining technological knowledge and the nature of technology. New Zealand research is well recognised overseas and the new 2007 technology learning area in the New Zealand Curriculum is based on this increased understanding of technology education.

LOOKING FORWARD

The tale of technology education developments in New Zealand from 1985 to 2008 is one of visionary optimism for the development of a new learning area that might help support New Zealand's future economic growth and social needs, and of an opportunity for development taken when the time was right. This vision is what continues to drive the emerging maturity of technology education within the New Zealand school system.

It is also a tale of the challenges that await those who envisage such new things, as actual developments take place of course within the complex social arena of democratic contestation; about what technology is or ought to be, and of historically entrenched views about technology or inflated future expectations for it. All 'agreements to proceed' have to be achieved within the very leveling realities of the human and financial constraints and capabilities that affect progress in educational systems all around the world.

While New Zealand has much to be proud of in its developments in technology to date, there is still much to do. Those who care for this learning area will need to work together to ensure the growth of technology. The strong New Zealand research base has provided a stable foundation for technology and its ongoing refinements. Workforce capability and capacity issues are slowly being addressed. It is likely that evolving agreement between educators, researchers, industry groups and the Ministry to manage a fine balance of both practical and intellectual aspects within technology will prove a critical threshold for long term social acceptance of this young learning area within the education system and the wider community.

It will be most interesting to see how the next chapters unfold over the ensuing twenty three years of technology education...

Appendix 1: Differing Perspectives of Technology (as summarised from Black 1994 by Mather, 1995)

Technology as craft skills
Here the concept is primarily linked to making things via recipe step-by-step instructions. The educational purpose would seem vocationally orientated.

Technology as 'design and make'
The concept of technology is an expanded version of the 'Technology as Craft' in that whilst it is very skills orientated, it also incorporates elements of design as distinct from following a given recipe. Again the educational purpose is primarily vocational.

Technology as a subset of science
Here the concept of technology is essentially as applied science – reducing often to applied physics. That is, technology is the practical application of scientific knowledge and skill. Educational purpose could still be considered vocational but in a different sense than the first two. Some links are made to general education specific for future citizenship of 'technological' societies.

Technology as 'design and make' in the context of the application of scientific principles
Here the concept of technology focuses on the process of design and manufacture. However, the focus includes exploring the questions of 'purpose and value' in the context of solving problems using scientific or mathematical principles. The educational purpose of this perspective would seem to be a more focused attempt to educate people as future citizens, able to make informed decisions from a 'rational' as opposed to an 'emotional' basis.

Technology as practical capability
The concept of technology here is primarily centred around a complex process that focuses on cooperation, defining of needs, designing, implementing and evaluating solutions. Scientific (including mathematical) domains are viewed as being important, but only one of the many domains critical to technology. Educational purposes are citizenship, broad vocational fitness and personal development by way of the development of a synthesis of the powers of analysis, decision making, manual and aesthetic skills, evaluation and collaboration with a range of other people.
These perspectives provide descriptors that could be placed on a continuum whereby the first reflects 'technological literacy' as restricted to technical competency and the last suggests a far broader inclusive notion of technological literacy.

Appendix 2: Recommendations in the PPTA report Technology: theory without practice (2006)

This report recommended that the Ministry of Education urgently develop a strategy that ensures:

a. The establishment of a well-funded two-year pre-service teacher education course designed to produce technology graduates with a Level 7 subject qualification and teacher education.
b. That students in years 7 and 8 in technology centres are taught by specialist technology teachers.
c. That the revised technology curriculum balances theory and applied concepts/skills and uses language that is accessible and clear in intent.
d. That high quality curriculum exemplars across the full range of technological areas in Levels 3 to 8 of the revised curriculum are produced and made available to teachers.
e. That priority is given to improving the range and quality of assessment exemplars for NCEA technology.
f. That adequate professional development along with in-school support in all aspects of technology is provided for technology teachers throughout New Zealand.
g. That priority is given to covering the full range of technological areas in the allocation of senior subject adviser positions over at least the next three years.
h. That tagged funding is provided to schools to resource ancillary support for technology departments.

i. That technology facilities in all schools are subject to a full health and safety audit, to ensure compliance with Occupational Safety and Health requirements, followed by appropriately funded remedial action.

Appendix 3: Teacher Knowledge

Alister Jones (University of Waikato) in a recent APEC presentation in Chile discussing teacher knowledge related to technology, made the following observations:

To be effective teachers need to develop four dimensions of knowledge and practice:

- knowledge about technology
- knowledge in technology
- technological pedagogical knowledge – what when and how to teach
- knowledge of the curriculum including goals and objectives as well as specific programmes.
- teachers can only be effective at assessing if they know about both how students learn and the subject area:

Teachers also need:

- knowledge of student learning in the subject including existing knowledge, strengths and weaknesses and progression of student learning.
- knowledge of specific teaching and assessment practices of the subject, eg. authentic, holistic, construct reference.
- an understanding of the role and place of context.
- an understanding of classroom environment and management in relation to the subject, eg. groupings, managing resources, equipment and technical management.

Jones also suggested the following strategies to enhance teacher pedagogical content knowledge:

- reflecting on case studies of their own and others' classroom practice.
- using a planning framework.
- negotiating interventions and support in the classroom.
- involvement in workshops.
- involvement in teacher agreement meetings.
- using student portfolios.
- summative profiling.

Appendix 4: Technology Subject Teacher Associations

Technology Education New Zealand (TENZ)

TENZ, (mentioned in Part 2A) since it was established in 1997, has provided a very valuable professional network promoting and supporting Technology Education in New Zealand. It has provided information and support to all those working in Technology Education, working in a technology-based enterprise with an interest in education, and those just plain interested!

TENZ is a network which:

- fosters the development of Technology in the New Zealand Curriculum
- develops and maintains national and international links between those working in Technology Education and with the wider technological community
- supports professional, curriculum, and resource developments in Technology Education
- encourages research in Technology Education
- organises a national Technology Education conference every two years.

The electronic newsletter **t-news** (www.tenz.org.nz/t-news/), published eight times a year, contains professional matters relating to technology education and case studies of successful school technology projects.

(It is important that TENZ continues to provide this support and encouragement.)

NZGTTA (Graphics and Technology Teachers Association)

The NZGTTA, formally the Technical Teachers Association Inc, was established as a support network for teachers of graphics and technology related subjects in primary, intermediate, and secondary schools in New Zealand.

The association has a national president and an executive made up of four regional vice presidents, a treasurer, secretary, a technology and graphics curriculum and assessment adviser and a communications officer. Every two years the annual general meeting takes a professional development role by offering a conference including seminars, visits and promotions from relevant business and educational interests. Regional branches hold regular meetings, usually one per term during the school year to attend visits to related industries, listen to guest speakers and share programmes and general classroom teaching materials and resources.

Regional branches also circulate information of interest to teachers received by them from the National Executive, Ministry of Education, New Zealand Qualifications Authority, and teacher training institutions. Information on products and resources from related industries and their sponsorship is also sought.

HETTANZ (Home Economics and Technology Teachers' Association)

HETTANZ is the official subject association for teachers and/or interested people of home economics, technology and the allied fields of health, human development, human nutrition, hospitality and life science.

The Association has a national president, vice president, secretary, treasurer and Māori representative. HETTANZ is recognised as a vital and visible organisation actively working towards the objectives set and providing quality services for the membership.

HETTANZ objectives are:

- to provide a national voice and to act as a forum where all teachers of home economics can share ideas and experiences
- to promote the professional development of home economics teachers and to provide professional support
- to promote the teaching of home economics at all levels of the education system and beyond and to unite all teachers of home economics
- to encourage and foster research related to home economics education
- to provide liaison with international organisations and other national associations for the teaching of home economics.

HETTANZ holds biennial conferences and the 2008 conference was held in July.

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