Technology Education and Industry Links: An exploratory case study.

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ABSTRACT

The purpose of this research is to provide an exemplar of one school's innovative approach to developing links with local industry in order to enrich its technology education programme. Investigation of the rationale and policy for having such a link is discussed and possible benefits and deficits are presented in a case study.

The research has been undertaken in one school which has won national awards for its involvement in these links. This school is the focus of an exploratory and evaluative case study. A variety of procedures has been used including a document analysis, teacher and student interviews and a small questionnaire. The data has been gathered from the principal, the classroom teacher, the industry person and the fourteen children involved in the link.

The technology curriculum was introduced as a compulsory part of the New Zealand curriculum framework for schools in January 1999. It was appropriate that this research should be carried out at the same time. This research also investigates the introduction of the new curriculum. Questions such as, what is technology education? and, where has it come from?, are addressed. Identified as important aspects of this new curriculum are the links to be developed with the local community which include business and industry, tertiary institutions, and local authorities. It is proposed that these links could work together to develop what is described as an *"inclusive"* technology curriculum.

A case study of an existing school-industry link is reported. Interested parties are identified, their perceptions and the possible underlying principles behind their visions are discussed. This investigation explores the notion of an inclusive technology curriculum and discusses in the light of the case study whether it is feasible or even desirable.

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CHAPTER ONE - INTRODUCTION TO THE STUDY

This chapter provides an introduction to the study, including a brief outline of the researcher's interests and involvement in the area followed by an introductory background to the study. The research objectives are outlined and key terms are identified and definitions are discussed.

1.1 The researcher's interests and relation to the study.

The idea for this thesis developed from occasions where the researcher and others have called into question some of the rationale for the involvement of external organisations, particularly business and industry, in the development and delivery of technology education. My twenty year working career has spanned both the industrial/business and educational sectors. My teaching career began right at the cusp of the introduction of technology education as a compulsory part of the national curriculum in England, the first country internationally to do so. Initially my involvement was as a classroom teacher charged with helping to facilitate the transition to technology education, then as a Head of Department to co-ordinate its delivery across a school.

This was followed by a position as director of technology education at the first girls' technology college in the United Kingdom This ultimately led to a position as assistant principal with responsibility for SCITT (School centred initial teacher training) and business liaison for the college. My current position as a lecturer in technology education at Massey University College of Education has given me the ideal opportunity to critically view the role of school and industry links from a more informed research base.

1.2 Background to the study.

> *The link between schools and the community, including business and industry, tertiary institutions, and local authorities, is important to a well developed, inclusive technology curriculum.*
>
> (Technology in the New Zealand Curriculum 1995, p. 17)

In New Zealand, along with other western English speaking countries, there has been a shift in education policy; this shift is away from a liberal-humanist education towards a more vocationally focused curriculum. The change has come about partly as a response to economic targets and objectives set by national policy makers (Bronte, 1991). An example of this shift can be seen in the growing emphasis on making education more responsive to the needs of industry and business. This policy has led to the development of a variety of school-industry partnerships or links. Although not a new idea these links have found prominence in the recent addition to the New Zealand national curriculum framework of the essential learning area, *technology education*. Little research has been done to ascertain what actually goes on in a link and the motives that might be behind their push within the Technology curriculum. In 1996, the Education Review Office (ERO) published a report entitled *School-Business Links.* The executive summary at the beginning of the report highlighted the need for more research.

> *Many New Zealand secondary schools have relationships of some kind with local businesses. There is little information available, however, about how extensive these relationships are, why they are established and whether they contribute positively to the learning outcomes of students.* (ERO, 1996)

The report also noted that some specific programmes were being developed in the areas of science and technology but few in the other areas of the New Zealand Curriculum Framework. This could be as a direct response to the overt links made in the technology curriculum statement.

1.3 Research objectives

The primary aim of this study is to explore through a case study what actually occurs in a school-industry link in the area of technology education. The study also seeks to explore the ideology behind the links from a policy perspective and also the perspective of the parties involved in this particular case. Technology education in schools is a recent innovation, therefore its development in New Zealand and internationally will be explored to ascertain similarities in the ideology behind its introduction in different contexts.

RESEARCH QUESTIONS:

1.) What actually happens in a school-industry link with technology education?

2.) Why are links promoted in the Technology Curriculum?

As with all research there are additional questions which will be raised and discussed such as:

- What is technology education?
- What is the history of technology education in New Zealand?
- What is meant by an inclusive technology curriculum?
- What is meant by a school-industry link?

1.4 Research Method

This thesis will use qualitative methods to explore what is actually taking place in a school-industry link. To meet the objectives, an in-depth single site exploratory case study will be conducted. This study will try to ascertain the student and staff perceptions of school-industry links and try to match these to the policymakers' rhetoric for technology education.

The case site has been chosen not for its typical nature but for the recognition it has received for its "success" in developing these links. The question of validity has been addressed by the use of a range of collection methods much in the way Hitchcock and Hughes (1995:324) describe methodical triangulation. This particular case study has a program where the industrial partner comes in and leads the teaching with support from the classroom teacher. This program is time-tabled and those students who elect the study are expected to attend. The program was observed in its entirety by the researcher and detailed records were kept, the students involved were given a questionnaire to fill in. Focus group interviews were held and recorded. The adults involved i.e. the teacher, industrialist and the school principal were also interviewed. To enhance validity the teacher was involved, both as participant and observer in a number of the interviews.

1.5 Organisation of the Thesis

This thesis is organised into six chapters with each chapter having a theme.

Chapter one sets the scene for the study and outlines the research objectives and methods to be employed. In addition it explains the researcher's interests and background.

Chapter two gives a detailed account of the literature relevant to this study. It is in two parts. There are various aspects which are identified. The first provides definitions and gives the reader some access to the language to be used throughout the thesis. Technology education is a new curriculum area and the possible directions it may take are dependent on its origins and the view of the stakeholders who have introduced it; these will be explored. One argument remains the strongest for the introduction of the technology curriculum and this argument will be examined.

Chapter three explores the methodology used in this research in light of the recent research literature. The chapter will outline the strengths and weaknesses of qualitative research and in particular case study. Links will be made to these theories and this researched case.

Chapter four details the findings of the research; these are portrayed in a variety of ways. A detailed document analysis begins with a historical account of the parties involved in the link, and this is followed by researcher observations. Some detailed individual interview responses are outlined along with focus group interviews. Finally, a small questionnaire and the responses to it are outlined.

Chapter five analyses these responses and separates them into viewpoints detailing the positions of each of the main parties involved in the case study. These viewpoints explore mainly the particular programme but also indicate viewpoints in relation to other types of school-industry links.

Chapter six draws conclusions from the research, identifies the weaknesses of the study and offers suggestions for further study.

CHAPTER 2 - REVIEW OF THE LITERATURE

PART A

2.1 Definitions.

The growth of technology education as an area of study within general education is one of the most significant curriculum developments of recent years. Throughout the world, numerous countries are developing ways of offering technology education within mainstream education. In 1999 technology education became a compulsory subject in New Zealand for the first time. The introduction of any new curriculum area is bound to cause some trepidation and confusion, particularly amongst teachers required to make the changes.

However, in the case of technology education this confusion has been compounded by the association of technology with modern artefacts (Burns, 1990; Jones and Carr, 1992). This association has become more common due to the growth in computing use over the same period. When we read or hear about computers the word technology will often appear nearby. An additional problem for technology is the lack of direct correlation with equivalent disciplines in the academic world. Although technology degrees are available at some institutions, they are relatively new and are not understood widely outside of those immediately involved in the programmes. Finally there has been very little research carried out in New Zealand or internationally into technology education in comparison to other disciplines.

What is technology education ?

In many countries technology education has replaced previous offerings such as craft education. However, the change to technology education is more 'fundamental' than just updating or revamping, so much so that one could be justified in calling it a new subject (De Vries 2000). The viewpoint which identifies technology with computers, though extremely narrow, is not incorrect. Whereas technology is often associated with computers there is more to technology education than just modern artefacts or products. Technology is as old as people themselves. Thus according to Anthony Williams:

The first reference and definition of the word occurred in the 1615 edition of a New English Dictionary on Historical Principles in which it was defined as 'a discourse or treatise on an art or arts: the scientific study of the practical or industrial arts'.

(Williams and Williams, 1996 p.1)

The Ministry of Education through its publication *Technology in the New Zealand Curriculum* describes technology as:

....a creative, purposeful activity aimed at meeting needs and opportunities through the development of products, systems, or environments. Knowledge, skills, and resources are combined to help solve practical problems. Technological practice takes place within, and is influenced by, social contexts.

(Ministry of Education, 1995 p. 6)

In different countries different variations of technology education have emerged. They all reflect the different economic, ideological and social demands placed on the policymakers responsible for its introduction. Approaches vary with some becoming almost synonymous with the country of origin i.e. the design approach with England and Wales.

Technology can be viewed in different ways at the individual level also, depending on the personal construct a teacher has about it (Banks and Barlex, 1999). Sterry and Hendricks (1999) discuss four alternative viewpoints from which technology can be understood.

The first is as *'objects'.* As stated earlier this is probably the most popular viewpoint. These technological objects, products or artefacts are generally modern in nature and typically include computers, facsimile machines etc. If we look at the New Zealand Ministry of Education's definition we can see how the development of the computer or fax machine can be seen as meeting our needs in terms of counting and communicating. Perhaps we might reason that the computer itself is not technology but the process by which it came about is.

This *'process'* is the second of the viewpoints described by Sterry and Hendricks. The process viewpoint implies action towards meeting identified needs or wants, in this sense technology involves doing. This process is often referred to as problem solving or even more specifically in technology education as 'a' design or technological process. The process itself is often made up of mini processes, or sub processes. They are worth identifying, but they should be viewed in a non linear fashion:-

Questioning processes, inquiring processes, investigating processes, observing processes, analysing processes, visualising processes, communicating processes, modelling processes, predicting processes, manipulating processes, quantifying processes, valuing processes, managing processes, and evaluating processes.

These processes and others are expressed as what technologists do or 'technological practice'.

The third viewpoint described by Sterry and Hendricks is that of technology as *'knowledge'*. One can see how this viewpoint would be popular with teachers of technology. The traditional school subjects all have a distinctive knowledge base and this is one of their defining features as separate subjects. For technology to be accepted as a discrete curriculum area it must have a knowledge base for itself. However, most dictionary definitions of technology describe technology as the application of science and maths. This creates another contentious point. Technology as a curriculum area is new and as such does not have a traditional place within an already crowded school day. To dismiss the subject as having no knowledge base might be an easy way to ignore it. However, technology education does have a knowledge and one that is growing at a very fast rate. According to Burns, (1997 pg.25) an aspect of the knowledge can be referred to as *'tacit'* and is developed through practice. This knowledge is derived from a different way of thinking and according to Burns hardly ever involves straightforward application of scientific laws.

This view has been expressed before. Cross et al 1981 describe a concept of 'knowing how' like Polanyi's 'tacit knowledge'. They also describe a 'knowing that' which can be made *explicit'* and formulated by rules, scientific or mathematical. They go on to argue that knowing how and knowing that are mutually exclusive and can in fact interfere with one another; explicit rules can inhibit practice. Therefore straight application of science and mathematics knowledge on their own is not technology education. Historians have also argued that technology can no longer simply be referred to as applied science (Staudenmaier 1985). Scientific concepts often go through some sort of transformation before being used by technologists. McCormick (1997) in his article about conceptual and procedural knowledge has developed some definitions which might be useful.

Procedural knowledge: is used in other areas such as psychology and has different levels of understanding. These can relate to problem solving and strategic thinking as well as know how, in technology education the association with the later is the most prominent.

Conceptual knowledge: this is often associated with knowing that. In technology education often the relationships between the 'items' of knowledge is referred to as conceptual understanding (McCormick (1997) p. 143).

Strategic Knowledge: educationalists refer to strategic knowledge, which has a controlling function over the procedural and conceptual knowledge. (Gott, 1988)

A similar notion has been developed by Stevenson (1994) who holds a theory on the hierarchy of knowledge. Three levels are proposed:-

First order: these are linked to direct goals, e.g. hammering in a nail. These forms of knowledge are specific and can be automatic or systematic.

Second order: these operate in a more unfamiliar situation. Such knowledge statements operate using specific procedural skills and strategic skills e.g. problem solving.

Third order: these switch cognition between the other two and have a controlling function i.e. knowing which and knowing when.

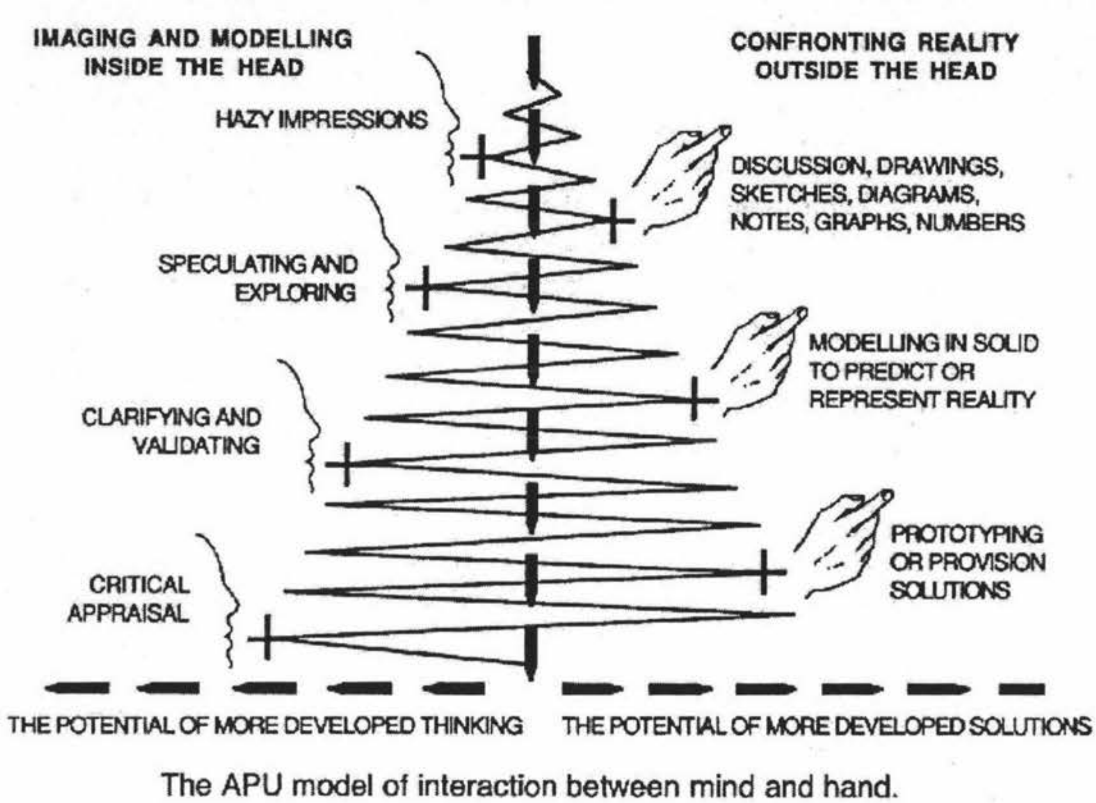
Technological knowledge is by no means a proven case, but the other 'domain' areas have had a long time to establish and identify their 'knowledge base' and given time technology may well be able to do the same.

The fourth viewpoint described by Sterry and Hendricks is that of *'volition'*. This they describe as the "desire to do something" (1999 pg. 3). This is the creative side of the subject. This creativity is often linked to innovation and is put forward by the policymakers when talking about the introduction of technology education and economic prosperity. However, to educationalists it should mean much more than that. It is the freedom for children to learn through trial and error. It may or may not be as a response to some identified problem. After all if a formula or algorithm can be applied to a problem then it was not really a problem in the first instance. In technology education there is no formula or prescribed solution. Each individual's response can be different yet equally right.

> *Technology is a creative activity whose goal can be described in the most general terms as bringing things into being and making things work better.*
> (Cave, 1995 pg. 2)

Technology teachers rather than policymakers often cite this creative aspect of technology education as a key component. In fact according to Chidgley (1994) designing as part of technology is a creative activity and any attempts to equate it to science fail due to the ineffable ingredient of craft knowledge gained through non scientific experience. Technology education offers the learner the opportunity to pursue a personal area of interest through their own volition. As a learning process it can be seen at a very early stage when, for example, a young child builds a tower out of blocks. It is what Kimbell (1987) described as the interaction of mind and hand (see figure 1). The Assessment and Performance Unit (APU) was funded by the Department of Education and Science in England and based at the Technology Education Research Unit at Goldsmiths College, University of London. Their research between 1985-91 involved a large sample that supports generalisable conclusions and is cited widely in technology education.

Figure 1: The Interaction of Mind and Hand.



The APU model of interaction between mind and hand.

(Kimbell 1987, APU model p.62)

This model (figure 1) was used to express how the process of technology had become just as important, if not more so, than the final product. It was described as what occurred both inside and outside of the head. Technological practice involves more than just conceptual knowledge and practical skill yet its success is dependent on both. Perhaps we can identify a third component missing from Kimbell's model, that is the interaction of mind, hand, and heart. The critical appraisal identified by Kimbell must be more than just questions of quality or economic viability.

> *A beautifully constructed knuckle duster, for instance, may meet all the criteria except the fundamental one- that of desirability of the product in the first place! Selection and weighting of the criteria are therefore important processes as are the values which are emphasised by the teacher. Our main point is that evaluation in school technology should reflect a wide range of types of values, with appropriate weight being given to ethical, social, political and environmental questions alongside questions about efficacy, efficiency and economics.*
>
> (Ditchfield and Stewart 1987:11)

The "hearts on" refers to a critical component supported by the environmentalists as well as other stakeholders. There have been those who have criticised the New Zealand Technology Curriculum statement for its lack of direction here and in particular its focus on values driven by business people.

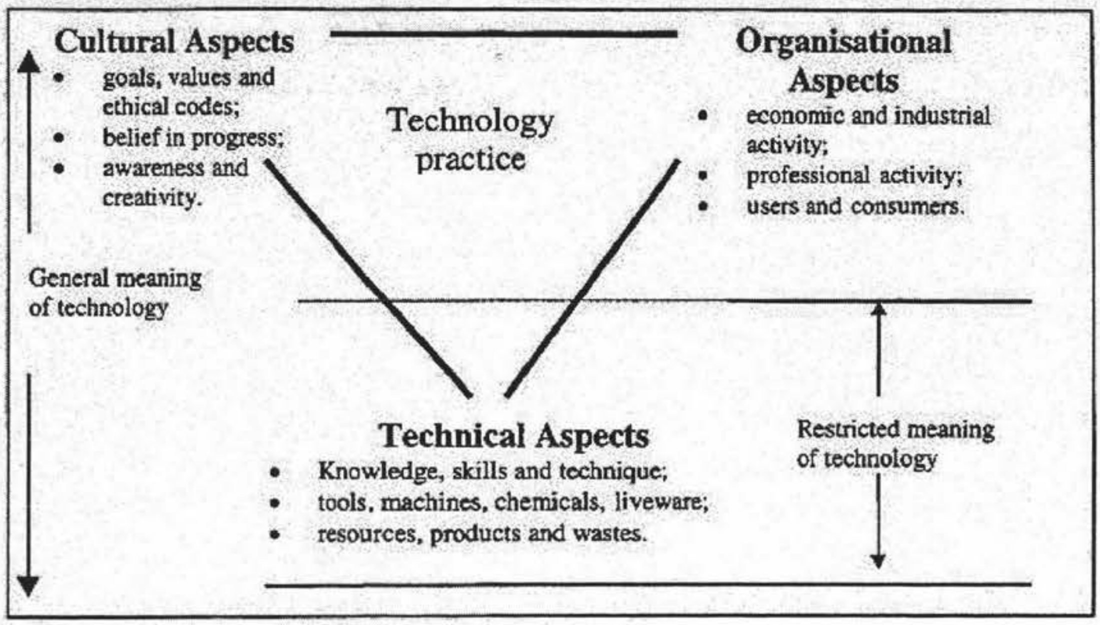
> *It is true that the curriculum mentions the importance of the cultural and environmental and the economic, but the language is not at all about critical evaluations of these. The reality is there: students have only to "understand it' and 'adapt' to it. They are to be led down a particular path without realising what that path is. The curriculum will guide them to adjust to a world pre planned by business people while believing, if they believe anything, that it is all inevitable.*
>
> (Snook 1996 p 3,4)

The view that technology is value free and drives itself without that critical check is called technological determinism or technicism. If this were to be the focus of technology education as it occurs in the classroom then clearly the students practice would be lacking in the "hearts on" aspect. Technological literacy without this critical evaluative component can never be a liberating literacy.

What is technological practice?

One of the most cited models of technological practice (what technologists do) is that of Arnold Pacey (1993) (see figure 2). Pacey described technology as involving three widely differing 'aspects'. These aspects are embodied, either consciously or unconsciously, within technological activity.

Figure 2: Definition of Technology Practice.



(Pacey 1983,p.6)

Cultural aspects, according to Pacey, involve the goals of society, values and ethics and the awareness of the relationship between technology and society. Additionally there should be consideration of the creativity within that culture. This is a view strongly supported by others who are interested in the cultural aspects of technological practice.

> *There is a sense in which technology, both its products and its processes, represents the embodiment of culture. We create the things we value, the things we think beautiful or useful. We devise tools, machines and systems to accomplish the ends we value. ....Our beliefs, our values, our philosophies, our experiences, in short our culture, is made manifest, in part in the artefacts and systems we create.*
>
> (Prime, 1993,p.30)

Obviously, if one agrees with Prime, the cultural context of technological practice should be explored when making observations on the development and impact of technology. This could be seen as a worthwhile component of strand C (*understanding and awareness of the relationship between technology and society)* of the New Zealand curriculum statement on technology education. (see appendix one)

Organisational Aspects involve economic and industrial activity, professional activity, users and consumers. Management systems, quality control, financial controls, production systems would all be included in this aspect. In addition Pacey identifies the users and consumers of the technology; this would include all the marketing and promotion sectors as well as the service sectors. This is an important aspect for technology education where one of the outcomes for technological literacy might be a critically informed user and consumer base. An understanding of this aspect might create makers, consumers and users of technology who can play an active role in technological selection or rejection as opposed to passive acceptance of the latest technological fad.

Technical Aspects This is the most commonly expressed perception of technology i.e. technology as things, or involving the technical skill to make things. These aspects have been the focus of the traditional curricula which might be seen as the precursors of the current technology curriculum, i.e. craft subjects, home economics etc. These aspects include the knowledge skills and techniques used in the development of a technological solution or technological practice. Pacey refers to tools, machines, chemicals, liveware. This is consistent with the technicist or instrumentalist (application of instruments or tools) approach to technology education. Included here is additional knowledge of resources, products and wastes associated with technological practice. This aspect is closely aligned to the organisational. This is a restricted meaning of technology, as Pacey points out but certainly one which is consistent with teachers perceptions of technology (Jones and Carr, 1992).

Because Pacey's definition of technological practice is broader and more comprehensive than most, it will be the definition preferred in this thesis.

What is technological literacy?

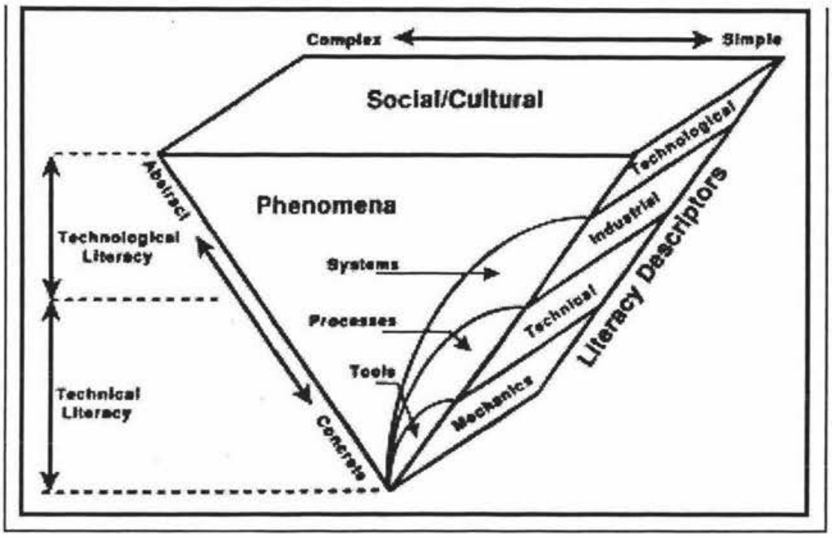
In New Zealand the aim of technology education is for students to achieve technological literacy (Ministry of Education 1995). Accepting the many interpretations for literacy found in dictionaries and reference materials it could be described as the ability to encode and decode a message. If one encodes and decodes very well, one is literate, or at the least, one can read and write very well. In other words, there is a minimum level of attainment if one is to be literate, but at the same time, there is a range of literacy. The same conditions must apply to technological literacy, which entails the ability of an individual to encode and decode technological messages.

Hayden (1989) conducted research about technological literacy and takes the position that it involves having knowledge and abilities to select and apply appropriate technologies in a given context. While not revealing the source of his thoughts, Steffens (1986) claims that technological literacy involves knowledge and comprehension of technology and its uses; skills, including tool skills as well as evaluation skills; and, attitudes about new technologies and their application. Croft (1991) devised a series of characteristics which identify a technologically literate student. The characteristics are:

- abilities to make decisions about technology;
- possession of basic literacy skills required to solve technology problems;
- ability to make wise decisions about uses of technology;
- ability to apply knowledge, tools and skills for the benefit of society;
- ability to describe the basic technology systems of society.

Technological literacy does not have a commonly accepted meaning. *The 1991 Yearbook of the Council on Technology Teacher Education,* a publication from the United States, is devoted entirely to the subject of technological literacy. This publication examines technological literacy from a variety of angles: its need or not, as a goal, as a concept, as a program, societal factors influencing it, and in terms of curriculum organisation. In this volume, Todd (1991, p.10) comments that, *"Technological literacy is a term of little meaning and many meanings."* Later in the same text (p. 11) he makes the statement: "Currently we are unsure whether we are using technological literacy to represent a slogan, a concept, a goal, or a program."
In 1980, Wright produced a journal article which included a diagrammatic representation of technological literacy.

Figure 3: Levels of Technological Literacy.



(Wright, 1980,p.36)

The above diagram differentiates between a technical literacy and a technological literacy, the former being concerned with the concrete and the later moving from the concrete to the abstract. Noticeable is the difference also in size in what Wright calls phenomena. In technical literacy it is quite narrow the tip of the wedge, looking at phenomena which are concrete such as tools and mechanics moving to technological literacy which is more abstract and involving systems, all the time recognising the cultural and social relationships. Thus:

> *Technological literacy is a concept used to characterize the extent to which an individual understands, and is capable of using, technology. Technological literacy is a characteristic that can be manifested along a continuum ranging from non-discernible to exceptionally proficient. As such, it necessarily involves an array of competencies, each best thought of as a vector, that include: Basic functional skills and critical thinking, constructive work habits, a set of generalized procedures for working with technology, actual technological capability, key interpersonal and teamwork skills, and the ability to learn independently.*

(Dyrenfurth, 1991, p.179)

Also concerned with technological literacy, Professor Todd presented a taxonomy to describe technological decision making that embraces five levels: awareness, literacy, ability, creativity, and criticism. (Todd, 1991, p.24) These powerful levels of competence are concerned with the knowing and doing of technology but advance into the more difficult areas of criticism and judgement. This notion of criticism and judgement is important for this thesis.

A technologically literate person might be one who

- **Knows and understands about technology. (Conceptual knowledge)**
- **Knows how to do technology, i.e. has capability. (Procedural knowledge)**
- **Makes critical judgements about their own and others technological activity. (Strategic Knowledge)**

(Adapted from Todd 1991)

What is an inclusive technology education?

Pacey's definition of technological practice one might argue is inclusive, a word that is used in the technology curriculum statement and requires further explanation. This 'inclusive technology' is often a statement used by authors when they wish to promote the positives of the technology curriculum.

> *Good technological practice is therefore, by definition, inclusive and thus technology education should uphold the same philosophy.*
>
> (Compton 1997, p63)

In reality this inclusivity has never been defined and is clearly related to the stakeholders interpretation of technology. These stakeholder positions are in fact the driving forces of technology curriculum development not only in New Zealand but internationally.

When defining an inclusive technology curriculum, issues such as the following will need to be considered:-

Gender, historically women are seen as users of technology not creators.

Culture, dominant cultures imposing their technologies over indigenous technologies.

Access, an underclass of those without access to technology.

Environmental, decisions taken without adequate consideration of environmental impacts.

Historical, an awareness of the mistakes as well as the triumphs of previous technologies.

Societal, the question of control, and who has it over the proposed technology?

Financial, who are the winners and who are the losers should be considered.

Some of these issues will be discussed further in later sections of this thesis.

What are school-industry links?

Firstly the phrase used predominantly in this thesis will be 'school-industry links'.
For ease of understanding this phrase is applied to any link or partnership between a school and any outside industry, agency or enterprise. When talking of links or partnerships the term 'industry' should not be applied narrowly to the manufacturing sector but according to Price (1991,p.2) "includes the entertainment industry, the tourism and hospitality industries, the agricultural industry and the communications industry, to name but a few and takes in employers, managers, unionists and other workers."

2.2 Why technology education?

It is important for this thesis that the reader has an understanding of the competing influences which have led to the introduction and formulation of technology education as a new curriculum area. Therefore in this section a review of the literature on the coming of technology will be discussed.

There have been many attempts to introduce notions of technology education into schools. Most have been in the form of projects such as 'The Man-made World' in the United States, and "Project Technology" in the United Kingdom in the 1960s. However, it is not until recently that we have had a curriculum subject called technology being introduced as a compulsory part of a national, indeed international, curriculum. There are now a number of professional associations and academic journals promoting the virtues of this new curriculum area. What is the rationale for this much stronger recent support?

In 1993, Layton published as part of a UNESCO volume on Science and Technology a paper which has become widely cited when speaking of stakeholders in technology education. The concept of "technological literacy" which is a concept central to the New Zealand curriculum document is discussed. UNESCO's support for technology had been stated much earlier. In 1971, there was an International Commission for the Development of Education appointed. In 1972, a report entitled *Learning to be* was published and in this report it was argued technology education was important because:

> *Lack of understanding of technological methods makes one more and more dependent on others in daily life, narrows employment possibilities and increases the danger that the potentially harmful effects of the unrestrained application of technology... will become overwhelming.*

Then later

> *Education in technology at the conceptual level should enable everyone to understand the ways in which they can change their environment.*
>
> (UNESCO cited in Layton, 1993, p.12)

Layton's work identified the stakeholders and tensions that arose from the different positions held. After a general introduction where he describes the range of influences and the politics of technological literacy, he distinguished some of the more prominent characteristics of the parties involved under these headings.

Economic instrumentalists

Economic instrumentalists comprise a very strong lobby group and historically probably the most influential. Their viewpoint has an important bearing on this thesis. They argue that education has a crucial role to play in the national economic competitiveness of nations, such that wealth creation should be the overriding aim. This association is at its strongest when talking about technology and the economy. Another important point is the link between vocational education and technology education. The economic instrumentalists see the two as synonymous. The researcher will critique the economic instrumentalist viewpoint throughout this thesis as it is paramount not only to the development of New Zealand technology education but technology education internationally. The first country in the world to introduce technology as part of a national curriculum was England. Medway (1992 p. 66) in his chapter on constructions of technology notes that economic instrumentalism may in fact be the beginning of a move away from the classical subjects of mathematics and science towards the more instrumental subject of technology education. Similar viewpoints have been expressed in the United States for the introduction of *Technology for all Americans*, a project which has produced curriculum guidelines for technology education at a national level.

Professional Technologists

This group is allied to the economic instrumentalists in that both see the connection between technology education and the economy. In addition the professional technologists see technology as a third culture and one that is different from the arts and the sciences. Professional associations, such as engineers in various nations, support the development of technology education as a means to influence not only the content of what is taught in schools but also to expose children to their importance in the wider society. This image building and possible future attraction into the professions will also be discussed further in this thesis. Suffice to say that these professional organisations have been a significantly powerful lobby group in driving the policy decisions and ultimately the content of curriculum documents around the world. The engineering council in the UK were quite damning of the original technology curriculum in England and Wales which resulted in a re-write and a swing towards their agenda (see Smithers & Robinson, 1994).

Sustainable Developers

This group has a different viewpoint as to why technology education should be taught in schools. Their concern is the future of the biosphere. An emphasis is placed on the values and attitudes fostered within technology education. Empowerment through education is seen as the method to ensure the quality of life is not reduced purely for technological developments. This viewpoint is also important for the understanding of technology education in the New Zealand curriculum. One of the three strands is aligned to this view, at least in the structure of the curriculum. However, whether it is being taught is another matter open for debate. One can already see a tension between the compatibility of economic growth and environmental protection.
Nevertheless there are a number of organisations that promote education about alternative technologies. This viewpoint, often associated with sustainable developers, focuses on the culture in which the technology is placed and developed. Issues such as appropriate and intermediate technologies would be a significant factor in a technology education curriculum promoted by this group.

Girls and Women

Women have always lived with technology and been heavy users of technology both in the workforce and home. However, they have never been a major force in terms of the creation of new technologies (see Hynes, 1989, p. 9-11). Layton (1993) supports his views by quoting a number of researchers (such as Bekoe and Prage, 1992) who have written on this issue. The main point made by Layton and others is that it is time for technology education to redress the issues of gender biases. The researcher's own experience of teaching in single sex girls schools has led to the support of this viewpoint. Women and girls have attitudes and values important for the development of future technology education courses. Wajcman (1993 p 64) notes through the feminist movements of the 1980s that the focus has shifted towards the gendered character of technology. Pacey, in his respected work entitled *The Culture of Technology* (1993), outlines three sets of values which impact on views of technology:(1) virtuosity; (2) economics; and (3) responsibility. It is here in the valuing of responsibility that Pacey sees a significant difference between the genders in the viewpoint expressed. Women, the author argues, are more inclined to work with nature and act accordingly and men are more concerned with conquest of nature.

Defenders of participatory democracy

This group of stakeholders has central to its viewpoint the notion of equality for all citizens. The fear of a technocratic elite who alone would have access to the specialised knowledge and language associated with technology education is one of their driving forces. The idea of a non technologically literate underclass who are fearful of a technology which is out there and something that they have no control over is a viewpoint shared by many. These viewpoints are often associated with age, and a fear that as new technologies emerge and a whole new set of understandings and knowings are required to deal with it, they are left behind. It is their viewpoint that only through technology education for all will it be possible to protect society from this elitism. Only through an educated citizenship can society possibly deal with the impacts and developments of technology. According to McCormick:

> *The value-laden nature of technological activity, and the need to reflect this in education, is now accepted in most proposals for technology education.*
>
> (McCormick, 1993 p. 12)

McCormick highlights two overlapping strands in technology education; the first is the capability for the citizen to make judgements about technology, and the second is preparing students to live in an increasingly technological future society.

Liberal educators

This group supports technology education for its intrinsic value to teaching and learning. They argue that technologists and the way they do their work involves a particular type of cognition. All children should be exposed to this form of cognition to enable them to reach their full potential. A strong liberal humanist education position may in fact be directly opposed to the world of work, in that what is important is the individual intellect. Any criteria which are imposed or set from outside of that subject culture are seen as irrelevant. (Banks 1994 pg.200)

Does technology have intrinsic value as a subject area? McCormick (1994, cited in Banks) argued that technology does have intrinsic value and thus supports the liberal educators' position. Initially McCormick identifies two aspects of importance for teaching and learning; firstly the solving of real problems, and secondly, the reflective thinking such problem solving activities promotes. This educational justification relies heavily on the work of Dewey and reflective thinking. Callaghan's "Great Debate" 1976, in England emphasised the need to educate people to be able to 'do' as well 'know' i.e. individuals who were technologically capable.

> *Dewey was able to argue that technology is the ONLY mode of knowing and performs a unique role between the so called certainties of science and the dogmatism of ill informed beliefs.*
>
> (Snook, 1996, p.5)

Dewey also had very strong views on the relationship between education and industry.

> *The demands of an industrialised and technological society cannot be ignored.*
>
> (Dewey, 1935 p. 89)

However, Dewey rejected the dualism of vocational education and liberal arts education. Dewey proposed a strong and necessary connection between schooling, the social world and the world of work. Dewey was opposed to separate vocational schools yet he believed that the right "*occupation*" was essential for human happiness and the route to obtaining it was through "*exposure*" (Dewey 1916 p.308). Perhaps school-industry links, if organised correctly, could facilitate Dewey's views. The curriculum under Dewey would not follow a "*rigid direct*" preparation for a vocational career which was decided at some arbitrary point, but would be flexible and "*indirect*" and incorporate problem solving in its most intellectual form. Those who conform to the view that the technology curriculum is different and an improvement on its predecessors (the craft curricula) might find comfort here. Dewey's proposal of 'connection' between schools and industry is significant to this thesis.

So, from this viewpoint, technology education can be said to be the integration of the cognitive, psychomotor and affective domains quite similar to Kimbell's model (see figure 1). It also emphasises the teaching of heuristics (problem solving methods) which again reflects Dewey's pragmatism according to which all knowledge is related to problem solving. Dewey collapses the dualism between liberal and vocational education through his version of technology as general education.

2.3 Technology education and industry links: international perspectives.

International perspectives need to be critiques to look for consensus and parallels. Australia has some history in this area albeit a little ad hoc until recently.

> *In the last decade, federal initiatives such as the commonwealth funded Transition Education Program and the Participation and Equity Program allocated substantial funds to the states. One of the main purposes of the these provisions was to encourage the development of closer links between schools and industry.*
>
> Price (1991, p.4)

Bronte Price is one of the few people to have written widely in this field and he highlights the early tensions which arise in any link. Fundamentally, the move to further links between the two sectors is stifled because of the lack of knowledge and understanding which each has of the other. This lack of understanding also leads to an air of mistrust. From an industry perspective this mistrust is based on a lack of experience or exposure in the teaching profession to industrial practices. Bronte states that this belief comes from too much reliance by teachers on their teacher training courses, which have not kept pace with current practices in industry. The lack of trust is also based on the assumption that most teachers go from school directly to a tertiary institution and then back to the classroom (Price 1991, p.4)

There are five states and two territories of Australia all of which are educationally independent and have quite different educational systems. However, within this diversity there are some similarities and commonalties in technology education. In 1994 a national project in technology education was completed. All the states co-operated to produce a statement of technology education and profiles of student activities illustrative of that statement (Williams 1996).

It was unusual for the states to work co-operatively in this way and although the statements produced were not legislated, which meant it was not a national curriculum, it was used as a guide throughout Australia.

The statement had four strands and eight levels which combined to make a framework for technology education. According to Williams a number of trends can be seen as common in technology education throughout Australia.:

- recognition for a general type of technology education which should be a core and compulsory part of lower secondary education;
- the lagging behind of primary developments in technology compared to those at the secondary level;
- a breaking down of the barriers that existed between vocational education which had traditionally been the domain of technical and further education (TAFE) and general education.

These points signal a connection between technology education and a breaking down of the vocational and general education divide. A county report in 1968 by the Organisation for Economic Co-operation and Development (OECD), summarised Australia as 'having a large majority of unskilled and semiskilled workers; critical skills gaps have been filled by immigration.' The Finn Report in 1991 had some fifty recommendations including increased industry and education links (Williams, 1998).

According to Williams one result of these developments in technology education and those in industry has been a confluence of their goals. The influences for this confluence are listed as:

- increasing significance of technology in culture;
- common economic conditions providing the stimulus for change;
- increasing internationalisation;
- increasing unemployment and student retention rates;
- the recognition of a diverse range of learning styles;
- increasing quality of teaching and learning;
- the need for accountability.

Williams suggests that these influences have resulted in the entry levels of core competencies of industry and the new nature of technology education having a number of parallels:

- multidisciplinary in nature;
- standards developed as a guide to quality;
- competency based assessment;
- difficult to model;
- increasingly complex;
- similar personal development goals such as flexibility, creativity, critical thinking, innovative and adaptable;
- individual responsibility for personal development;
- team work skills.

(Williams 1998, p. 7)

Williams argues that although developed by different sectors there is indeed a confluence of goals between technology educators and industrialists. The recent shift in technology education away from liberal education is referred to as *'the new vocationalism, pre-vocationalism, the new practicality, or instrumentalism' (ibid. p.8).*

The view that the mistrust between schools and industry can be a factor in links is supported by the technology trust initiative in England. Ian Lynch of the C.T.C. City Technology College's trust highlights some of the concerns from both parties when talking of education and industry partnerships. The trust describes how there are different perspectives which can inevitably lead to heated differences of opinion which are not helped in instances where each side is ignorant of the other's modus operandi. According to Price, the teachers have resorted to industry accusations. They accuse employers of having an outdated perception of what goes on in the classroom based on their own personal experience, some of which might be twenty or thirty years old. (Price 1991, p.7)

The different perspectives and underlying ignorance of what the other party does, often inhibits links from a very early stage. The so called gap discussed here and in the New Zealand section of this thesis is also a focus for attention in the province of Ontario in Canada.

> *Education for the new millennium must provide authentic educational experiences for our youth. Closing the gap between school life and*

workplace life is an important step in this direction. Community involvement in school programs is an integral part of the restructuring of technology education in Ontario.

(Ontario Ministry of Education and Training, 1995.)

In the United States, there are similar views expressed. For example, during a conference at the 1997 Governor's Education summit Governor Shaheen of New Hampshire said:

"Our Ultimate goal is to have the best schools possible; to have the best prepared workforce in the world; to make New Hampshire an example for the nation of how to teach our children and prepare our people for the challenges of the twenty first century."

(Http://webster.state.nh.us/governor/summit/p6.html 22/1/99)

From this summit four themes emerged as important, two of which are significant for this thesis. Firstly, the importance of integrating technology fully into the curriculum; and secondly, the involvement of the wider community in school improvement. Later in the report they were even more specific when they said:

"Our schools can no longer function as islands unto themselves, where students are insulated from the external realities of work and community. The invisible wall between school and community must be dismantled. Parents and business and civic leaders must be encouraged to participate in the development of school curriculum tied to real world experience."

The above viewpoint is similar to Dewey's proposal for more 'connection'.

One impressive aspect of this commitment is the sheer size of the activities. In 1989 it was noted that there were 140,000 partnerships between industry and schools. This involved some 40 per cent of the nation's primary and secondary schools about nine million students (Training Agency, 1989). The most prevalent type of school-industry links is twinning, where a close bond is formed between a worksite or local employer and a neighbourhood school.

Similarities between technology education and the school-industry links development in New Zealand and the United Kingdom have already been mentioned. A short timeline of developments in the United Kingdom is included for comparison.

In the UK, school-industry links date back to the 1960s (Benson 1991).By 1990 the number of agencies involved in school-industry links in the UK had grown substantially. In fact a speaker at an awards function in Birmingham referred to a total of 154 agencies working at local, regional or national level. (*ibid.*, p.24). The creation of all these agencies has been a direct response to curriculum developments and national policies over many decades. In 1985, The Bryce Commission declared:

> *No definition of technical instruction is possible that does not bring it under the head of Secondary Education, nor can Secondary Education be so defined as absolutely to exclude from it the idea of technical instruction.*
>
> (Fullick, 1992, p. 128)

The British Education Act 1944, included a three tier system of grammar, technical and modern schools. The technical schools were to concentrate on an education for less academic pupils, selecting the sphere of industry or commerce as an area of preparation for their pupils. In 1959 the Crowther Report continued with this vision of technical education for the less academic. However, it was to lose momentum over the next decade as comprehensive education took hold. In 1976 James Callaghan, the Prime Minister during the 'Great Debate', argued that contact between schools and industry was insufficient and partly to blame for Britain's poor economic performance. It was almost a decade later when the then Prime Minister Margaret Thatcher launched the T.V.E.I. the Technical Vocational Education Initiative. This initiative according to Benson (1991) had mixed success in encouraging schools to design curricula which more closely meet the needs of the economy.

> *It was aimed at the 14-18 year olds who, it was felt, largely failed to jump the intellectual hurdles of GCE (General Certificate of Education) valued by the liberal tradition because its relevance was, for them, too vague and ill defined. A focus on preparation for work and adult life, it was argued would re-motivate them.*
>
> (Banks, 1994, p. 202)

Banks explains that the T.V.E.I. was not a curriculum itself, but was a funding scheme which influenced what was taught. It contained certain criteria which was aimed at challenging the traditional assumptions of liberal education. T.V.E.I. encouraged particular teaching and learning strategies and favoured certain curriculum areas. These included:

- relating what is learnt at schools and colleges to the world of work;
- improving skills and qualifications for all, in particular in science, technology, information technology and modern languages;
- providing young people with direct experience of the world of work through real work experience;
- enabling young people to be effective, enterprising and capable at work through active and practical learning methods;
- providing counselling, guidance, individual action plans, records of achievements and opportunities to progress to higher levels of achievement.

(T.V.E.I., 1990,p.3)

1986 was declared 'industry year' and this gave more publicity and incentive to those interested in school-industry links. In 1988 the first C.T.C. (City Technology College) was set up. These were schools that were literally purpose built to focus on school-industry links and the curriculum areas of science, mathematics and technology. The national curriculum document on technology education was produced in 1989 and introduced as a compulsory part of the curriculum in 1990. The technology curriculum in England and Wales came under the heading of design and technology and was in the form of an 'order'. This order consisted of two profile statements, one for design and technology, the other for information technology. There were five attainment targets, four for design and technology and one for information technology. This order was the first compulsory technology education national curriculum in the world. In 1991 the first designated technology schools were introduced. These were schools along the same lines as the C.T.C.s but were converted from existing schools, and comprised a much cheaper and more viable option for the government.

T.V.E.I. ideals were not followed by every school who received funding (Benson 1991). The British Government in 1991 produced a white paper entitled 'Education and Training for the 21st Century'. The notion of a more focussed vocational curriculum was introduced and a new qualification was designed to acknowledge this (Yeomans, 1998).

The G.N.V.Q. General National Vocational Qualification was to operate at three levels (Foundation, Intermediate and Advanced) and target 16-19 year olds. The G.N.V.Q. was based upon a competence-based curriculum already in operation for occupationally specific qualifications in industry. Its critics (e.g. Hyland, 1994) claim it is too narrow in focus, behaviouristic and atomised. Whereas its advocates (e.g. Jessup 1991) claim accessibility, transferability, transparency and the promotion of independent learning. Similar arguments occur in New Zealand with regard to Unit Standards.

The G.N.V.Q., according to the white paper, was designed to:

> *Offer a broad preparation for employment as well as an accepted route to higher level qualifications, including higher education. Require the demonstration of a range of skills and the application of knowledge and understanding relevant to the related occupations. Be of equal standing with academic qualifications at the same level.*
>
> (DES/DOE/Welsh Office, 1991, p. 19)

Six years after the original order, in January 1995 England and Wales had a new technology education curriculum. The old order had received wide criticism, most notably from teachers who found almost 200 assessment statements difficult to deliver. There was confusion about the generic nature of technology for teachers who had come from different more traditional backgrounds. HMI, Her Majesty's Inspectors of Schools, published in their annual reports, 1990 and 1991, a picture of declining ability to design and make (Barlex 1998).

In 1992 the political debate around this new curriculum area was fuelled by a report from the Engineering Council which opened with the statement 'technology is a mess'. The authors of the report were Smithers and Robinson, and this report was to play a significant part in the demise of the first order.

The main reason why technology in schools seems so elusive is that it embodies the aspirations of a number of different interest groups which have been kept together only by pitching its objectives and content at such a high level of generality that it can include almost anything.

(Smithers and Robinson 1994, p. 37)

Smithers and Robinson mention one other source of confusion and that is the tendency to use vocational education synonymously with technology education. The authors acknowledge the importance of industrial contexts within technology education but suggest that it adds to the confusion if technology and vocational education are used interchangeably. There seems to be a significant contradiction here. The main rationale for the introduction of technology education in England and Wales was to bring schools and industry closer (see Great Debate p.31). However, those charged with curriculum review in the area, usually educationalists, wish to keep vocational and liberal education separate.

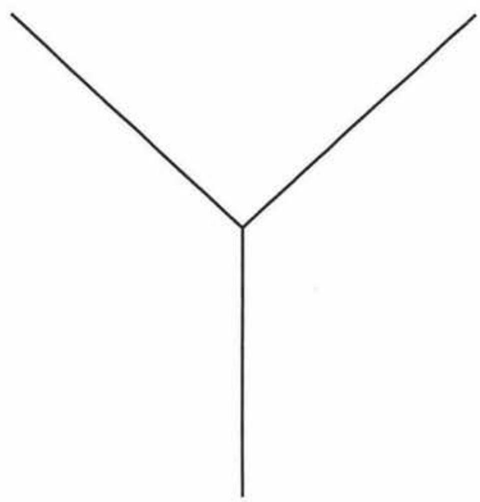
In the new orders of 1995, the original four attainment targets for design and technology have been reduced to two. The assessment procedures are more holistic than atomised which makes it easier to understand. There has been a shift more centrally to designing and making, which has given the teachers a clearer focus.

In 1998 there was a workshop at the Design and Technology Association (DATA) conference where two researchers carried out a survey of delegates. The Design and Technology Association is the professional association for teachers of technology in the United Kingdom. The workshop survey was to try and ascertain where the delegates who were mainly teachers saw the subject at present and where did they wish to see it beyond 2000.

Figure 4: Rationale for the study of technology education

Children should study
D&T because it enables
them to understand and
operate more effectively
within an increasingly
economy.
more technological world.

Children should study
D&T because it enables
them to contribute
towards a more successful
and competitive



Children should study
D&T because it enables
them to realise more fully
their potential as humans.

Delegates were asked to mark their scores on each of the axes differentiating between current and future situations. The conclusions were that delegates appeared to feel all three were currently valid, but with less sympathy for the economic rationale. This became more pronounced as they considered the future with 40% feeling this was a low priority and 88% voting for the subjects raison d'être being primarily humanistic (Wilders & Pitt, 1999). This study, though small, does indicate a difference in the rationale from the policy makers to the classroom teachers. The economic instrumentalist may dominate the policy but the liberal educators retain control of the delivery.

On September 9th 1999, the Secretary of State announced revisions to the national curriculum in England. For design and technology the changes were more organisational than content specific. The main shift was to reduce the attainment targets from two to one. This was done to simplify assessment further and to emphasise the inter-dependence of designing and making.

Clearly, the international picture emphasises the economic instrumentalist stakeholder position at least at the policy level. In the United States one of the driving forces over the last couple of decades has been the publication of a report called *'A Nation at Risk'*

According to Alex Molnar (1996) who has written condemning the involvement of industries in schools; *A Nation at Risk* put educators on notice that they had better co-operate with business in building a "world class" system of public education. Again and again teachers hear that "outrage is stalking boardrooms across the land." He goes further to describe what really was upsetting the American business world.

> *Executives are fed up with a debased and trivial school curriculum that fails to provide children with the skills needed to compete with the Germans and the Japanese.* (Molnar 1996, p.29)

The reason that school-industry links are a topical issue seems to relate directly to the economic woes of the country. When the country is doing well, school-industry links are not top of the agenda, however, if there is an economic downturn it seems that the state education system comes under much closer scrutiny and criticism for not delivering the 'skilled' workforce required. When considering why school-industry links are popular, both in Australia and internationally, Price comments:

> *The emerging school-industry links program in Australia is part of a world-wide movement to establish closer links between education and industry. It is important for us to realise that while the reasons for the recent upsurge in the degree of school-industry co-operation may vary in detail from one country to another, in general terms there is one underlying catalyst responsible for this activity: the restructuring of the international economy.*
>
> (Price 1991,p. 11)

Jamieson (cited in McCormick) puts it quite succinctly, thus

> *Crudely when the economy is in boom there is a tendency to allow education to fulfil the needs of the individuals rather than the needs of the economy. In times of economic depression, there are pressures to force all parts of the social structure to conform to the needs of the economy.*

(McCormick, 1992, p210)

That would explain why *'A Nation at Risk'* had such an impact in the United States. The enthusiasm with which executives and their political allies responded to *A Nation at Risk* was not surprising . Its underlying logic cast America's enduring economic crisis as primarily a symptom of the failures of public education. (Molnar, 1996)

'Tomorrow's Schools' (1988) in New Zealand offered much the same rationale for educational reform as *A Nation at Risk* did in the United States.

> *With the introduction of tomorrow's schools reforms, there is increasing pressure schools to adopt business sector management models, systems and principles.*

And then later

> *This is seen as a battle between a functionalist or utilitarian view of education and the liberal ideals that have underpinned the historical development of the New Zealand schooling system.*

(ERO, 1996)

It is worth noting that the case study school in the present study has used some STAR (Secondary Tertiary Alignment Resource) funding for the promotion of school-industry links. This funding was introduced as a result of a Ministerial Reference Group (MRG) review of school resourcing in 1995. Part of the groups recommendations were that :

> *...a proposals pool be made available to provide additional resources for state secondary schools to purchase or provide their students with*

tertiary level programmes which have higher costs than conventional programmes.

(Ministry of Education, 1995)

Eligibility for this funding was on a contestable basis, and to be eligible the programmes offered by secondary schools had to meet certain criteria. These criteria were described in general terms. To be eligible, programmes had to:

- lead to assessment towards credit for unit standards on the new National Qualifications Framework for non conventional school subjects;
- lead to assessment towards other specified qualifications which are not registered on the National Qualifications Framework (e.g. New Zealand Certificates of Science and Engineering, a trade certificate, the Primary Cadet Scheme);
- lead to credit towards a degree programme or teacher training certificate or;
- be a 'vocational taster programme' (a capped pool of $1.5 million).

(Ministry of Education, 1995)

Molnar argues that if the education system was to provide more highly skilled workers all that would happen would be that the level of discourse at the unemployment offices would be raised. Price (1991) noted that any improvement in the education sector which leads to further education for a higher number of students may in fact create a shortage of those ready to go into the manufacturing industries. Additional questions about social justice and values and ethics might lead us to the conclusion that these links or partnerships are politically too hot to handle. Yet there are a significant number of schools both here and overseas who partake in some kind of link.

The United States has a decentralised education system with each state responsible for its own education. The federal government provides some general control through funding guidelines. Some states have curriculum development and implementation at a state wide level whereas others have broad guidelines which are delivered through school districts. The diversity available makes it difficult to generalise but there are some general commonalties.

There has been a manual arts tradition since the manual training curriculum in 1870. This curriculum was based around woodwork and metalwork and resulted in students making throwaway component parts i.e. joints etc. This changed slowly over a long period of time to making artefacts that the teacher selected, such as birdhouses, bookracks etc. This change represented a shift towards Scandinavian handicraft methods where students get to take things they have made home (Zuga 1997).

Zuga argues that because industrial arts courses shared facilities, texts, and funding with vocational courses, there has always been a problem with establishing a technology curriculum suitable for general education. According to Williams (1996) the Jackson's Mill Industrial Arts Curriculum in the early eighties was a major turning point where there was a shift from industrial arts per se to curriculum organisers. These organisers (construction, communication, transportation and manufacturing) have been the mainstay of curriculum developments in subsequent years.

More recently, the powerful International Technology Education Association (ITEA) which is made up of mostly North American technology teachers has produced a conceptual framework for technology education. This framework has a focus on 'doing' emphasising process education through problem solving. McCormick (1993) notes that it has the following attributes:

- People create technology;
- Technology responds to human need or wants;
- People use technology;
- Technology involves action to extend human potential;
- The application of technology involves creating, implementing. Assessing and managing;
- Technology is implemented through the interaction of resources and systems;
- Technology exists in a social/cultural setting;
- Technology affects and is affected by the environment;
- Technology affects and is affected by people, society and culture;
- Technology shapes and is shaped by values.

(Savage and Sterry, 1989, cited in McCormick 1993, p. 46)

The ITEA took this framework further and developed the Technology For All Americans project. This project, funded by the National Science Foundation (NSF) and National Aeronautics and Space Administration (NASA) produced a rationale and structure for the study of technology. In April 2000 these were published as *Standards for Technological Literacy: Content for the Study of Technology.* These standards define what students should know and be able to do in order to be technologically literate. They also provide standards that prescribe what the outcomes of the study of technology in grades K-12 should be. However, the standards are not a curriculum document and therefore do not put forward a method of achieving their goals.

In its executive summary, ITEA provide a list or reasons why content standards are important:

- Technological literacy enables people to develop knowledge and abilities about human innovation in action;
- Technology content standards establishes the requirements for technological literacy for all students from kindergarten through to grade 12;
- Technology content standards provides qualitative expectations of excellence for all students;
- Effective democracy depends on all citizens participating in the decision making process. Because so many decisions involve technological issues, all citizens need to be technologically literate;
- A technologically literate population can help our nation maintain and sustain economic progress.

(ITEA 2000)

2.4 School-industry links: theoretical assumptions.

Saunders (2000) argues that there are four 'significant underlying or tacit theoretical assumptions' used to debate education and work links. They are not always explicit or easily identifiable but they are, according to Saunders, the main perspectives; they are:

1. **Functionalist.**
2. **Marxist.**
3. **Liberal.**
4. **Progressive / emancipatory.**

The first two can be described as 'structural' frameworks. They are modernist theories that look at operations from a macro or big picture perspective, invoking notions of the whole society. They imply strong causal frameworks and according to Saunders tend to be reductive, looking for explanations from meta-theories.

The liberal and progressive/emancipatory perspectives look at the relationship between work and school from an education standpoint. Their main focus is not on the connectedness between education and work, i.e. one leading to the other but more about educational practices and their relationships with work.

The understanding of these four perspectives is fundamental for this thesis. Hence, each will be explained further.

Functionalist perspectives.

The functionalist perspective views society as a whole almost like a living organism. In this perspective each aspect of society has responsibilities for the next and all are mutually dependent. Throughout this thesis a cause and effect relationship has been argued i.e. the introduction of technology education and education's responsibility for the economic woes of the society. This is clearly evident in the functionalist perspective.

Put crudely, if labour market requirements are not being met, we should be looking for policy which brings them into line. Critically, this view presupposes that requirements can be 'known', that they are of a 'technical' nature and the 'norm is that they can be met through the choice of appropriate policies.

(Saunders, 2000, p. 686)

Saunders elaborates to say that in this perspective it is seen as logical that education should 'co-ordinate with the requirements of work because that is how societies function'. Watts (1983) identifies this notion as *'human capital'* and offers two key metaphors which are referred to as *'bonds'*. These bonds or *'functions'* are the ways in which education can service employers needs. These functions fall into four categories:

- selection;
- socialisation;
- orientation;
- preparation.

Selection function:

The process of selection matches closely the employment strategies of the industrial era. It relies heavily on industrial practices of division of labour. Educationally it includes systems that regularly test students and separate them by the results. This separation normally includes splitting into academic and vocational type courses with those that fail being filtered off into lower level employment. This forms the basis of social division of labour. Watts argues that this 'technical fix' doesn't work and that this is partly due to the inability of qualifications to accurately reflect skills and abilities. In addition, the variety of qualifications, their differing status and access requirements. This leads to misunderstandings from every party, student, employers and society in general. In this thesis the historical accounts of technology education, both internationally and in New Zealand, clearly reflect this use of a selection policy.

Socialisation function:

The second function identified by Watts is the socialisation process. This is embedded in the pupils' experience of schools. These experiences can involve explicit or implicit procedures, whereby the pupils begin to associate themselves with a particular type of work. This is often done by reinforcing stereotypes i.e. the place of women, class and racial associations with particular employment or courses. Historical forms of technology education are often associated with this function i.e. craft for boys and food for girls. Saunders argues that although education systems are important this function is over estimated and there are other institutions which may have a greater affect of social control i.e. the family and the media. In terms of school-industry links care must be taken to ensure that socialisation does not occur. In the United Kingdom there was a programme called Women Into Science and Engineering WISE, which was particularly aimed at exposing school girls to opportunities in this male dominated employment arena. This programme was designed to redress the stereotype.

Orientation function:

The third function of orientation moves from the slightly more subtle socialisation process to deliberate curricular intervention. Most notably this can be seen through career guidance, work experience or placement programmes. Other curriculum intervention strategies where the study of work practices is encouraged include industry weeks etc. Additionally one could quite easily associate school-industry links with this function if they are carried out without a critical or questioning premise. Typically the words 'enterprise' or 'entrepreneuralism' are used in such orientation practices.

Preparation function:

The fourth of Watts (1983) functions is that of preparation. This refers to the role of schools in preparing pupils with specific skills and knowledge required in the workforce. According to Watts at the general level this may mean numeracy and literacy. However, Saunders (2000) argues that it is this preparation aspect which underpins *'new vocationalism'* and the introduction of education as training. It is also evident in many of the rationales for technology education highlighted throughout this thesis.

This functionalist view would see people as 'human capital' and society would be making an investment in people a term used in both New Zealand and English education policy directives of the eighties and nineties. Lee and Hill (1996) state that this was exactly the rationale for the introduction of the New Zealand curriculum and was the driving ideology of the Minister of Education Lockwood Smith. Therefore this perspective argues that investment in technology education will no doubt bring returns in the technological fields of both higher education and employment. According to Saunders this human capital theory has proved to be incorrect, citing the English example of higher numbers of students going on to University but studying in "esoteric courses" like sociology rather than science and technology (Saunders 2000).

Marxist perspectives.

As the researcher suggested earlier, Marxist perspectives share many similarities with functionalist perspectives. Traditionally Marxist perspectives would encourage the study of relationships that exist between people as they go about their work and how that fits with their family life right down to feeding and clothing themselves. Of course the wider picture would need to be considered, including the social and historical context of such a study. According to Saunders, at present we are in a capitalist mode in which classes of people buy and sell labour, this is not an equal relationship. There are many cases of labour exploitation, and Saunders argues that these Marxist perspectives are sustained by the existing education system.

Education, according to Saunders, if studied from a Marxist perspective, is there to maintain the status quo, thus enabling the capitalist mode of production to continue. This is done in education following much the same bonds as described earlier in the functionalist perspective. The difference is more ideological than practical. Functionalists identify socialisation as a means of creating order, Marxists as a means of maintaining social control. Functionalists identify selection as distributing recruits into a division of labour; Marxists as a means of sustaining inequalities in the education system and later life. These are often found in work habits and attitudes and Saunders describes this as the "hidden curriculum".

These perspectives are related to industrial practices and are often called Fordism. In England they are also linked to the class structure, i.e. working class boys being prepared for work. Identification of cultural capital, on which the middle classes can draw to try and maintain or improve their position, is the essence of the vocational and academic divide.

Young (1998) refers to a divided system which has a divided curriculum and divided qualifications and ultimately has a selective function. This thesis has highlighted the divisive systems of overseas countries and New Zealand and its relationship with technology education.

The liberal perspective.

The liberal perspective, through the delivery of liberal education, has come to signify the opposite view of education from functionalist or instrumentalist. The liberal perspective sees education as important for its own sake not just to fulfil some extrinsic factor such as employment. According to Saunders(2000) this view of education historically was associated with the aristocratic classes, but in the modern era is free from the divisive aspects of class etc.

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"The liberal perspective considers as misconceived the explicit preparation for work through work related activities as part of general education," (ibid., p. 691) The liberal perspective would advocate that explicit vocational preparation is best undertaken either at work or just prior to beginning it. Instead advocates of this perspective highlighted by Saunders believe the best preparation for life is a general education which is broad deep and informed by the whole culture not just one aspect of it. This may include interactions with the world of work but not as direct preparation for a particular occupation but as a pedagogical process. Effectiveness within this perspective should not be analysed in a narrow sense related to a particular employment or national economy.

The attributes one would expect to get from a liberal education are more general e.g. autonomy, creativeness and critical thinking. Another key component would be equal access for all.

What is important for this perspective is the democratic imperative that no child should be denied access to these forms of knowledge and experience in the mistaken belief that they are not 'relevant' either to them or an extrinsic need like that of employers.

(Saunders, 2000 p. 692)

The liberal perspective advocates that this *'general education'* preparation is suitable for future life including work. Saunders describes the main problem for this perspective is finding ways for all pupils to get the opportunity and access. Generally in education the knowledge is imparted and learned in disembodied chunks and then tested through exam at a latter stage where only those who have the cultural means to accommodate this method succeed. The liberal perspective may support technology education but it would be technology education as general education not vocational.

The progressive emancipatory/perspective.

This perspective is associated with individual growth and learning styles which accommodate these. This, according to Saunders, will lead to social goals of civic participation and democratic emancipation. Saunders identifies two sub-themes in this perspective. The first surrounds *'learner centredness'* and personal growth, whereas the second is *'social reconstruction'* through empowerment. It positions education centrally in social and personal reconstruction and is optimistic in nature. This perspective brings these two sub-themes together in the style of learning.

Unlike functionalist and Marxist perspectives the progressive perspective underplays the social and political context. It also under-emphasises the nature of knowledge and skill that the liberal perspectives see as the starting point. It emphasises the power of the educational process to allow the learner to transform the above to allow the individual to re-orientate itself. School-industry links like the liberal perspectives are not needed to be explicit.

The purpose of the educator is as facilitator and enabler to allow discovery to take place rather than direct it. Interestingly for technology education the learning is considered to be tacit and to involve situated learning which is contextualised. Self fulfilment leading to self esteem and the capacity of the individual to take up a responsible and active position in society is the desired outcome. There are similarities with Dewey's notion of doing and thinking as learning. However, there is some contradiction in this perspective, if the learner becomes so self sufficient and self centred they may reject all notions of civic responsibility and may not wish to play any part in it.

All of these perspectives have a different ideology and offer different approaches to school-industry links. Some have been established for a long time and are historically entrenched in the education system itself. Is there a way forward?

Recently there has been a shift internationally in industry away from the Fordist approaches and the division of labour which have dominated industrial production for at least three quarters of the last century to a *'flexible specialisation'* characterised as post Fordism. Will this bring about changes in educational policy?

The views of Dewey have been expressed throughout this thesis. According to Marshall, Dewey was offering a reconstruction of school methods.

> *This was not to make the schools an adjunct of industry and commerce and to acquiesce in the 'untransformed, unrationalised and unsocialised phases of our defective industrial regime', but of utilising the intellectual problem-solving potential inherent in modern technology; 'to make school life more active, more full of meaning, more connected with out of school experience'.*
>
> Marshall (1997, p 309)

This connection theme has also been highlighted throughout this chapter. Young (1998) when talking about flexible specialisation and its relevance to education introduced a notion of *'connective specialisation'*. This contrasts with the insularity of the traditional subjects specialists and ultimately with the divided curriculum *per se*. This is not to dismiss the specialisation but to see it from a different perspective. Divisive specialists see the curriculum from the point of view of their subjects, whereas connective specialists see their subjects from the point of view of the curriculum. Young argues for a shift from teacher centredness to learner centredness.

According to Young, at the individual level the connective specialisation refers to the need for an understanding of the social, cultural, political and economic implications of any knowledge or skill. It would enable the student to transcend the divisive curriculum and reject the split between 'educated person' and 'competent employee'. In other words it would do away with the qualification's and curriculum's selective function clearly evident in the English system.

The connective curriculum acknowledges that education takes place in a community of practice and that learning is purposive and a social process (Lave and Wengler, 1994 cited in Young 1998). It highlights the need to relate educational activities to developments in the wider society including but not exclusively linked to industry. So connectivity is more than just a curriculum model, it is the purpose of school itself.

Technology education may be a step towards the connective curriculum, as described by Young. It replaces the divisive practices of the past craft subjects. It acknowledges the community of practice; it can be student centred and incorporate the liberal perspective. If technological literacy, as identified by Pacey, is the focus of study in this area and if school-industry links are seen as part of a whole i.e. connecting school with the 'real world' and not just as in a functionalist or Marxist perspective of preparation. for work, technology education has some promise.

PART B

2.5 A New Zealand perspective.

A similar set of rationales to Layton's for the teaching of technology in New Zealand is expressed by Alister Jones (1997) who had a leading role in the development of the technology curriculum. He describes six grounds for developing technology education.

These are as follows:

(i) Economic

In his description of the economic justification, Jones identifies that enterprise has expressed the need for people who are creative, innovative and resourceful and have the ability to adapt to an ever changing world. He goes further to state:

> *Our economic future depends on developing product and market niches. This argument points to the value of the interaction of school students with the commercial world.* (Jones, 1997, p.49)

This viewpoint is similar to that expressed by the economic instrumentalists as described by Layton (1993).

(ii) Pedagogic

Jones describes the pedagogic dimensions through the real life contexts that technology education can bring to the curriculum. An integrated curriculum approach brings together the knowledge and skills from the other curriculum areas and external experiences into an individual problem solving learning experience. It also brings together and, more importantly, values equally the different domains of knowing and doing. This combined with an increased understanding of the relationship between technology and society is a strong pedagogical argument. This would seem to concur with the arguments presented by the liberal educators as described by Layton.

(iii) Motivational

Under this heading Jones describes how students will readily engage with technology education because of its real life relevance to them. If technology is about meeting people's needs, wants and interests then topics such as sports technology, communication technology and health technology should allow easy access for students. From this starting point of motivational interest and familiarity, technology teachers could then expose them to different unfamiliar aspects of technology education.

Cultural

Jones describes how different cultures throughout time have had different ways of tackling technological issues and that this is particularly important in a multicultural society. The opportunity to discuss values and beliefs within the technological context is seen as a valuable reason for technology education. This could be seen as a direct response to the cultural aspect identified by Pacey (see figure two). It can also be associated with the ideas of the defenders of participatory democracy as identified by Layton.

Environmental

Pupils should explore the environmental impact of technology and know the possible environmental considerations for past and future technologies. By studying technology in this way students are better informed and equipped to deal with further advancements in this area. This argument for technology education is similar to Layton's sustainable developers in many respects.

Personal

Lastly Jones describes a personal reason for teaching technology, this personal argument is looking at education in terms of the student's personal needs.

> *In a technological world students should be aware of their responsibilities as members of a technological society to contribute to informed decision making about technology and to become empowered to be active in response to new technological challenges.*
>
> (Jones, 1997, p51)

Jones elaborates by describing how students are not encouraged to take risks within the traditional curriculum areas yet in technology it should be encouraged. Choices and decision making play a major role in a technological activity sometimes the decisions involve conflicting criteria and this offers students opportunity to become risk takers. This 'empowerment' notion is important and also links to liberal educator's aims.

These six grounds for teaching technology which are identified by Jones and follow closely Layton's stakeholders, are very similar to what appeared in the final version of the New Zealand technology curriculum.

> *Technology education is a planned process designed to develop students' competence and confidence in understanding and using existing technologies and in creating solutions to technological problems. It contributes to the intellectual and practical development of students, as individuals and as informed members of a technological society.*
>
> (Ministry of Education 1995, p7)

2.6 Technology education in New Zealand: bright future or repackaged past?

It is beyond the scope of this thesis to research fully the development of technology education in New Zealand. However, it is appropriate to highlight the key events which had a bearing on its rise and the policies behind it, leading to its inclusion as part of the current curriculum framework.

In 1877, the public primary schooling system was introduced and it was made available and free to both rural and urban children in New Zealand. The quality of education however, was bookish and resource-poor, often with a staff to pupil ratio of 1:100(McKenzie 1992).

In 1900, John McKenzie, the Minister of Lands, argued that rural schools should focus the curriculum more on technical and agricultural content and that this would have a more direct bearing on students' lives and the occupations that they might pursue in their area.
However, it was noted that:

> *If in an agricultural district you trace the occupations followed afterward by pupils passing higher standards you will find that a larger proportion of them go into fancy occupations, such as clerking etc. than go into agriculture. And the same applies in the mining districts. For some of the district high schools double the number go into the teaching profession than go into mining, and four times the number go into the Civil Service than go into mining.*
>
> (McKenzie J. cited in McKenzie D. 1992, p. 31)

Thus, even in its early development, schooling in New Zealand faced the dilemma of vocational versus academic aims. John McKenzie believed that students should study courses that would help them obtain work generally agricultural in their locality. In reality, during the early 1900s, New Zealand society was continuing to become more urbanised and students leaving school were trying to enter occupations in the towns and cities. The policies of the government directly affected the content to be taught in schools aligned to some perceived need, but in this case as in others they often got it wrong. (McKenzie et al ,1990)

Attitudes, and to some degree policy, reflected the educational practices of England where, according to McKenzie, technical schools of that era were associated with second class knowledge. Nevertheless by 1910 technical high schools were established in all the major centres. Again, instead of offering a route into the manufacturing sectors these courses, which were typically only a year long, tended to prepare pupils for the commercial sector mainly helping pupils into clerical positions. There were apprenticeships available for those who wished to go into the manufacturing industries.

The powerhouse of Western Europe during this time was Prussia and they had a technical curriculum although many viewed it with suspicion. In 1919, Henry Holland; the leader of the Labour Party in New Zealand, described the German system as preparing pupils to be 'wage slaves' and part of the efficient machine (McKenzie 1992). In 1926, W.J. Morrell, the Rector of Otago Boys High, stated that his school would continue to serve the professional sector and the local technical schools could cater for the artisans and lower commercial classes.

There was a shift in the policies and views expressed through the Atmore Report of 1930 where it was stated that post primary schools were small in size and should cater for both sectors. In 1935 the Labour Government proclaimed equal status for students entering post primary education, however, the reality was quite different. Academic studies were for those who would go on into professional courses and short 'realistic' courses were available for those who would not stay at school, typically the Maori youth. These early attempts to end the divided curriculum failed.

After the Thomas Report in 1945 the Education Department imposed a compulsory core curriculum. The committee responsible for the report saw its role as preparing a curriculum to educate pupils for their forthcoming roles as 'workers, neighbours, homemakers, and citizens (Lee 1992). This led to a comprehensive type of education which was to be the demise of the technical school, though it did take almost twenty years for it to happen (McKenzie 1992). The author acknowledges that the path for the academic into further and higher education changed little in comparison during this same period.

It would seem that the stakeholders behind the curriculum in 1961 were quite liberal in their approach to technical education. The syllabus of the time declares:

> *It is most important to keep in mind that the development of children as individual personalities is the purpose of handcraft. It is not our purpose to train cabinetmakers or to give a course preparatory to apprenticeship in a metal trade.*

The introduction goes on to lay out the aims for the curriculum:

> *To provide opportunities for children to develop in character and personality by using their abilities creatively.*
>
> (Department of Education 1961)

The next curriculum change occurred in the technical area after a national course on craft was held at Lopdell House in 1972. A curriculum unit paper *entitled Craft Subjects Forms 1-5* was published. The main recommendation of this document was that a revision committee should be formed to draw up new syllabuses, and that these syllabi should be offered to both boys and girls and should include a School Certificate course.

In 1986, the Department for Education published *the 'Forms 1-4 Workshop Craft Syllabus for Schools'*. The aims for workshop craft were expressed in this document as follows:

> *To provide workshop experiences that enrich students' growth and development, and encourage them to be creative and imaginative. These experiences should foster in students responsible attitudes, a sense of achievement, and personal satisfaction.*
>
> (Department of Education 1986)

Again one might suggest that the liberal educator stakeholder is still evident.

Vocational or liberal: the argument in New Zealand.

According to Steve Benson, a Senior Policy Analyst at the Ministry, there has been a keen interest in technology education initiatives since the late seventies (Benson,1991). What was the driving factor for that interest? Marshall describes a connection between the rise of a 'new vocationalism' and youth unemployment.

> *It became possible in New Zealand in the 1980s to refocus this attention away from economic factors and the restructuring of the industrial, economic and welfare sectors and onto education and training - and the skilling of young New Zealanders for the economic and technological challenges ahead.*
>
> Marshall (1997, p304)

Marshall highlights the New Zealand Employers Federation as a key driver in this regard. The federation was very critical of the schools' lack of involvement with vocational preparation. They even went so far as to blame schools for the youth unemployment, citing a narrowly academic curriculum. These views in part were the reason why transition programmes for 'at risk' pupils were introduced. According to Marshall, education changed from being of intrinsic value, and became extrinsic and instrumental leading to the world of work (Marshall 1997). Marshall argues that the involvement in education of industry is part of what is called 'busnocratic rationality'.

> *Central to this notion are the concepts and stances taken in promoting skills, as opposed to knowledge; and the view that it is consumers, especially industry, who define and determine quality, as opposed to the providers.*
>
> (Marshall 1997, p.318)

In this 'new vocationalism' truth and quality are determined by business values. It leads to consumer choice and the 'autonomous chooser' but, according to Marshall, in reality this is not the case because all the choices have behind them the business ideology. The importance of this change was understood by the Chief Executive Officer of the New Zealand Qualifications Authority (NZQA) who stated that: *"The big challenge is to change entrenched attitudes and establish an education and* *training culture"* (Hood, 1994, p.40 cited in Marshall). The NZQA was a body established by the Education Act 1989. The NZQA was required amongst other things to set up the National Qualifications Framework (NQF). The goals for the NQF included creating a single integrated qualifications structure which is flexible, and responsive, widely and easily accessible, and is informed by both labour market requirements and educational requirements (Hood et al., 1996, p. 1).

There was criticism of the NQF from many quarters, one of which includes evidence from an empirical study by Fitzsimons (1997). Initially the focus of the qualifications policy was on developing unit standards for industry. To facilitate this, Industry Training Organisations ITOs were registered under the Industry Training Act 1992. Their job was to develop standards to meet their industry's needs. In 1993-94 work on Unit Standards widened to include schools and their subjects. Despite advocates of standards based assessments such as Peddie (1992) the introduction of these initiatives has not gone smoothly. In 1998, a revised structure for senior secondary school qualifications, labelled Achievement 2001, was developed by the Ministry of Education and NZQA (Ministry of Education, 1998b). The qualifications developed from 'Achievement 2001' the (NCEA), National Certificate of Educational Achievement, has three levels designed to be the main school qualifications for 16-19 year olds. They form part of the NQF and can be provided in school or by other educational providers. Schools can offer a combination of Unit Standards and the NCEA. The level one NCEA for technology was developed in 1999 and levels 2 and 3 will be developed by 2001 for a phased introduction beginning with level 1 in 2002. The technology NCEA has involved meetings of 'expert panels' led by the Qualifications Development Group made up of various stakeholders, and different interpretations of technology education have been put forward. Already there has been strong criticism levelled at the NCEA, most notably from the Education Forum (August 2000) suggesting it will lower standards. A response from the government was sent to all schools on 23rd August in a letter from Howard Fancy, the Secretary for Education. The debate is sure to continue.

There are many similarities historically between what happened in England and what happened in New Zealand. Technology education can be seen as a pawn in the arguments between the advocates of vocational and those of liberal education, in both countries. The association seems to be stronger in the vocational argument. It is too early to judge technology education's justification as part of a general education due to its relatively recent introduction.

However, there are researchers in New Zealand who have highlighted the possibility of technology education to support liberal education ideals. Davies (1998) noted that if curriculum developers were to incorporate both technological knowledge and the intellectual as well as practical components of technique combined with the history and sociology of technological change liberal ideals could be met. These 'dimensions' combined together in technology education would contribute to technological literacy and ultimately support liberal education.

By 1988 some proposals for the inclusion of technology as a core curriculum subject had been made but these were overtaken by the 1989 education reforms. In 1992 a government appointed working party led by the Centre for Science, Mathematics and Technology Education Research (CSMTER) at the University of Waikato produced a framework for technology education. It was identified by researchers at the time that even amongst this group the various stakeholders positions as identified by Layton were evident. (Burns 1992; Monteith, 1992). Six papers addressing various aspects of policy were produced, and they reflected in many ways the technology developments in the UK. These papers were adopted by the Ministry and went on to form the basis of the draft curriculum statement for technology education. Davies (1998) points out that the foreword to the policy framework contained an economic rationale which was a shift from the more liberal approach put forward the year before in a paper entitled *So This Is Technology!* (Ministry of Education, 1992).

The (CSMTER) team, led by Dr. Alister Jones and Dr. Malcolm Carr were asked to develop the new materials and in 1993 the draft curriculum was produced. Two advisory committees were appointed to review the milestone reports. The make-up of these committees has been called into question.

> *It could be suggested that the construction of the committees strongly favoured approval of a curriculum supporting an economic instrumentalist philosophy designed to achieve government goals of entrepreneurship and national economic growth.*
>
> (Davies, 1998 p.125)

The draft curriculum was distributed for comment and the timeline was extended to 1994. According to Davies, the overall response rate was just over 50 percent, with primary schools were more positive in their response than secondary. The Education Forum produced a submission on the draft. It included a report from Andrew Breckon, an experienced design and technology inspector and educator from the United Kingdom. This submission was quite critical of the draft and argued for more focus on design and making activities and the removal of the strand concerned with the relationship between technology and society.

At the same time a video television series was produced by Copeland Wilson and Associates to support the draft curriculum called *"Know How"*. It went to air in mid 1994. By 1995 submissions on the draft had been received and the final statement was published in October 1995. Implementation concerns were central to a decision taken by the Ministerial Consultative Group on workloads, who met in May 1997. Subsequently the revised date for implementation became 1999. The final curriculum statement retained three strands, not two as Breckon had suggested. The strands are:

(a) Technological knowledge and understanding.
(b) Technological capability .
(c) Technology and society.

The curriculum statement can be interpreted by teachers to develop their own programmes and there is the opportunity for those with the breadth of knowledge to attempt to match Pacey's model and retain a liberal perspective. Reflective and capable teachers can interpret the statement in accordance with their educational goals. However, one of the main concerns is the availability of such teachers in the school system at present. Critics from the new right claim that this will undoubtedly lead to *'provider capture'*. The curriculum statement is quite vague in detail beyond the three strands and this allows for those who are opposed to change to try and maintain the status quo. As suggested throughout this thesis there has also been *'ideological capture'* of technology education by economic instrumentalists and some researchers have spoken out strongly against this (O'Neill & Jolley 1996, Snook 1997)

Sullivan (1997) describes the introduction of the technology curriculum in New Zealand as part of an ideological shift. This shift has meant the demise of what he calls a 'true partnership' where teachers parents and the community work together focussing on children's education. It is a shift to a business model where teachers are seen no longer as partners but as employees. In this role they are there to service the needs of their employers and meet the needs and demands of the market. This ideological shift to the "new right" can be seen as the thrust behind the Picot Report, Tomorrow's Schools and the Sexton Report.

Although there have been relatively few historical accounts of curriculum reform written in New Zealand, those that exist invariably mention the importance of technical education in shaping curriculum reform. Some, such as John Nicol's *'The Technical Schools of New Zealand',* give a sympathetic account of technology education's involvement. Others such as John Codd spoke of the conflicts between the *'Traditionalists and Progressives'* and the involvement and influence the stakeholders had, describing them as 'legitimated sources of power and authority'. In fact for Codd these influences have been especially strong in New Zealand:

> *For it was the social demand of industrial and technological expansion in the nineteenth century, with its resultant needs for specialised skills and a well-trained workforce, which gave impetus to the whole political movement towards universal compulsory education.*
>
> (Codd 1981 pp.55-56)

This thesis argues that the same can be said for the development of the current technology education curriculum and particularly the notion of school-industry links. The voice of the economic instrumentalists would seem to be the loudest of all. Is there evidence to support their position? If the Bright Futures Package published by the Ministry of Commerce in 1999 is to be believed, New Zealand must take action now. Similar rhetoric from the government has not gone unchallenged in New Zealand. Snook (1996) addressing the issue of links between a country's prosperity and the education system argues that:

> *...there is in fact little evidence to suggest that manipulating schools makes any impact on the economy or on a person's ability to get a job. These are two doctrines which have been held uncritically over the past few years but they are increasingly implausible.*
>
> (Snook 1996, p7)

2.7 The Economic Growth Argument

If as argued earlier the main influence for the introduction of the technology curriculum was the economic imperative, what are the determinants of economic growth?

According to Alcorn (2000 p. 77) there is a mix of factors which impact on the ability of an economy to grow. The author categorises them under five general headings.

Population: This heading includes overall size as well as things like demographics. New Zealand is a small country and will always struggle to meet this factor.

State of the arts: This is described as the types of technology, their availability and application. Again for New Zealand there will always be a difficulty because of size. That said, in certain areas of technology New Zealand has made some impact, biotechnology being a prime example.

Growth of knowledge: This includes the specificity of the knowledge, the overall growth in knowledge and how it is assimilated and communicated through education. This has not been a strong factor for New Zealand low expenditure on research and development in technology related fields.

Available resources: This includes the type and quantity of resources available, their use and expectations of resources for the future. New Zealand is relatively resource rich but small in size, and many resources are now owned by off-shore investors e.g. forestry.

Rate of capitalisation: Investment in productivity, according to Alcorn, is as much about attitude towards the investment as it is about the actual amount of investment. There seems to be an exodus of investment from New Zealand to foreign shores, notably Australia.

Alcorn (2000) states that three of the five factors in economic growth are directly related to technology: (a) State of the arts, (b) growth of knowledge and (c) the rate of capitalisation. The state of the arts is the development of technology in that society. The rate of capitalisation relates to spending on technology, and the author specifically talks of technology in terms of artefacts. The third factor, i.e. growth of knowledge, is identified as the most important of the factors for long term economic growth. Unlike questions of resourcing, which are hard to change the quality and quantity of technology education can be increased. Perhaps this is why technology education has become increasingly popular as a new curriculum area in national curricula around the world. Perhaps this also explains policies such as the "Bright Future" package which look to education to meet some of the factors described by Alcorn.

2.8 The employment argument.

One of the major impacts of economic growth is the effect on employment. The significance of technology education for the employability of future school leavers is one of the key assertions of the economic instrumentalists. The association of technology education with vocational education has already been identified in this thesis.

In their recent publication, *'Working together building partnerships between schools and enterprises',* the New Zealand Ministry of Education outlines why these "links' are required.

> *The nature of work, and the workplace that students can expect to enter, are rapidly changing in response to technological developments and changes in trade relations and the economy. To respond to these changes , schools need to develop in students the knowledge and skills that enable them to be self reliant and adaptable participants in working life, whether paid or unpaid.*
>
> (Howard Fancy, Secretary for Education, 1999, p.2)

Later, in the same foreword, the secretary states that one of the ways the New Zealand government plans to improve education responsiveness to this issue is by:

> *incorporating into the curriculum framework the new essential learning area of technology, which encourages participation with enterprise through its emphasis on technological practice and links with the community.*
>
> (Ibid.)

Again in recent years technology education has become synonymous with vocational education. This relationship is being explored by teachers throughout New Zealand as they begin to teach the new curriculum area of technology which has been introduced from January 1999. As stated earlier, the curriculum document for technology education regards the links between schools and the community as important to the development of inclusive technology education.

> *The link between schools and the community, including business and industry, tertiary institutions, and local authorities, is important to a well developed, inclusive technology curriculum.*
>
> (Ministry of Education 1995, p. 17)

Consideration needs to be given to the political climate in which technology education has been introduced and whether there are other reasons for creating links with parties outside schools. Late in 1999 the New Zealand Government published a booklet entitled *"Bright Future, 5 steps ahead, Making ideas work for New Zealand."* (New Zealand Ministry of Commerce, 1999). Max Bradford, the then Minister for Enterprise and Commerce and Minister for Tertiary Education, led the team that produced the booklet. The purpose of the booklet was to highlight how the government planned to transform New Zealand into a knowledge-based economy. The challenge was how to reverse the trend which had seen New Zealand slip from being a country with one of the highest standards of living in the developed world thirty years ago to one of a much lower standing currently.

> *"New Zealand stands at a crossroads. Knowledge will be one of the essential drivers of the New Zealand economy. We are part of a global marketplace. We must create value from ideas. The five steps hold the key to a brighter future."*
>
> (Bradford, 1999,p.6)

As one might expect from an experienced politician, Bradford's statement was largely rhetorical, but assuming that we can believe it, how is this government going to halt this slip? The five key steps of the Bright Future package were announced in February 1999. These are:

- lifting our skills and our intellectual knowledge base;
- better focusing the Government's efforts in research and development;

- improving access to capital;
- getting rid of the red tape stifling innovation; and
- promoting success, and supporting creative and innovative New Zealanders.

(NZ Ministry of Commerce, 1999)

The first of the five steps is focussed on education. The responses to this "step" include the introduction of scholarships for the brightest and best. These scholarships are designed to encourage able students to keep learning, particularly in the areas of science and technology.

The important elements of this scholarship are:

- 500 enterprise scholarships jointly funded with industry for the 2000 academic year, rising to 1500 by 2002. When fully implemented, these scholarships will be worth more than $30 million a year.
- Up to 80 doctoral scholarships worth around $40,000 each a year.
- Increased bursary awards for top maths, science and technology secondary school students, worth $1 million a year.
- $10.2 million over three years for teacher study awards and fellowships in maths, science technology and enterprise.
- Taskforce to ensure enterprise education meets the needs of business.
- $1 million over three years to foster enterprise education in schools.

(NZ Ministry of Commerce, 1999)

If the government is serious in expecting students to take up these scholarships it makes sense to expose them to technology education in school. In any event this package was overtaken by the 1999 general election and a change of government. However this association between the knowledge and wealth of a country is a viewpoint not only held by the New Zealand Government but also others internationally:

> *Knowledge has become perhaps the most important factor determining the standard of living-today's most technologically advanced economies are truly knowledge based.*
>
> (World Bank, cited in *Bright Future*, 1999, p. 12)

The link between wealth generation and technology education has also been raised by many when introducing technology into national curricula (Banks, 1994). It is of significance that around the same time as the publication of the five steps came the compulsory introduction of technology education into the national curriculum of New Zealand. This new addition to the New Zealand education framework includes statements to support the links between schools and industry.

> *Exploring technology in the community, whether in the environment, in products, or in systems, such as those relating to public safety, gives students an appreciation of the relationship between technology and society, how decisions are made, and future opportunities for technological development.* (Ministry of Education, 1995, p17)

In 'Working Together Building Partnerships Between Schools and Enterprises' (1999) the New Zealand Ministry of Education outlines why these 'links' are required. It is argued that the workplace of the future will be significantly different from what we know today and constantly changing in response to new technologies and changes in the economy. Schools will have to change to enable students to be successful participants in this new environment. One of the ways the New Zealand Government plans to improve education responsiveness to this issue is by incorporating into the curriculum framework the essential learning area of technology which encourages links with enterprise and industry. There are researchers in New Zealand who have already called into question the timings of such criticism.

> *Thus, unemployment does bring us back to fundamentals which are not new at all but are frequently overlooked during times of full employment when schools seem to be doing their job and hence are not challenged. The assumptions underlying schooling need to be challenged but in times of economic growth only political activists and academic theorists get around to such challenges- and few listen to them for schools are carrying out (or appear to be carrying out) their main function of preparation for the labour market.*
>
> (Snook 1988, p.220)

There has been little research on school-industry links carried out in New Zealand. However, in 1997, Kay Hawk published a final report on the technology development schools which were established by the New Zealand Ministry of Education in 1993. In the report, the author notes that there might be a mismatch between political ideology and actuality in schools. All four schools in the scheme endeavoured to forge links with industry and they were successful in the areas of job shadowing and work experience. However, the time and effort involved did not bring great rewards in other areas, for example, the learning outcomes of the pupils. Obviously this report involves only a small sample but it was in direct response to the government offering $400,000 in the Education Gazette for schools to become a 'technology development school'. There was a great emphasis on technology programs in all four schools. None of the schools particularly promoted careers in technology but there were early indications that the studies were broadening the students options and making them more attractive to employers. A similar scheme on a much larger scale was operated in the United Kingdom via the Technology College Trust.

> *Perhaps the best indications of a successful education-industry partnership will be when teachers and industrialists genuinely understand each other's point of view and there is an acceptance that the purpose of education is to prepare young people for later life, a major part of which involves working to provide a better quality of life for future generations through scientific and technological progress.*
>
> (Lynch, I. 1993, p. 31)

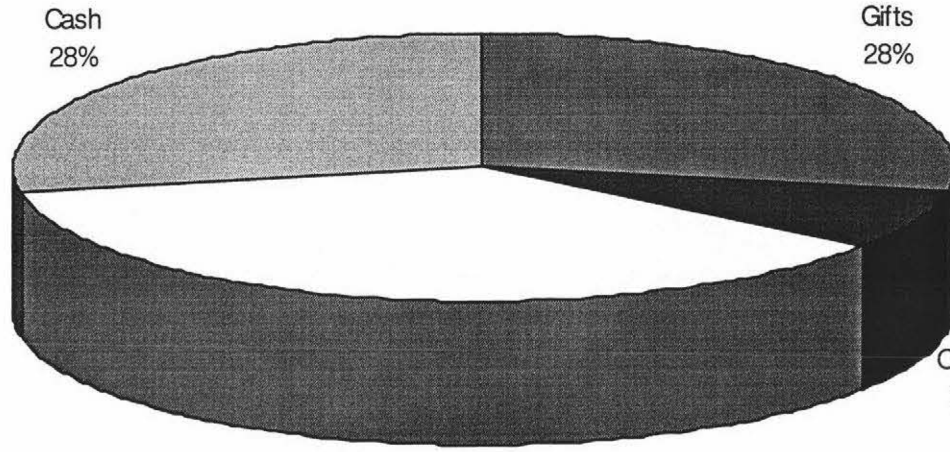
In the United States, one of the driving forces over the last couple of decades has been the publication of a report called *'A Nation at Risk'*. According to Molnar, (1996) who has condemned the involvement of industries in schools, there were reports of outrage in boardrooms across America with the debased and trivial school curriculum, which allegedly, was failing their children. This sounds all too familiar! 'Tomorrow's Schools', in New Zealand offered much the same rationale for educational reform.

It is noted that some New Zealand schools have used their STAR (Secondary Tertiary Alignment Resource) funding for the promotion of school-industry links. Molnar argues that, if the education system were to provide more highly skilled workers all that would happen would be that the level of discourse at the unemployment offices would be raised. Price (1991) noted that any improvement in the education sector which leads to further education for a higher number of students may, in fact, create a shortage of those ready to go into the manufacturing industries. Additional questions about social justice and values and ethics, although too broad for this thesis, might lead us to the conclusion that these links or partnerships are politically "too hot to handle." Yet there are a significant number of schools both here and overseas who partake in some kind of link.

A recent addition to the Times Educational Supplement (TES) (1999) in the UK entitled "Business Links" included an article by Stephen Hoare, who describes how initial interactions with companies were based around donated information posters. These posters contained information about certain industries, often power and oil companies. There was a much greater involvement when, in the early eighties the T.V.E.I. (Technical and Vocational Education Initiative) was introduced. This greater involvement continued with local management of schools and the technology college movement where schools were actively encouraged to seek industrial sponsorship.

The following pie chart was included in the TES article to show how business is investing in education. The chart highlights the involvement of the top 100 companies in the UK. The findings are part of a survey carried out by the Education and Business Partnership (EBP) in 1998.

Figure 5: Percentage breakdown of company involvement with schools.



Source: Times Educational Supplement (1999)

The author also notes that cash donations have been in decline, as businesses prefer to offer help in kind. The rationale for any support is made later in the article when the author states:

> *The reason why education comes top of the business agenda is not hard to guess. Skills shortages are biting across the board and young people's lack of basic skills makes them unemployable in a modern world. Under-performing schools eventually equals under-performing companies. It is not a case of philanthropy it is more a case of self interest.* (Hoare, 1999 T.E.S.)

A more worrying concern is the final reason offered in the article for the business involvement in schools. This is where selling and marketing to schools directly is seen as a future growth area. Perhaps we will see pupils as a potential cash crop or, at the very least, a "pester" power to force parents into buying. This is a viewpoint shared by Molnar (1996) and this move seems to be an ever-increasing reality in the United States. Perhaps the "bright future" that the government is talking about is a bright future for companies be able to sell direct to a brand new untapped marketplace: the school. This may sound abhorrent and not something that could ever happen in New Zealand. According to Molnar, it has been rife and increasing in America for years. The United Kingdom, in reaction to the growth of practices like this has put in place voluntary guidelines to try to prevent it taking hold but the marketing people already have a name for it: “cause related marketing”. The trend is beginning in New Zealand and there are a number of such schemes in operation in schools today such as "book it" pizza, "apple stickers" for sports equipment, "bread tags" for computers. Is it a bright future or just a repackaged past?

2.9 Technology Education and Industry: Making the connection

In the press release for the *Bright Future* brochure the then Minister of Education (Dr. Nick Smith) said:

> *Many students study science, maths and technology subjects in the secondary school. These subjects make up the foundation of a knowledge economy.*
>
> (NZ Government press release, Bright Future package 1999)

This statement again places an onus on curriculum areas such as technology to produce students who will drive New Zealand's economy and reverse the trend from its current low standard of living. Quite clearly this is a representation of the economic instrumentalist stakeholders position.

The technology education curriculum statement in New Zealand cites business and industry as legitimate contexts for technology education. There are also a number of organisations and initiatives that promote technology education links. For example, the Royal Society of New Zealand web site identifies its main role as:

> *the promotion and support of science and technology education and to the improvement of the links between the science and technology community and the education sector from pre-school to tertiary.*
>
> (http://www.rsnz.govt.nz/education/index.php 4/5/99)

The Royal Society implements this policy by being involved in a number of initiatives. These include:

- Technology Challenges: these are very successful. In 1996, 135,000 students took part in the school and regional Challenge events, in addition to many more enjoying them as part of classroom programmes. They generate a very high level of enthusiasm, enjoyment and satisfaction, in addition to developing skills and knowledge;

- Through its publishing unit SIR Publishing, The Royal Society of New Zealand produces a range of educational resources. These include the DELTA series. These publications are case studies highlighting existing practices and looking specifically at the links between schools, technology education and local industries. These publications have a particular focus on the promotion of school-industry links and contain little if any critical reflection, which is not surprising considering the aims of the Royal Society;

- Co-operation between the Royal Society and the Building Research Association of New Zealand (BRANZ) led to the development of the BRANZ ALPHA award. This consists of a $2 000 award at three levels. New Entrants - Standard 4, Form 1 - 2, and Secondary. One award will be made to a school at each of these levels. The award is to be used by the school to further their work in technology and science;

- Science and Technology Fair projects can be big or small in scope. Any area of science can be covered, with projects in applied science and technology having become increasingly popular. A range of topics are explored in over 50,000 projects nation-wide - all involve investigation, challenge and imagination;

- The Royal Society of New Zealand supports the Technology Education New Zealand (TENZ) professional teachers association and its work in promoting technology education in New Zealand;

- The Young Investigators Programme is an initiative by the Royal Society to provide activities for Year 5 and 6 students, their parents and teachers. The programme also provides information on New Zealand science and technology and promotes science and technology career opportunities;

A forum held by the Royal Society on 17th April 1997, was attended by more than 60 participants from technology enterprise, education and research. A book entitled *Technology Enterprise and Technology Education* was published highlighting the programme and main findings of the forum. In the foreword of the book the Chief Executive Officer of the Royal Society describes the '*crucial*' role that schools and industry links have to play in the development of a successful technology education programme. (Royal Society, 1997)

In 1994, the Institution of Professional Engineers of New Zealand (IPENZ) launched an initiative called *The Neighbourhood Engineers Scheme.* This scheme has been described by TENZ as having the potential to provide schools with real assistance in the delivery of the technology curriculum. The concept was re-launched in 1998 with the intention of closely knitting local TENZ groups with IPENZ groups to ensure national coverage. CREST (CREativity in Science and Technology) schemes are also popular and they require students to work on projects with experts from outside of the school.

Potential benefits for students from participating in such initiatives include:

- Motivational aspects such as pupils working on real issues with real people outside of the school environment.

- Wider involvement with the community and increased understanding of the role of industry in the community.

- Improved careers advice.

- Accurate information available to pupils concerning specific enterprises or industries.

- Access to experts.

- Access to facilities beyond the scope of the school.

- Possibility of sponsorship, allowing extra funding to support the curriculum (see figure one)

- A greater understanding of the expectations of possible employers.

- Increased staff motivation through involvement in placements, etc.

Access to the latest technologies used outside of the school environment.

The different perspectives and underlying ignorance of what each party, (the school and the industry) does often inhibits links from ever being started. However, according to some in New Zealand it is vital that we bridge this gap if our children are to receive the best education. (Lynch cited in New Zealand Ministry of Education, 1999). If the potential benefits mentioned above are indeed to be found in such a link, which areas of the curriculum should lead the way?

The *Bright Future* booklet claims that technology education has an essential role to play. This is exemplified in the following statements:

Everyone will need to be literate and numerate and the so-called "soft" skills such as creativity, flexibility and teamwork will be more important than ever. So too will be problem solving and analytical skills and high levels of specialised knowledge, particularly in technology and science.

(NZ Ministry of Commerce, 1999 p. 17)

The "skills" mentioned above are all identified as essential skills in the New Zealand Curriculum Framework (see appendix 2) of which the technology curriculum is a part. For a business or outside organisation to be involved with technology education, there are also possible benefits. The following list is adapted from *Working Together Building Partnerships Between Schools and Enterprises.* (Learning Media, 1999)

They might include:

- Wider involvement with the community and a increased understanding of the role of education in the community;
- Opportunities for increased personnel training;
- Enhancement of public relations through community involvement;
- A greater appreciation of the attributes that technology education can offer;

- Improved employer/employee relationships through contact with children from their communities;

- Access to facilities for education and training of employees;

- Access to experts outside of their industry, e.g. language teachers who could be used to help with international trade i.e. translations;

- Increased staff motivation through involvement in school projects. Allowing employees to get involved in a community good i.e. education;

- Fulfilment of a altruistic desire to help improve the quality of teaching and learning;

What kind of school-industry links are in operation currently?

At this stage it is probably important that some of the common school-industry links are explained, The following list is not exhaustive but is an indication of typical links and what they involve and each of these would have advantages and disadvantages.

Teacher placements. These are short term and generally involve a teacher being placed in a local industry or organisation to gain some insight into the workings of the host. They are usually organised at a local level and are often funded by either the host, the school, or a combination of both. Clearly there is only so much a teacher can gain from such a short placement. That said, it can generate interest from the teacher concerned to be followed up at a later date. Also, teacher placements often help to breakdown the mistrust between the education institution and business communities.

Teacher secondments. These are extended periods out of school where the teacher has some objectives from the association. Often there might be some sort of research carried out or educational resources produced. These secondments are funded either by government or some other national body. In New Zealand they have grown in popularity recently, particularly in the areas of Science, Maths and Technology. The Royal Society have a teacher fellowship which began with 17 participants in 1994 and has 36 involved in the year 2000. To date some 145 primary and secondary teachers have been involved in a fellowship. The introduction to the current profile booklet contains some insight as to the rationale behind the scheme given by the current Minister of Research Science and Technology, Pete Hodgson.

> *It goes almost without saying that firing up bright young minds is one of the keys to this country's future. The teaching of science and technology, in particular, is vitally important if we are to transform the New Zealand economy into one based on knowledge, high technology and high skills.*
>
> (Royal Society 2000 p.v)

Visits to industry. These are normally organised by the school and involve teachers taking pupils out to see local industries in order to see technological practice taking place. Ideally they should involve practices which are difficult to replicate in the classroom yet are of sound educational merit. To obtain the best from such a visit, sites must be chosen carefully, not least for the safety considerations. Additionally it may be difficult to see the most controversial aspects of the process due to industrial security and competition. Educationally, lessons should be carried out both pre-and post-visit to get the most from the endeavour. Costs of travel etc. can also be prohibitive particularly for rural schools; however, alternative local enterprise may offer many of the points the teacher is looking for. Schools often use parents as a starting point for discovering industries willing to accept a visit. Davies (2000) argues that school visits could provide a method to contextualise technological practice. This however, would require a change in emphasis and visits should become more like a case study. Figure 6 characterises the changes required in the relationship if this case study model was to be adopted.

Figure 6: **Industry visits comparison**

Traditional visits:	**Collaborative case studies:**
Instruction in practice	Investigation of practice
Observation	Observation, interview, document analysis
Experts and novices	Collaborators

Asks how and what	Asks why and who
Training	Education
Skill	Understanding
Reflecting practice	Examining practice

(Figure 6, adapted from Davies 2000).

Industry days or weeks. These are where the schools devote their timetable to the study of particular industries or industrial endeavours such as production. If done well they can involve the children in looking at both the positives and negatives of the studied industry. The association with technology education is often created as an option to save time on the timetable. Instead of delivering a full technology programme some schools opt to suspend the timetable for a week and do this type of activity and validate their technology education through this one slot.

Mini enterprise activities. These activities are heavily associated with technology education. Often the focus is on industrial and economic understanding. The activities usually involve the realisation of a product which is then marketed and sold. Usually the pupils operate in teams and there is a competition and a strict timeframe in which the team that makes the most profit is the winner. However, educationally, things like essential skills identified in the New Zealand curriculum framework, such as communication and problem solving, can be incorporated and make the activities more acceptable. The mini enterprise activity is often associated with the wealth generating aspects of technology education.

Work experience. This is where the pupil has a period of time in a local enterprise to gain insight into the world of work. Naturally this has favour with those who link technology education with vocational education. Viewed rather like conscription by some and a panacea by others it is another facet of school-industry links which creates argument. Looking for possible educational positives some would argue that work experience encourages students to behave in an independent and professional manner and might offer them a vision inside a career they were seeing as potential future employment arena they might pursue. That assumes that they have been able to obtain an experience in something they are really interested in which is not always the case.

Guest speakers. A technology teacher is expected to have a wealth of knowledge about a number of different and sometimes quite diverse fields of study. Realistically, no one technology teacher could ever hope to be a "fountain" in all the areas. The New Zealand curriculum has seven technological areas each of which could easily be considered an area of study in its own right. Therefore it is understandable that a technology teacher might look to external speakers who are engaged in these fields to give some insight into the different areas. Again, as was stated earlier, they are often chosen from parent contacts. Care should be required to ensure the suitability of the speaker from both an interest point of view but also to ensure biases such as gender are not confirmed.

External supervision of projects such as CREST, Creativity in Science and Technology, awards are an idea started in the United Kingdom and brought to New Zealand. Pupils are allowed to enter an award scheme where they can move from a first crest through to bronze silver and gold. It is run by a non-profit educational trust. Pupils are encouraged to undertake independent projects and with the help of the class teacher and external consultants work their way through the problem-solving exercise. The awards are designed to encourage pupils in the area of Science and Technology. The case study school in this thesis has been involved in CREST for a number of years.

What are some of the perceived benefits to New Zealand of these links?

The Ministry of Education produced two sets of videos to help implement the technology curriculum and both include examples of school-industry links. The first videos were called *Know How,* in which our case study school appeared as an exemplar. The follow up videos were called *Know How 2.* The Ministry also supplied a booklet for facilitators of technology education. The *Facilitators Guide Book* describes the work of the strategy published in 1993 to promote school-industry links. A particularly focus of that strategy was secondary schools, transition education, work experience and career planning. In the guidebook the technology curriculum statement was to promote and extend this strategy (Ministry of Education, 1997.)

Included in the guidebook was a section devoted to developing links. In it there was a section on ways of working together. It was suggested that the following strategies could develop these types of interaction:

- Enterprise people could visit the classroom during a unit of work in an expert capacity.
- Enterprise people could attend teacher planning meetings to provide information about their enterprise and even suggest how best to get the knowledge across to students.
- Teacher placement could occur.
- Students could be offered work shadowing experiences.
- The enterprise could provide or lend specific resources to the school or class.

These were not identified as benefits for the school but such an assumption could be made as there was no mention of school benefits but it was followed directly by; a section entitled 'Benefits of the Link for the Enterprise Group'. It was made explicit that the school should identify the benefits it could offer and these might include:

- access to a potential workforce with an interest or experience in a relevant technology.
- the opportunity to raise the profile of the enterprise and to educate consumers about it.
- the offer of feedback to the enterprise liaison person on how to work with large groups.
- assistance to the enterprise in the development of information packages they could make available to schools.

2.10 Conclusion

According to some in New Zealand, it is vital that we bridge this school/work divide if our children are to receive the best education.

> *The African proverb "it takes a whole village to raise a child" is a timely reminder that New Zealand requires a dynamic education system that serves all of our young people. Only by all sectors of the*

community working actively together will outcomes for our young people be enhanced.

(Lynch, 1999.)

The Trustee Partners New Zealand group was established around 1997 and has some 100 links operating throughout New Zealand. In the executive summary of the 1996 ERO review of school-industry links it was noted that few links operate in reciprocal fashion with benefits for both the industry and the school (ERO p.3). It goes on to highlight that most links do not have clearly defined goals or objectives, and that there is little recognition for student involvement towards recognised qualifications.

Concerns at the philosophical level were also highlighted by ERO:

> *Many professional educators consider that the opinions of business leaders are heeded by Government policymakers more than by those directly involved with the provision of education. Some educationalists fear that the business sector would prefer the creation of an education system that turns out 'industry fodder', rather than well rounded individuals with creating and questioning minds. This is seen as a battle between a functionalist or utilitarian view of education and the liberal ideals that have underpinned the historical development of the New Zealand schooling system.*

(ERO, 1996, p. 8)

Is there a bright future or repackaged past for young people in New Zealand? The early part of this chapter focussed on why the recent push is included in government policy. Whether the rationale is a sound one is debatable. There have been some promising beginnings highlighted through resources like the *Delta* (Royal Society,1999) series of published case studies. However, these contain inherent weaknesses. Most notably there is little critical exposure of what the companies actually do and the negative impacts as a result. The case studies read like promotional materials and really need to be more of a critique of technological practice using Pacey's model. If students are not to repeat the mistakes of the past then lessons need to be gleaned from current practice. This must include critical analysis for only then will students be technologically literate and then there might indeed be a bright future ahead for New Zealand.

CHAPTER 3 - METHODOLOGY

3.1 Case study argument.

This chapter will begin by looking at some definitions of case study before proceeding to describe what a case study is, why it is used and some of the procedures involved. The chapter will also highlight the case study school and the reasons for its selection. By the end of this chapter, the reader should have a clearer understanding of the case study and its usage in social science research. This chapter will also outline the research design and methods used in this particular study. The data gathering and analysis procedures will be made evident and matched to descriptions of this methodology in the literature.

Merits of case study

Case study is often used as an umbrella term. To gain further understanding some definitions are required. A technical one offered by Yin is:

> *A case study is an empirical inquiry that:*
>
> (a) *Investigates a contemporary phenomenon within its real life context when*
>
> (b) *the boundaries between phenomenon and context are not clearly evident and in which*
>
> (c) *multiple sources of evidence are used.*
>
> (Yin, 1981, P. 23).

At this introductory stage we need something a little easier to focus on, and Bouma gives a more satisfactory starting point when he states:

The case study can answer the question "What is going on?". In a case study, a single case (hence the name) is studied for a period of time and the results recorded.

(Bouma, 1997, p. 89)

So a case study is used to ascertain "what is going on", but the question remains what is a case study?

Case study is an umbrella term for a family of research methods having in common the decision to focus an enquiry around an instance.

(Adelman, 1976)

Two terms which are introduced in the above definitions require further elaboration. The first is that of Yin where he mentions "boundaries", what do they have to do with the case study? And secondly, the idea of an instance as quoted by Adelman. The first of these terms is often attributed to the American theories of Robert Stake when he describes a "bounded system". Typically following ethnographic studies the case was based around or bounded by communities. However, a wider source for the case could be used and this argument is supported by Robert Stake.

The case need not be a person or enterprise. It can be whatever 'bounded system' that is of interest. An institution, a program, a responsibility, a collection, or a population can be the case.

(Stake, 1980, p.64)

Yin argues that the boundaries need to be set at the outset but clarified as part of the study, and that these boundaries might range from those such as time, right through to the actual case being studied. One could argue that there is not a case to study until the researcher has carried out their research and defined one. This point is made by Kemmis:

The case study worker makes the case by carrying out the study. He attempts to transform the situation as an object of perplexity into an object of understanding.

(Kemmis, 1980, p. 117)

The proponents of this research design see this uniqueness not as a hindrance but rather as something positive. In this study the relationship developed between the school and the company is not bounded by the particular course. The usefulness of this particular study in making generalisations to other cases will be discussed in later chapters. Kemmis, when describing a *new perspective* on research, states:

> *Case study consists in the imagination of the case and the invention of the study.*
>
> (Kemmis, 1980, p.119)

The second term identified earlier was that of an instance; the term "instance in action" has become synonymous with the British tradition of case study research, as described by authors such as Adelman, Jenkins and Kemmis. Case study has been used extensively to evaluate the curriculum as well as innovations in the curriculum. An example of this are the links made in the United Kingdom with the Nuffield Foundation, who have worked heavily in the technology education arena.

> *Case study research always involves "the study of an instance in action.*
>
> (Adelman, 1976)

Facing these challenges one wonders why case studies are undertaken. The answer lies in the link to professional practice. Thus advocates would argue that case studies offer the most to the practitioner.

> *We would argue that the qualitative or ethnographic case study is the research approach that offers most to teachers because its principal rationale is to reproduce social action in its natural setting,... it can be used to develop new theory or improve and evaluate existing professional practice.*
>
> (Hitchcock and Hughes, 1995, p. 323)

Criticisms of case study

However, it is exactly this vagueness which those who criticise the case study as a legitimate form of research use as an example of its weakness. When talking of the bounded system, Atkinson and Delamont point out that :

> *...it certainly does render it so general and vague as to be of next to no methodological value. The notion of a bounded system is unhelpful. Naturally occurring social systems are not self-evidently bounded.*
>
> (Atkinson and Delamont, 1985, p.29)

Just because each case can be described as unique one should not dismiss the usefulness of the case in drawing inferences about similar cases. If case study were not useful then other areas of study would not use the case either. However, they do with law, medicine and anthropology basing their research on the case study model. The link to curriculum reform has fuelled those who see case study research as a 'fad' and highlighting those researchers who undertake it because of its obvious funding from those looking to create curriculum reform, government departments etc.

> *Inevitably, any movement that rapidly acquires many followers has some qualities of a fad.*
>
> (Atkinson and Delamont, 1985, p. 32)

One can trace the recent developments in case study research back to the Chicago school and most notably to the work of Thrasher in 1928. If it is indeed a fad it has been a long time coming. That said, this study is closely linked to curriculum innovation, i.e. the implementation of the technology curriculum as part of the New Zealand Curriculum framework. Methodologically, how does a case study work ?

Case studies can be seen in direct opposition to experimental types of research and although they sit comfortably with qualitative researchers, some quantitative researchers would argue that case studies as a research design are flawed. Atkinson and Delamont, for example contend that:

> *... the case study research tradition is seriously deficient due to both inadequate methods and a lack of methodological self-awareness.*
>
> (Atkinson and Delamont, 1985, p. 33)

What is obvious here is that one of the key thoughts a case study researcher must have before entering into the research is related to validation. Although this is true with all research it must be particularly so for the case study because in most cases their findings are of interest to more than just those partaking in the study and the researchers in that field, but particularly to the practitioners and social groups surrounding the study. This view is supported by Kemmis:

> *Participants in a research study, readers of the findings, sponsors, other members of the research community and the general public are always entitled to ask how the study is justified.*
>
> (Kemmis, 1980, PG 96)

Can case studies possibly survive in a realm where science has had the mantle for holding the *'truth'* and scientific method for being the only *true* method of extending our knowledge? To convince the sceptics, case study must be able to overcome the questions of "justified true belief" (Kemmis, 1980). To answer the 'truth' question, case study research must have stout validation procedures.

The first pre-requisite for validation is empirical evidence, this should be easily evident from case study as the basis of the study is formed through observation. There are however, problems with observation which Kemmis highlights:

> *Those who expect to follow the progress of science in brilliant light will be ill at ease following the case study worker stumbling from lamplight to lamplight in the fog.*
>
> (Kemmis, 1980, p.100)

Kemmis goes further to point out the difficulties a case study researcher faces with those who adhere to a philosophical viewpoint supported by a scientific method. Educational research can be carried out in a variety of ways, the selection often depending on the philosophical perspective held by the researcher. There are essentially three main viewpoints or paradigms taken and although different each is valid. They are: positivist, interpretive and critical theory.

The positivist viewpoint is based on scientific and experimental research, the gaining of factual knowledge is the key. Any research carried out by a positivist will focus on the observable and measurable and deal with factual matters. According to Clark, (1997) positivism is supported by educational researchers who believe that the natural scientific methods could be equally applied to social research. One of the key features of this philosophical position is that the researcher acts as an observer whose values are kept discreet from the research. Positivists maintain a strict view of science and place virtually no emphasis on subjective or interpretive meaning.

The interpretive researcher places more emphasis on values. Social research invariably involves working with people, and includes some study of human behaviour. To gain an insight, the interpretivist will incorporate meanings including their own into the study. These meanings are paramount in this research paradigm and are seen as a social reality based on common sense. The interpretation of these actions along with recognition of values form the basis of any findings.

Critical theory as a philosophical framework combines the strengths of the other two positions and tries to go beyond what they can offer individually (Clark, 1997). Thus critical theorists must engage in research which is not just for the researcher but should be for education, it usually involves some critique of ideology as well as the observable.

> *The ascendancy of the view of science inspired by logical positivism was so complete in social science that case study research today is still frequently judged and dammed by truth tests which, though they may make sense in the philosopher's library, make little sense in and of the social world outside.*
>
> (Kemmis, 1980, p.100)

It is obvious from the above descriptions that case studies will generally involve either an interpretive or critical theory paradigm.

Types of case study

According to Stenhouse (1981 p. 22) there are three levels of case studies. The first, **naturalistic** case study, is mainly used by anthropologists carrying out holistic types of study. Secondly, **evaluative** case studies are mostly used in curriculum reform, and thirdly **action research** case studies are used where there is a close study of an individual classroom.

Stenhouse identifies the financial incentive (carrying out research for a fee) when he describes the move towards an evaluative model of research. However, despite the above assertions that some undertake this kind of research because of the obvious financial gain, the main reason for the growth of this kind of research is linked to the 'instance in action'. If a researcher wants to have a link to actual practice and hopefully identify areas for further research which might in turn have some positive effect on that practice one must firstly ascertain what is actually going on. This is where the instance in action as observed by case study research gives the researcher that snapshot picture.

Yin also describes three kinds of case study differentiated by their outcome: **exploratory, descriptive** and **explanatory**. The first can be seen as a kind of "pilot" study where questions are identified for further study. This is where case studies are referred to as pre-experimental. The second study according to Yin 'descriptive' studies are along the lines of Bouma's definition given earlier to ascertain what is actually going on in a social situation. They could be described as giving a narrative account of the instance. Thirdly Yin identifies 'explanatory' which can be described as a case study being used to generate a new theory or to analyse an existing one.

Looking more specifically at case studies within education, Hitchcock and Hughes cite Merriam as describing four types of case study:

The first is the ***ethnography case study****, characterised by its socio-cultural interpretation, whatever its focus of study. The second is the* ***historical case study****, especially the historical organisational case study which focuses on a specific organisation and traces its development. The third is the* ***psychological case study****, with its focus upon the individual as a way to investigate human behaviour. Fourth is the* ***sociological case study****, with its emphasis on the constructs of society (class, gender, ethnicity) and the importance of socialisation in studying educational phenomena.*

(Hitchcock and Hughes,1995, p. 321,322)

Similarities can be seen between the various models of case studies as described above. The only slight variation is described by Stake (1994: 237-8) as a "**collective case study**". This is where there are several case studies involved in the one research.

As the process of case study gets described, the question of validation will be addressed further. It is worth noting at this point that case study is not being promoted here as a particular methodology. It is an **approach** to research that employs a range of procedures (methods) for gathering data. Moreover, the author's view is that case study is a combination of existing methods brought together in the case. Therefore there are a number of ways of obtaining information; these include surveys, participant observation, and interviewing. Case study is linked closely with action research and naturalistic research. (see the Adelman quote at the beginning of this chapter.)

The term *participant observer* as mentioned earlier has been developed through ethnography, most notably when western anthropologists studied societies where the only real method of obtaining a perspective of their lives was to live amongst them. In addition there may be another perspective that the observer is trying to obtain, that of an 'outsider'. These two views of observation are described in detail by Gall et al as follows:

The participants viewpoint is called the emic perspective. Typically the researcher obtains this perspective through direct observation of the *participants-sometimes called the insiders as they behave naturally in the field. At the same time case study researchers generally maintain their own perspectives as investigators of the phenomenon (instance). Their viewpoint as outsiders, which is called the etic perspective helps them to make conceptual and theoretical sense of the case, and to report the findings so that the literature is clear.*

(Gall et al, 1996, p. 548)

Of course the researcher must also consider what effect the observer has whether they are a participant or not. This is particularly true in the case of classroom research where every adult can be seen as teacher or teachers aide and therefore may have an effect on children's behaviour.

In a natural setting it is difficult for the researcher who wishes to be covert not to act as a participant. If the researcher does not participate there is little to explain his presence, as he is very obvious to the actual participants.

(Cohen and Manion, 1990, p. 127)

Perhaps the answer to this question is to use technology and observe from a hidden camera, however, this raises ethical issues for the researcher. Should studies of human subjects be explicit or covert? It is now the accepted norm that studies involving humans should be conducted with full understanding and disclosure to the participants.

Interviews are another favoured method of collecting data during a case study. These usually will be tape recorded and the transcripts can be checked by both the researcher and those who were interviewed. This will ensure accuracy and also any meanings that may have been inferred through voice tones etc. are not missed. As the case study is an eclectic research design where the researcher needs to be able to change the methods as the case demands. Bouma, in his chapter on doing qualitative research, identifies in-depth interviewing as:

The in-depth interview provides the greatest opportunity to find out what someone thinks or feels, and how they react to various issues and situations.

(Bouma, 1996, p.178)

Stenhouse expresses a preference for interview over observation because of the "condensed" circumstances in which case studies occur.

I lean towards interview rather than observation... this is partly because I feel that the conditions of condensed fieldwork preclude classic participant observation.

(Stenhouse, 1981, p.26)

He elaborates on this reasoning when he states that the people he interviews were themselves observers and participants of the events. The role of the researcher is to draw the information out from those studied in the case. This, however, raises another concern of validation. How do we know that those being interviewed are not trying to deceive the researcher. This highlights the need for a variety of methods of data collection, to check one against the other. The term to describe this procedure is triangulation.

This is an important issue not just for the individual case study but also on the wider philosophical front.

Validity and reliability become problematic, however, if one rejects the positivist assumption of a reality that can be known objectively. How does a researcher arrive at a valid, reliable knowledge if each individual being studied constructs their own reality (the constructivist assumption), if the researcher becomes a central focus of the inquiry process (the reflexive turn in social sciences, and if no inquiry process or type of knowledge has any authority over any other (the post modern assumption)?

(Gall et al, 1996, p.572)

This triangulation needs to be convincing to achieve the goal of validation. How is it achieved? Gall et al offer a description of triangulation which is useful:

> *Case study researchers might begin their case study with one method of data collection and gradually shift to, or add, other methods. Use of multiple methods to collect data about a phenomenon can enhance the validity of case study findings through a process called triangulation.*
>
> (Gall et al.,1996, p557)

Perhaps from this discussion, one might conclude that only qualitative methods are valuable. This would be an incorrect assumption. Both quantitative and qualitative methods of data collection are valid within the case study. Perhaps one should argue that the best kind of research actually uses methods from each where appropriate.

A good starting point would be to disclose the researcher's interests, as making them overt may alleviate some questions later. However, the level to which disclosure should occur is a debatable issue.

Another check could demand a comparison of one person's recollection of an incident by asking others about the same incident, with the researcher drawing the conclusions from the confirmed points. In addition, there might be textual evidence to support a claim that it is the researcher's role to collect the evidence and to substantiate the findings, a point supported by Hitchcock and Hughes, who suggest that:

> *triangulation can, in addition, also help the researcher to establish the validity of the findings by cross-referencing, for example different perspectives obtained from different sources.*
>
> (Hitchcock and Hughes, 1995, p. 323)

Making records of field contacts is another case study method. Miles and Huberman (1994) recommend that case study researchers use standard forms to summarise data collection events. This *'contact summary sheet'* is not a substitute for the researchers field notes, which should be extremely well detailed and descriptive of events. But it could provide a concentrated focused method to indicate where the research may need to move to next. The case study researcher must be prepared to move in the direction that the case requires. According to Walker (1993 p.54) there are advantages and disadvantages when using field notes. His points are summarised in the figure 7 below.

Figure 7: Walker's field notes evaluation.

ADVANTAGES	DISADVANTAGES
1. Very simple with no outsider required	1. Need to fall back on aids such as question analysis sheets, tapes and transcripts.
2. Good on going record. Used as a diary it gives good continuity.	2. Conversation impossible to record as field notes.
3. First-hand information can be studied conveniently in researchers own time.	3. Notebook works with small groups but not with a full class. Initially very time consuming.
4. Acts as a aide-memoir.	4. Can be highly subjective
5. Helps to relate incidents, explore emerging trends, etc.	
6. Very useful if the researcher intends to write a case study.	

(Figure 7 table adapted from Walker 1993)

Hitchcock and Hughes elaborate on the notion of triangulation by quoting Denzin (1970)

> *there are four types of triangulation used in research: 'data triangulation', investigator triangulation, theory triangulation, and methodical triangulation.*
>
> (Hitchcock and Hughes, 1995, p. 324)

The first of these, *data triangulation,* is a sustained data collection from more than one source. According to Walker (1993, p.64)

> *Document analysis is superior in finding out retrospective information about a program, and may be the only way that certain information is available.*

The second, *investigator triangulation*, uses more than one observer looking at the same phenomenon. The third involves different approaches to produce categories of data. Fourthly, we have *methodical triangulation,* which basically uses a range of collection methodologies on the same topic.

Another consideration worth noting might be the language used. Obviously the case is a *'real'* instance, therefore the language recorded must be that used by the participants but the researcher may be required to bridge the gap between the *'real'* and the language of the social science research fraternity, when reporting.

> *It should be stated at the outset that there is no sure way of assuring validity but that there are only notions of validity*
>
> (Ratcliffe, 1988 :158, cited in Hitchcock and Hughes, P. 324)

Considering the quote above, the researcher must accept the limitations of any case study but by perhaps expressing ones own bias early on and allowing the participants ready access to evaluate the findings as they progress. The researcher is ensuring triangulation via a variety of methodologies and the research can maintain some credibility. Those who are opposed to case study as a research design argue strongly the case of validity, however, as identified the case study researcher can take steps to ensure that a *notion of validity* is achieved. Perhaps the opponents of case studies have another motive, maybe they are protecting their lot.

> *It is our contention that the case study research tradition is seriously deficient due to both inadequate methods and a lack of methodological self-awareness.....rather than adopting the essentially philistine attitude that "anyone can do it'.*
>
> (Atkinson and Delamont, 1985 p. 33)

Case study, appropriateness for this research.

With arguments like those highlighted above, one might ask why carry out a case study at all? Hitchcock and Hughes suggest that an answer to this might be that:

> *Case studies can be of particular value where the research aims to provide practitioners with a better alternate way of doing things.*
>
> (Hitchcock and Hughes, 1995, p. 322)

This may explain why they are commonly used in educational research.
This chapter has aimed to clarify the terms involved and provide some notion of what is involved in case study research. The final consideration is perhaps their usefulness. Cohen and Manion (p. 129) describe two types of validity, *external and internal.* Most of the arguments raised above refer to internal validity but external validity can be seen as the extent to which these findings can be applied to other situations. This is sometimes referred to as 'generalisation'. Although this chapter has highlighted the importance of the individual case, denoted by the developed boundaries and looking at instances in action, we end with the question of what generalisations can be drawn from cases.

Data analysis and transfer in quantitative research, once the factual accuracy of numerical data has been confirmed, might seem a more straight forward task. The case study research is based on transcripts and observational records which can be difficult to create generalisations from. That said, one of the values in case studies is the easy access created by the descriptors of real life situations. Those who find themselves in a similar situation can relate to the findings. Although similarities might be drawn the researcher must take great care to try and keep the participants of the case anonymous in order to protect them from condemnation.

So the extent to which generalisations can be drawn relate to the validity of the research, and the interpretation of the reader.

For this reason, Stake 1974) has advocated the use of "portrayal" in evaluation reports. Portrayals are intended to communicate the experience of the situation to the reader; they offer surrogate experience. Portrayal promotes knowing through imagining. Stake calls this imaginative function "naturalistic generalisation" which he contrasts with "formalistic generalisation" based on propositional knowledge.

(Kemmis, 1980, p. 127)

3.2 The research study school.

Selection of the case.

The site chosen is an Integrated Secondary school in a small provincial town. The school, which has some special features, is a boarding school with special character - Anglican. The selection of this school for the study was made based on (a) the number of involvement's of this school with external groups such as industry and (b) the reputation the school has for success in this area. During the study year, 1999, the school won the ALPHA AWARD. This award was established in 1992 by the Royal Society of New Zealand. The aim of the award is to recognise and promote the establishment of links between school programmes in science and technology and the practice of science and technology in the wider community. The current sponsors of the award are the Building Research Association of New Zealand (BRANZ).

A school that receives the award will have clearly established a culture that promotes and nurtures educational links between itself and its community in the area of science and technology education. This would be displayed through:

Initiation of, or participation in, specific programmes linking the individual school with the science and technology community at large, e.g.

School – Industry Links
Fieldwork using specific local resources
Working links with tertiary institutions
School visits by local resource people
Science education projects involving the local or international community
A record of participation in schemes such as Science Certificate, Science Badge, Science Fair, CREST, BP Technology Challenges etc.

Credit would be given for both the numbers participating in such schemes and the degree of innovation involved.

The study school was also included in *KNOW HOW,* a video used by the Ministry Of Education to promote the implementation of the technology curriculum. In the video the school is portrayed as a successful example of the CREST award programme and the development of an inclusive technology curriculum. The video shows a school-industry partnership that resulted in the production of an air track which they have gone on to market and sell to schools around New Zealand. The partnership was between students from the study school doing their CREST awards and a local engineering firm in the town. They used the expertise of the engineering firm to supplement the school teaching and also their facilities to put the designs into production.

The bounded system for this study is a particular programme offered by the school. In this programme, the school uses its Secondary Tertiary Alignment Resource (STAR) funding to employ an engineer from a local company to teach an electronics course.

To provide a base of empirical data, every class taken by the engineer was observed by the researcher. However, the level to which it can be repeated again by anyone challenging the findings is debatable, especially if we accept the "instance in action" described earlier. Obviously this study is heavily dependent on the particular parties involved and any comparisons made with other industrial links may not survive "scientific truth" inspection. However, the case provides some insights into the workings of a school-industry link.

There were certainly times in this study that the students being observed looked to the observer as another teacher. This is a problem noted earlier by Cohen and Manion. In this study interviews were carried out in both group and individual settings and voice recorders were used to aid accurate transcription. A number of additional methods of data gathering were used. These included questionnaires, observations and interviews. The notion of triangulation was kept at the forefront of the researcher's work. The researcher tried to overcome any personal biases by giving a short resume of his previous experience at the beginning of this thesis. Thus allowing the reader access to any biases that may have impacted on the research.

Validation of observations is always necessary in this type of research. This was achieved in this study by using the classroom teacher as an additional observer. Field contact records were completed during the observations and at other visits to both the school and the engineer's workplace. Additional textual evidence used included reviews carried out by the Education Review Office, reports by consultants on education in the small provincial town. The school also has an extensive record of press clippings and reports to governors which were made available to the researcher.

3.3 Ethical Considerations.

According to Anderson 1990 the practice of research is subject to ethical principles, rules and conventions. Clark (1997) also identifies that educational researchers conduct their research within a framework of ethical deliberation. These ethical deliberations are relevant both in the collection and dissemination phases of the research. The researcher has to decide how much information to give the parties involved in the research and how much about the parties to reveal in the findings. Obviously to receive informed consent the parties involved must have sufficient information on which to base their decisions.

One possible way forward is for the researcher to constantly place themselves in the position of the party being observed and to decide how one might feel about the research. Professionalism must be maintained i.e. being prepared, on time etc. According to Anderson, (1990) a researcher who ignores the courtesies or oversteps the ethical bounds can do great harm.

The Massey University Ethics Committee has its own guidelines for research and the considerations are highlighted as:

> informed consent (of the participants), confidentiality (of the data and the individuals providing it), minimizing of harm (to participants, researchers, technician etc.), truthfulness (the avoidance of unnecessary deception), and social sensitivity (to the age, gender, culture, religion, social class of the subjects)
>
> (Massey University, 1997, p.1)

These guidelines have been strictly adhered to throughout the project. When working with schools, where a position of influence may be held, it is particularly important to ensure that the study is justified.

> *Participants in a research study, readers of the findings, sponsors, other members of the research community and the general public are always entitled to ask how the study is justified.*
>
> (Kemmis, 1980, p. 96)

Additionally, educational research can be problematic as schools are easily identifiable. In this case it was decided that the school would be so evident that the school and parties involved were asked if they would consent to being identified. The children involved in the study have remained anonymous.

When observing pupils it is paramount that the appropriate consent is obtained. This **informed consent** may involve contacting individual parents as well as the school principals, teachers and the pupils themselves. In this case, due to the age of the pupils involved, consent was sort from them, their teacher and their principal (see appendix 3)

> *There are those who believe that research with human subjects should not be conducted without their consent and understanding this points to an explicit approach.*
>
> (Stenhouse, 1981, p.27)

Minimising of harm was also a major consideration. The pupils are not referred to by name and no coercion was used. Participants could withdraw at any stage without penalty. None of the research was used in any way to judge student participation or affect the results of their course. Teachers, employees, and principals viewpoints were kept confidential.

Another consideration worth noting might be the language used. Obviously the case is a *'real'* instance therefore the language recorded must be that used by the participants but the researcher may be required to bridge the gap between the *'real'* and the social science research fraternity language when reporting.

Key points adhered to were:

- Informed consent was obtained.

  Approval was given by the school principal for the research to go ahead.

  Informed consent was gained from the classroom teacher, who acted as a research assistant to maintain the integrity of interviews etc.

  The research was discussed in full with the pupils and consent was given. This discussion included the researcher's qualifications, the purpose of the research (part of a post graduate qualification). The pupils were made aware that it was not compulsory and did not affect their own study. In addition, if at any point they wished not to continue, their requests would be honoured. The pupils were assured of total anonymity throughout the research. They are noted in the research as "female respondent 1" etc. This was done to distinguish them from other participants in the interviews who were male. Letters and protocols are included as appendices.

- Anonymity for participating schools will be assured, unless permission is given to name. In this case the parties representing the school, principal and classroom teacher agreed to naming. However, they are referred to as school A etc..
- Individuals and organisations information will be treated confidentially. Permission was sought from the industrial partner, and this permission was granted to name the company and employee involved in the study. Again however, to try and protect individuals as much as possible "the company" will be used with "Engineer A" who was the main person involved.
- Information received will be used for the purposes of this study only.
- The tapes and the transcription process remained in sole charge of the researcher. Transcription was carried out by secretarial staff at the University and verified by the researcher and the parties involved.
- Participants did not gain favour or credit from the University or researcher for their involvement in this study.

3.4 The research phases.

There were four phases to this research. Although they were not independent or discrete it is useful to discuss the phases separately.

The first phase developed from the research proposal, in which an identification of the topic was generated from a personal interest in school-industry links and a lack of existing research in this area. Initial literature searches and discussions with people from this field also indicated a lack of knowledge and understanding about what is actually happening under the heading school-industry links.

The next step was to identify possible participatory schools, and the decision was taken by the researcher to identify schools within a reasonable proximity to the University who had a reputation in this area. Consultation with colleagues and the national co-ordinator of Technology Education New Zealand (TENZ) led to the identification of two possibilities. Both schools were contacted and interviews with the persons responsible for the links were carried out. One school was clearly more organised and the links were better established for the research period. This school was therefore selected.

The main difficulty in this stage was the timing of the programme which meant that the research began in earnest early in semester one of 1999. Which left little time for procedural matters.

Phase two was spent preparing the sources of data to be used and trying to ensure selection of the most suitable data collection techniques for this particular case. Often in qualitative research things develop which were unexpected and yet become important to the research, the researcher must pursue these events to their conclusion. An example can be seen in this study with two major developments, neither of which could have been anticipated. The first was the industrial link going through an amalgamation right in the middle of the research. The second was the changes occurring in government brought on by an impending election which led to the announcement of policies such as the "Bright Futures" package

Phase three was the data gathering, which occurred throughout the research year 1999 and beyond. The most intense stage was during the actual programme offering. This meant close observation of every class, it is difficult to remain unobtrusive as a researcher yet the natural setting is extremely important for qualitative research. Time was spent in the classes before and after the event to try and ensure reasonable transition during the programme. The transition described is how the participants view the researcher, initially as an outsider and perhaps with some suspicion to just another adult in the room.

There were a number of observations carried out in this study. Most were naturalistic observations i.e. observations that were carried out in the natural setting such as the classroom or the place of work where the researcher tried to be non participatory. Others were more contrived not by the researcher but by circumstance i.e. at award ceremonies. The later observations were recorded retrospectively in a diary, whereas the former were recorded via field notes and in some cases voice recorders. Different procedures were used to obtain the relevant data and these will be discussed and a detailed account of what took place will be presented in the next chapter.

Phase four involved extra coding of the information along with data analysis. This chapter has outlined some of the difficulties of qualitative research. Remaining flexible to adjust to developments also means a tremendous amount of data is collected. The analysis and then organisation to a useful format was a long and complex undertaking. The final part of this phase was the report writing which was the culmination of two years effort. The focus is to present something which is useful. This can often mean a compromise between pure academic research and writing in a language appropriate for the intended readers, who in this case, hopefully, are practitioners in schools.

3.5 Conclusion.

This chapter has not advocated that case study should be called a method, or that it is qualitative and superior or inferior to quantitative. What it has done is describe the case study in detail and to emphasise its place in the "real world' which in turn has a direct link to professional practice. This has been the main justification for its selection and use as a foundation for this study. The overall design for this research was a single site case study that contains elements of both exploration and description. This chapter has emphasised the value of using a range of methodologies whether they be quantitative or qualitative whichever best supports the individual case being studied. The importance for all research to ensure validation but perhaps particularly that of case study has been argued. The selection of the particular case has been described and the research phases have been identified. Finally the ethical responsibilities of this type of research have been considered.

CHAPTER FOUR - RESULTS

4.0 Document analysis.

As was stated earlier this study is a single site case study looking at the relationships with local industries developed to enhance technology education by a secondary school in a small provincial town.

There were a number of data collection instruments used in the development of this case study. The first of these was a document search and analysis. The purpose of the document analysis in this study was to gather relevant facts, many of which were largely historical.

The strengths of document analysis as a research method are many. Walker (1993) highlights the retrospective or historical accounts as a major strong point. Others such as the credibility of the information, the cost of the information and the availability of the information all justify the inclusion of document analysis. In this case a number of documents were collected that were in the public domain and therefore available to the researcher. Some reports were published by national bodies such as the Education Review Office (ERO). A Ministry of Education report for the study town's schools was analysed and relevant information drawn out. It did highlight for the researcher one of the limitations of document analysis that the researcher should be aware of. It is not always possible to ascertain the purpose of the documents and their intended audience. Obviously the authors of documents used in this study could have their own biases and these need to be considered. Also worthy of consideration, is the rationale behind the document production; this needs to be investigated in case it influences the outcomes.

There was a vast array of documents collected for this study. These included brochures from the school, the industry, the relevant national bodies such as the Institute of Professional Engineers in New Zealand (IPENZ) and Technology Education New Zealand (TENZ) the professional association of technology educators, The Royal Society, who have played a major part in the development of school and industry links, An Education Review Office report and a report on the town's schooling from the Ministry of Education, Regional Management Centre. Further analyses were made of articles from the local press which were made available by the study school, which the researcher has given a fictitious name of Waterborough.

Waterborough school was established in 1891, originally located in a small nearby town it was later moved to Rowe Town (fictitious name). It is an integrated secondary school with a special character i.e. Anglican. The number of students at the time of the study is 248 and rising. The gender is 100% female, most of whom are boarders. The ethnicity of the students is about 2% Maori and 98% Pakeha. According to the principal who was interviewed (see appendix 1) and has been principal for over five years, there are seventy eight staff, part time and full time, employed at the school. This obviously enables a lower student to staff ratio than the average school. The school is marketed as a small traditional family rural school with very high expectations.

The girls who attend the school come from the whole of the North Island and an increasing number from overseas, mostly from New Zealand ex patriot families. There is also about half a dozen overseas students who are not from New Zealand families. Interestingly not a large proportion come from the study town itself. In external examinations the students generally perform above the national average.

In 1999 a report was published on state schooling in Rowe town by an education consultant working for the Ministry of Education. This report has been used to help compile the following description of the town.

Rowe town is a very attractive place which was established in the lower North Island 130 years ago. Like many smaller towns in provincial New Zealand it grew and prospered over a long period of time. Rowe town became the second busiest railway junction in the country with approximately 130 railway workers resident in the town. Sawmilling was another key industry which attracted workers and their families to the town.

Unfortunately in recent times there has been a decline in employment opportunities in the town with a number of key employers such as the hospital and a large timber company closing or shifting elsewhere. In addition, re-organisation of the railways during the eighties meant a shift of the shunting yards to a nearby city. The population of Rowe town has remained at around 5000, but the demographics of the town have changed significantly. There are far fewer school age children which has cast a cloud over schooling in the study town as there is clearly a surplus of accommodation due to falling rolls. There are currently nine integrated and private schools in the town. It is in this climate that the study school has been growing.

Both the principal and one of the teachers (Teacher A) commented to the researcher that the study school is fast becoming the "jewel" in the crown of Rowe town, and the community view of the school (as reflected in newspaper reports) is extremely positive.

The main industrial partner is an Engineering Company (The Company). This company was founded in 1939 by the father of the current managing director. Originally The Company produced armaments for the war efforts, particularly smoke bombs. The factory was operating twenty four hours a day during the war years. After the war, The Company had to look for new markets and it did so with some success. In 1945 The Company began supplying rice ploughs to China and for the next couple of years produced thousands which were exported. Through the managing director The Company had always maintained a connection with the New Zealand Oil Industry and it was this market which was to be the mainstay for The Company over the years.

Specialising in the manufacture and design of quality equipment for the oil industry gave The Company both a national and international reputation. In 1955 The Company began making petrol pumps under license to a British company and this was to ultimately lead to their products being used in petrol stations around the globe. The major production involved mechanical engineering and it was in this area that The Company had proved to be a market leader. In 1974 The Company invented and sold the worlds only horizontal electric fence. This fence reduced costs to farmers in New Zealand from $5,000 per mile to $400 per mile.

During 1975 The Company became aware of the impact that microprocessors were going to have, not just in the electronics field, but also in controlling mechanical engineering. Originally microprocessors were added just to help control the petrol pumps which continued to be The Company 's mainstay throughout the seventies and early eighties. In 1985 The Company began developments with magnetic strip technology to allow electronic funds transfer (EFT) as payment for fuel at the petrol stations. This led The Company into its next diversification which was integrated access, control and security systems. This technology which utilises smart cards and black box systems technology was to prove very successful for The Company .

From 1991 The Company became known as a solutions provider. This meant providing a whole host of mechanical and electrical products which could be linked by microprocessor technologies to provide a complete solution. Typically this began with a retail solution for the Oil Companies where they could monitor sales etc. across their networks without leaving the office. These solutions grew to include New Zealand Railways and even the London Underground.

The profile of The Company is important as it helps the reader ascertain why a teacher of a curriculum area like technology which is supposed to develop creativity and innovation, would make contact with an organisation like The Company . The document analysis of The Company's publicity brochures and employees handbooks gives an indication of why The Company might get involved with a school. In their management system policy document under 'Company Responsibility and Citizenship', it states:

> *We consider the needs of our communities as part of our strategic planning procedure.*
> *We support our key chosen communities through a variety of schemes and encourage staff members to support local activities.*
>
> (The Company manual, 1998, p.11)

Identified earlier in the literature review was the link between employee motivation and the opportunity to do social good. This was cited as a factor for encouraging school-industry partnerships. The Company it seems from their documentation take a similar position. A further section entitled 'Employee Well Being and Satisfaction' states:

> *A variety of services, facilities, activities and opportunities are available to support staff member well being, satisfaction and motivation.*
>
> (The Company manual, 1998, p.12)

It would seem that The Company has a positive approach to school-industry links at a management level and this is important and consistent with international findings on the factors which make school-industry links successful..

> *Overseas evidence suggests that school business relationships are more likely to be successful and sustainable if they are supported at the management level within both the school and the business. This helps ensure that the implementation is part of the overall operation of the school and not dependent for its success on one teacher or a single department.*
>
> (ERO, 1996, p.31

Whether the management of the school is as supportive in this particular case will be explored later in this thesis.

4.1 Observations

One of the differences between quantitative and qualitative research which is both a strength and a weakness is the flexibility that each method has with regard to the collection of data. Quantitative tends to be more structured in the early stages where a significant amount of time is put into the development of suitable questionnaires etc. Qualitative generally involves observation which can be participant or non-participant and often takes the researcher off into areas which may or may not have been anticipated before the data collection started.

The main observation carried out was where the researcher observed a particular class as part of the study. This class was in fact a co-ed. seventh form class, in which boys from the local college were invited to be involved. The observed aspect was a compulsory 10% component described as a "special topic". There were nine girls from Waterborough school and five boys from School B. School B, played a minor role in this link and therefore was not the focus of this study. The class was taken in a Physics lab at Waterborough school and was generally timetabled on Wednesday evenings from 7 PM until 9 PM. The course was a seven week special topic in analogue electronics. The pupils were described by their teachers as amongst the brightest from both schools (field notes, 1999).

Adults in attendance : (The first three attended every session, whereas others were intermittent.)

Mr. Gary O'Sullivan (Technology education Lecturer, (M.U.C.E.) Researcher.)
Engineer A (Team leader, hardware design (The Company). Industrial partner)
Teacher A (Senior teacher, (the study school). School partner)
Teacher B (Physics teacher, school B.)
Student teacher (M.U.C.E. secondary programme, a former technology graduate.)

The researcher was conscious that the students might be overwhelmed by the number of adults in attendance. The pupils were made aware of the research before it began, through their teachers and a pre-research visit. The researcher acted as the main recorder for the research. The researcher had been to the school on previous visits to become known and accepted to the wider school community. The researcher had also volunteered to act as a CREST technology consultant with a different class so as to reciprocate the time made available by staff who co-operated in this research.

Engineer A, the industrial partner had been involved with the school over a number of years. His involvement included CREST projects, guest speaking, industrial advice and previously taking this special topic course. Part of the school's STAR funding was used to pay Engineer A as a tutor on this course. The researcher discovered later that Engineer A had worked previously as a polytechnic tutor. It was made clear by all the teachers and the principal that Engineer A's payment was token in comparison to the time that Engineer A gave on this and the other projects. As was stated, earlier observational field notes were taken by the researcher using a pro-forma shown in Appendix 4. The acknowledgement of researcher biases has already been mentioned.

The field notes were taken during every class. Observations were often supplemented with question and answer sessions with the teaching staff involved. This helped clarify and triangulate the notes as they developed. Although difficult to maintain, the researcher remained strictly as an observer non-participant as far as the students were concerned. There were times when they tried to engage with the researcher as another adult, or a teacher and enlist the researcher's aid in the class. These attempts were re-directed to either Engineer A who was the tutor of the course or Teacher A who acted as an assistant in a number of the classes. Teacher A's role often saw him acting as a participant researcher. It was his class and therefore almost impossible for the students not to include him in the activities.

This viewpoint of pupils seeing every adult in the classroom as a potential teaching resource is well documented in the research literature (see Cohen and Manion, 1990). In this case, the number of adults involved in the class made the researcher's role as non participant observer easier to maintain. The researcher arrived before each class and stayed after each class to try and gauge the attitudes of the pupils both inside and outside the teaching situation. The researcher was looking for any apprehensions or enthusiasm the students might have before the classes began, and evaluative comments that might be made after. These were not question and answer sessions structured by the researcher, but rather observations of pupil banter. These observations are of course open to interpretation and may reflect any bias that the researcher held. This is why it is important to express relevant biographical data about the researcher, (see the introduction) to ensure the reader can acknowledge the influence this may have on assumptions made.

Generally the course was attended fully by the pupils, with the only exception being absences due to illness. The girls were usually happy and in good spirits when arriving, whereas the boys were more reserved and a little more apathetic. The girls were usually punctual, often ten to fifteen minutes early, whereas the boys arrived usually closer to the time of the class starting. This may reflect the greater travel distance required by the boys.

Engineer A's philosophy of teaching technology education reflected the applied science approach. Engineer A would spend 30 to 45 minutes approximately at the beginning of each class teaching scientific principles and theory. From a pedagogical perspective, this is far too long. The expectation that pupils can sit and listen passively and absorb useful information is flawed. There were times when the researcher found these long introductions too dry and confusing (field notes, 1999).

Electronics and control technology is one of the seven technological areas identified in the curriculum. Engineer A would use didactic methods of delivery, drawing on the whiteboard and talking in these opening periods. Electronics and control can be quite abstract, so that these long sessions were inappropriate and reflected a lack of teacher training. It was observed that Engineer A had one mode of delivery and this was presented in every class. Engineer A did not use his voice well to illuminate key points and the use of humour was rarely seen. Had this mode of delivery been used with a less motivated group of students the results might have been quite different.

The researcher clearly noticed signs of apathy from the pupils during these long introductory sessions. However, Engineer A did not. After the first few classes, Teacher B and the student teacher would stay away and not enter the classroom until these sessions were over. When questioned, Teacher B's response was "I've heard all this from Engineer A before" .... "Sometimes it goes beyond me". The student teacher acknowledged that he had done this topic before during his technology degree but the delivery was different and he did not want to get confused.

Engineer A did use question and answer sessions to try and maintain interest and additionally as an assessment technique to ascertain their levels of understanding. These occasions were generally answered by the girls, and normally the same girls responded. Teacher A's attempts to get others to answer usually resulted in a nil or incorrect response. The groupings in the class tended to be friendship groups which meant the boys spent the majority of the course sitting together on their own table. This only slightly changed towards the end of the course when one of the evidently more social girls instigated a mixed grouping.

...the researcher was impressed with the confidence of the girls which showed that they were (a) not overawed by having Engineer A there and (b) not unduly shy about having the boys in the class.

(field notes, 1999)

This didactic introduction would be followed by a sharing of previously prepared handouts. These handouts had a similar approach to Engineer A's delivery of factual information followed by questions. For an example, see appendix 5. These handouts would lead the pupils into a practical activity. Other supplementary sheets were also given out and these tended to be straight photocopies of manufacturers' data sheets on electrical components or pages from manuals on how to use equipment. Although relevant, they were not inspiring or engaging, and each class followed the same format. The questions were rarely completed in class. The girls would concentrate on the practicals, which they clearly enjoyed more, and complete the questions out of class. When questioned, the researcher was informed that the answers were shared once the answer had been figured out by someone.

A researcher comment Engineer A's delivery, although not inspiring, was not as dry as I feared it might be. "Researcher Bias"

(field notes, 1999)

Comments recorded from the classroom teachers were (a) that they learned a lot from Engineer A i.e. his wealth of knowledge and experience and (b) had they been teaching the same course they would have done it differently. This reflected the researcher's concerns that having a non teaching person teaching in the class was an issue.

The pupils the researcher observed to be quite attentive and very well behaved with a few managing to ask and answer some probing questions. The only real exception to this was when the class had to be switched to a Friday evening. The pupils were much more restless during this class and Teacher A, the classroom teacher, interceded frequently to keep the pupils on task.

...observation that the researcher didn't feel like studying analogue electronics on a Friday night either.

(field notes, 1999)

The practical sessions were obviously more hands on and followed a slightly more flexible approach to learning. The pupils were much more engaged here, particularly the boys who became much more responsive and alert. It was during these "hands-on" times that the other adults became more actively involved in the class, generally acting as facilitators while Engineer A roamed from group to group asking and clarifying questions. The pupils were observed to be much more enthusiastic during the practicals and they often engaged with the materials as well with Engineer A. There were a number of occasions where students would make a connection between the previously-not-understood introductions and what they were asked to do in the practical....i.e. "the penny dropped" (researcher's comment, field notes, 1999).

Links can be made here between the knowing and the doing facets of technology education. However, this was not the technology education of Pacey's model (1983). The problem solving which was occurring was limited to finding the correct answer which was always there to be had. It was a lock-step approach to technology education, involving a linear process with no acknowledgement of the social relationships that the study of electronics could entail. The technology curriculum does not extend to this level of the school as a requirement but there was no evidence of its influence on the practice the researcher observed.

Where necessary Engineer A would call the class together and become an instructor demonstrating how to use a particular piece of equipment (e.g. the oscilloscope). This could be seen as a technicist approach and would have been very similar to the technician training that Engineer A had provided at the polytechnic.

There was no evidence of Pacey's technological practice beyond the technical aspects, which the review of the literature showed to be a very restricted view of technology. If there was an economic instrumentalist perspective behind this alliance, it was not evident in the class. There was little evidence of creativity or innovation and the reflective thinking that occurred was confined to a very narrow understanding of "how things work."

There was little to connect these activities to the 'real world' except perhaps in a fault finding, circuit analysis which could clearly just as readily have been delivered by the class teacher. Young (1998) argues for a shift from teacher centredness to learner centredness, but this was not in evidence here; nor was the connectedness advocated by Marshall (1997).

Assessment techniques were to be pen and paper tests administered at the end of the module. Clearly these students had proven themselves in this arena before and would have little trouble with the narrow focus of this unit. The assessment techniques used would not go beyond 'surface learning' and therefore would not ascertain deeper levels of understanding and theoretical concepts.

4.2 Individual interviews

A variety of interviews were conducted, some of which were one-to-one in-depth interviews and others were small focus groups. The recording procedures used for the interviews varied dependant on the circumstances and location of the interview. Most were recorded using a voice recorder and transcribed later. These were then discussed with the normal classroom teacher, (Teacher A) who was in attendance during most of the interviews. This was done to maintain the integrity and reliability of the data. Research literature shows (see "member checks", Cresswell 1994, p. 158) that this is an important tool to ensure there were no missed inflections or misquotes during the transcribing. Some were recorded using notes, while others were recorded after the interview using a diary format.

The more formal, structured, small focus group interviews were held with the students outside of the teaching time. Focus groups according to Bouma (1997) are a combination of in-depth group interviewing and observation in a group context. The topics for discussion are initiated and facilitated by the researcher who tries not to express personal views. One of the strengths of focus groups is that they allow the researcher to see the individual's reactions to another individual's comments. This would be more difficult if not impossible to observe using other research methods. In this particular case the focus group interview was used to triangulate against the researcher's field observation notes.

4.2 ii Excerpts from Interview 1

The first interview was between the *Researcher* and *Teacher A*. It was quite a structured interview with prepared questions, copies of which were given to Teacher A before the interview took place. That said when topics of interest arose outside of the prepared questions these were also pursued. A short selected summary of questions and answers follows. (Coded tape 1 part 1)

Researcher. *How long have you been at Waterborough school?*
Teacher A. *Over ten years.*

Researcher. *When did you make your first industry link?*
Teacher A. *Eight years ago*

Researcher. *Who established the links?*
Teacher A. *Me (teacher A)*

Researcher. *What type of link was it?*
Teacher A. *Initially we had pupils doing CREST projects and the school had little facilities for doing practical technology activities so we used to use local expertise and equipment to get things done. It was all on a voluntary basis and mostly revolved around two companies, Waterborough Engineering (fictitious) and The Company .*

Researcher. *When did Engineer A become involved and when did things become more formal?*
Teacher A. *About five or six years ago Engineer A from The Company got involved with a gold CREST award and I realised that he was quite a useful character. He also let slip that he had an interest in teaching as he used to work as a tutor in a polytechnic. It seemed to me that if he got made redundant he might like to return to that profession and therefore wanted to keep his teaching record up. It was a bit of you scratch my back and I'll scratch yours, this should no way detract from what he has done.*

Researcher. *Did other staff from the school get involved? What about School B ?*
Teacher A. *No just me, I instigated the link with School B they kept losing their teaching staff in this area so it made sense to bring them on board.*

Researcher. *How do you see the link at present?*
Teacher A. *Tenuous it depends on the generosity of both Engineer A and the company he works for. The company may be shifting soon.*

Researcher. *Should this link come to an end will you go looking for more?*
Teacher A. *Yes. Not only one I will continue to troll for suitable people to work on the CREST projects the pupils are required to have consultants who are not teachers.*

Researcher. *What about your electronics programme?*

Teacher A. *I have actually made contact with someone already.*

4.2 iii Excerpts from second interview

The second interview was conducted by the ***Researcher*** and the other party was the ***Principal*** of Waterborough school. This interview was structured similarly to the first interview. The following is a selection of questions and some of the responses received. (Coded tape 1 part2).

Researcher. *How does the community of Rowe town see Waterborough school?*

The Principal. *From what I can gather the community thinks very highly of us; They see us as the jewel in the crown of the town and they cue up to send their children here.*

Researcher. *Why do parents select Waterborough school?*

The Principal. *They select it because they say its a place where magic happens, we don't expect failures.*

Researcher. *Are there people from industry on your Board of Trustees (B.O.T.)?*

The Principal. *Oh yes the chair of the board from last year imports and exports computer bits.*

Researcher. *How long has the school had industry links?*

The Principal. *I don't know you would have to ask Teacher A .*

Researcher. *What is your personal philosophy as far as school-industry links are concerned?*

The Principal. *They are absolutely great, we couldn't do without them. I think they are marvellous. The merits are, enormous support, we get financial support in terms of what they don't charge us for. The kudos the children get, the refreshing part of having people from outside of the classroom with all that expertise.*

Researcher. *What are the debits?*

The Principal. *There aren't any unless it collapses which might happen to us.*

Researcher. *What do the B.O.T. think?*
The Principal. *They are most grateful, they are most appreciative.*

Researcher. *How do the current links operate? I am curious about your involvement?*
The Principal. *You would have to ask teacher A really. From my point of view a very enthusiastic teacher who puts a lot of time into nurturing the right people who give us a lot for nothing.*

Researcher. *Is there senior management team monitoring of what takes place?*
The Principal. *No he's a HOD I expect him to monitor it, I delegate that to him. I just support him totally.*

Researcher. *Are you prepared for the school to be named?*
The Principal. *If Teacher A doesn't mind I don't mind.*

4.2 iiii Excerpts from third interview

A third interview was undertaken with *Teacher A.* The questions for this interview arose out of points raised in the other two interviews. Often with this type of research things arise which need to be explored further.

Researcher. *What is your personal philosophy on school-industry links?*
Teacher A. *There is a hell of a lot of people out there(outside of school) that know stuff which students can use. Basically I see it (the outside world) as a massive resource and it seems reasonable that students (a) Get access to the resource and (b) Get access to people out there that are actually doing things. So they get a better appreciation of what the real world is about. Dealing with teachers is sort of artificial we tend to give them a sanitised kind of science and technology and it becomes more sanitised the further we get from private employment. Like I used to be employed in industry fourteen years ago and when I first come in (to teaching) I think I was more vital than I am now. I think it is important that students tap into the real world.*

Researcher. *What are the benefits of the current link with Engineer A?*

Teacher A. *Its good because Engineer A is a real practising Engineer And therefore the pupils get a first hand knowledge of what it is like to work with somebody who is actually making a living in the technology world. I see it provides a alternative to me the way he speaks is different, the way he tackles a problem is different, I found his problem solving most interesting, because he tackles things in a completely new way to me and I think the pupils benefit from it.*

Researcher. *What do you mean by a different way?*
Teacher A. *The strategies he uses and also his understanding of electronics is possibly much more innate and sort of fundamental than mine and you know if there is a problem my solution tends to be more text book orientated where his tends to be more experienced based, still highly you know scientific and meritorious but different.*

Researcher. *Is there anything you would consider as a debit?*
Teacher A. *I think it should be acknowledged that Engineer A was given time to work with the school by his company. They actually had it as part of his job description these opportunities. I guess Engineer A having done this course for a number of years, maybe too could be he too was becoming old hat or whatever. Perhaps it is time for a change.*

Researcher. *Have you received any feedback from the BOT on the links?*
Teacher A. *None at all.*

Researcher. *Have you received any feedback from the principal on the links?*
Teacher A. *She has fed back that she is personally pleased with certain things that have happened.*

Researcher. *How is this particular link operated?*
Teacher A. *Engineer A has a contract and is paid out of STAR funding. Engineer A has always given more than the contract has ever specified, like he doesn't charge for the bits and pieces he brings. He always does more hours than the contract says. He does all the CREST stuff by virtue of his companies willingness to be involved in school-industry links. Engineer A' gives massive amount of time for free , great guy.*

Researcher. *Does anyone monitor your work?*

Teacher A. *Just me.*

Researcher. *Are you and the school prepared to be named in the study?*
Teacher A. *Yes.*

Researcher. *Anything you would like to add?*
Teacher A. *The inaugural youth science and technology fare was held in South Korea. We had two gold CREST winners representing New Zealand there.*

<u>*4.2 iiiii Excerpts from interview four*</u>

The interviews that were conducted with Engineer A were much more informal, and the recording procedure was in the form of note taking. The researcher did not feel comfortable taking recording devices into his place of work as they had a lot of security. The Company is involved in high technology security solutions and sensitivity was important. Engineer A is also a very private individual and the researcher did not wish to alienate him by being too obtrusive. The researcher did manage to (a) see the type of work that Engineer A carried out in his workplace and (b) get some interesting answers to questions, a sample of which follows.

Researcher. *Why are you involved in this link with the study school?*
Engineer A. *I do it because I enjoy it. Electronics is part of everyday life. Its good that students get to understand it a bit, whether they go on to study more of it or not. It is also important that they get to carry out electronics that are based on real life situations.*

Researcher. *What does your company think of your involvement?*
Engineer A. *The Company has a positive attitude towards community links. My previous line manager was the one who encouraged me to get involved. Since he left The Company, it is something I have pursued myself. I am lucky I am in a position where I can allow myself time to be involved.*

Researcher. *Does The Company gain from the involvement?*
Engineer A. *We get some publicity like the BRANZ alpha awards. We also work quite closely with Massey University technology graduates. This helps with future*

recruitment. We get to see some good students and they get to know about The Company and the opportunities. Engineer A also said that other staff at The Company get involved in CREST he sees it as good for morale.

Most of the other responses were factual and historical about The Company itself, Engineer A was more comfortable talking on these topics.

The researcher decided to have focus interview groups with the students. This was to clarify and triangulate the findings from other sources and also to give the pupils a chance to engage each other in conversation about the links. In attendance were the researcher and Teacher A. The researcher felt it was important to have Teacher A there to act *in loco parentis*, but also to validate the findings from the interview process. The interviews were recorded and transcribed later. The researcher will follow the same format as above, where there are notable responses from more than one person these will also be included. The pupils will not be named but referred to as pupil 1 etc..

Key:

Researcher. = Researcher questions.

Teacher A. = the class teacher

Pupil = A pupil from the school not necessarily the same one, responding. For example some responses have Pupil 1 this is not an allocation to a individual pupil. It is just the first responder that same pupil might be Pupil 2 later if they responded second.

4.3 Focus group interviews.

The focus group interviews were carried out by the researcher with Teacher A present. The group was made up of the girls from Waterborough school. The boys from School B were not included.

Researcher. *What did you think when you heard that someone from industry was going to be taking this part of the course?*

Pupil 1: *It is going to be difficult.* ***Pupil 2:*** *I just thought it would be different.*

Researcher. *Did anyone look forward to it?*
Pupils: *Laughing - it was just like another class – just a bummer it had to be at night. (Collectively) Two hours is too long – you need a break – the fact that you knew it was going to be an interesting person coming into our school. The fact that you are missing prep*

Researcher. *Do you think there would have been a different reaction if you thought it was going to be a woman taking your course from industry possibly a electrical engineer that was a woman?*

Pupil: *I think we would have been more interested to see what it was going to be like?*

Researcher. *So you would have been interested to find out about her.*

Pupils: *Yeah ... it must be harder for a woman to get into the industry. I remember *** saying she went to this talk about electrical engineers and she was the only girl. The guy up the front looked at her because she was the only girl in the audience and said "there aren't really any women in the industry" and so she was put off.*

Researcher. *Did you perceive that there would be benefits to you as a student? If so, what were they?*

Pupils: *Being a different teacher then you wouldn't get so sick of having the same teacher the whole time.*

Pupil: *Plus sometimes there are things we can go over that we can't go over in class. A lot of things about what they really do in industry*

Researcher. *Did you think there was going to be something good about having this person in?*

Pupil: *Well you can look forward to doing – the practical side of it. Like you know how it relates. It's interesting:*

Another Pupil: *It was going to be different from our class work because it was more involved, like more specialized.*

Researcher. *Did you think there were going to be any negatives?*

Pupil 1: *I never thought of it.*

Pupil 2: *If you had like questions say from that night that you didn't really go over with them – you didn't have time or something then during the week you wouldn't really be able to get hold of them easily to go over them.*

Researcher. *Were any views expressed to you about working with industry in schools by friends or family – if so what were they? Did you know anyone that had done that course with him before from last year or anything.*

Pupil: *Only my brother.*

Researcher. *Did you talk to your brother about it?*

Pupil: *Oh he just said it was alright.*

Researcher. *Did your parents know that there was somebody from industry in your class teaching. Did you talk to them about it?*

Pupil: *No not really.*

A follow up interview was conducted where the group specifically discussed the course itself the researcher was hoping to cross reference recorded observations and the views of others expressed in other interviews.

Researcher. *What benefits did you actually get?*

Pupils: *Just specialist information and expertise when you do ask him questions it is like he never has to think about it.*

Pupil: *.. in our little groups if you got something wrong and we said we don't actually understand what we have done wrong here .... he would explain everything and make it easier to understand than when he is standing up doing it on the board like he can explain it heaps.*

Researcher. *What were the negatives?*

Pupil 1: *usually he speaks to us for ten minutes but then I just ask him individually in groups.*

Pupil 2:... *the first ten minutes like we just get so bored*

Pupil 3: *He talks to us like on the board – we don't like really ask questions though like say if we are doing something really complicated we feel like too uncomfortable to ask questions and stuff*

Pupil 4: *Yeah I guess that is the other disadvantage of having someone strange here (lots of females talking)*

Researcher. *That is a different point what you are saying now is that because it is somebody from outside whom you don't know that well – even though you really want to ask a question you may not because you don't know how they will take you interrupting them?*

Pupil: *Yeah but that also might contribute because of the guys in the class like we don't know the guys – I mean its not like we have been in the same class for five years and we have gotten comfortable with each other*

Teacher A. *You don't mind feeling an idiot in the class ?*

Researcher. *A boy looking at you how do you feel?*

Pupil: *We just don't know them ……….*

Teacher A. *Another thing too, Engineer A tends to tackle things in his own way. He looks at – his explanations are different to what mine are? The same thing. I take it I guess from a more fundamental sort of what they know – what I taught them in 5th form what I taught them in 6th form and what I know they are going to know in 7th form and he often explains things a completely different way which is interesting and I find it fascinating but it is hard for the clientele to pick up the difference.*

Pupil : *Like if I asked a question – I don't mind asking questions because you know they understand the answers. Like I can't understand what he is trying to say so he goes into too much depth sometimes and I'm like I don't know what you are talking about*

Pupil: *Yeah he sort of goes beyond what is needed because he thinks you know exactly what is needed for the practical but we obviously don't.*

Researcher. *Do you think the technology education particularly should involve working with people from outside school?"*

Pupil 1: *Yeah (collectively) I do because like – their specialized knowledge is so much better than teachers which have got to teach like so much more schools like one teacher for all the technology – they don't really have time to keep up to date with all the new things that are coming out and stuff.*

Pupil 2: *Yeah I know I didn't say I was talking about you but some of the other teachers that have been here for like 20 years I mean they might not have an idea about what is going on*

Pupil: *I was just going to say yes to industry people but not necessarily to teach. Like you don't need them to teach you to find out what industry is like ……….*

Researcher. *Do you have careers days or anything like that where industry people come in?*

Pupil: *But we don't really get industry people in you just get people from universities trying to convince us to go on their courses.*

Researcher. *Well basically they are the areas of the technology curriculum that people are required to teach so I will read them to you – biotechnology, electronics and control, food, information and communication, materials, production and process, and structures and mechanisms. The question was which areas of technology education would benefit from school-industry links off that list?*

Pupil: *Biotechnology*

Researcher. *Why?*

Pupil 1: *I don't know it seems to me to be a important area and it has changed a lot.*

Pupil 2: *I don't know I just think food is the only one that struck me that probably doesn't need it because food technology is more like something that hasn't really changed whereas all the other areas are like all the ones that are changing.*

Researcher. *What were the good things if any? Or why would you recommend that people come in from industry?*

Pupil: *It is good having a different teacher some of the time. ...... and not only that he has the equipment.*

Researcher. *So would you say yes or no ... and be quite confident ... yes or no based on your experience of what has just happened with you would you recommend that somebody from industry come in.*

***Pupil** (Group) : Yeah but not necessarily to teach.*

There followed some banter between the students who gradually supported each other to get quite critical of the experience.

Pupil: *Has he been trained as a teacher ?*

Teacher A. *He taught in a Polytechnic*

Researcher. *But not trained as a teacher?*

Teacher A. *No he is not a teacher but he knows his stuff but that is quite often a disadvantage. He knows that much but he doesn't know what you are capable of*

Researcher. *How many times has he taught the course?*

Teacher A. *About six*

Researcher. *So because he has taught this six times, has it changed much in that time or...?*

Teacher A: *Initially it was a lot harder. I sort of – each year we try and sit down and try and go through it but again we have to look at the syllabus and there is basic things we have got to go through and so I have chopped quite a few things out but I still like to make - like that last session was quite tough I thought. We have got that* *balance that we have got to keep between what we have to do and you know – what Engineer A wants to do.*

Pupil 1: *But like I can do all the practical and bits but I don't understand the theory at the moment. ……………… (other females comment as well)*

Pupil 2: *I can't understand all the theory*

Teacher A. *Yeah I know but what I am saying is that is not really what is necessary. We don't want you to go away and spend your time doing problems on the stuff that he is doing.*

Pupil 3: *it is all theory like I would probably understand but I will be able to do what he is telling me to do but …. at the end of the day when I have to do it by myself I wouldn't be able to.*

Pupil 4: *I can see how these circuits and stuff work but I just don't know actually doing it what is happening or anything.*

Pupil 5: *I don't know why we set up that circuit for what to test a theory sort of?*

Teacher A. *I think possibly you should ask him "what – give me a practical use for this – what is the use of a voltage divider or what is the use of a single stage amplifier or something that he is doing"*

Pupil: *He says it but it is something out of my textbook …….. in classroom you usually take a theory .. like in mechanics you use ………. and then we would do the practical afterwards but it is like he does it we don't understand it – we do it and he tries to explain it*

At this point the researcher decided to ask questions about their other experiences of working with industry. All of these pupils had been involved in CREST projects with varying degrees of success. Some had worked with Engineer A in that capacity while others had different industrial consultants. The researcher thought it would be interesting to see if their views about the links changed when working in a freer way than in a teacher-student relationship.

Researcher. *So you have all done a CREST project. OK that means you have all worked with somebody outside right, so can you tell me about that was there good positive and negative experiences?*

Pupil: *I liked that heaps better than this course the work was what I wanted to do not as this course.*

Researcher. *Who were you working with?*

Pupil: *I was with Engineer A*

Researcher. *Oh you were with Engineer A oh I see OK anybody else? What about your experience?*

Pupil: *I liked it better than the class because it was an area I was interested in and I was planning on myself but you know it was quite different from this situation*

Researcher. *What about you?*

Pupil: *I worked with Engineer A as well and I like that heaps better than the classes ...easy just when you had problems with it, it was like one on one as well.*

Researcher. *Can I just ask you then if all three of you worked with the same person was he able to relate to you at a level which you understood on a one to one much more so than in the class. Is that what you are saying because he must have been still calling on his experience he still has the knowledge so how was he able to get it across easier in that situation than this?*

Pupil: *Yes I think he was more interactive like in class we kind of tune out a little bit like after a while in a class you can pretend that you have got it .... but when it is one to one you kind of have to listen.*

Researcher. *What about you I know you didn't finish yours you said but were you working with the same person?*

Pupil: *I was working with Engineer A*

Teacher A. *We won't say too much*

Pupil: *To be honest I didn't actually speak to him that much*

Researcher. *OK .. you were with somebody different and who was.... I am not interested in the person per se but where were they from.*

Pupil: *.......... XXXX*

Teacher A. *Who was it – Oh XXXX oh yeah he is a local guy*

Researcher. *Local what?*

Teacher A. *He is actually a telecom technician*

Researcher. *OK so how did that go?*

Pupil: *Good yeah it was good heaps more practical not like this experience.*

Researcher. *But was he easier to talk to – did he explain things well*

Pupil: *Yeah*

Researcher. *You did all the work and he just....*

Pupil 1: *Yeah just helped me*

Pupil 2: *I didn't finish mine*

Teacher A. *We don't want to be reminded*

***Pupil** 3: The question I had like I can't remember but I had one and it was like better because you could just ask the questions that you wanted there and then you know, you didn't have to wait until after they had finished up with someone else's question.*

***Pupil 4:** I haven't done much work on CREST I prefer math's problems*

***Researcher.** Of your experience of the two things can you tell me how they compare?*

***Pupil:** For me it was good individually.. but in a group not so …………*

At this point Teacher A had thought about the idea that the girls had not asked questions of Engineer A because the boys were in the class and so he interjected... Teacher A was concerned that the girls were suffering from a lack of confidence whilst the boys were in the classroom. If this was detrimental to their learning Teacher A would change the relationship and remove the boys from the equation. (field notes, 1999).

***Teacher A.** It might be worth saying that as a result of what you have said I am probably going to disallow Rangitikei option next year I will just keep it to our school.*

***Pupil:** ……. (all spoke at once) having different people in the class that is really good*

***Teacher A.** That is why I did it*

***Pupil:** Oh well you didn't ask about that I liked that although you are embarrassed to ask questions – I think I would still prefer it because it is interesting to work with people of different knowledge to bring into class.*

***Teacher A.** Well that is a good point because I looked around and I thought this year you have got on better than any other group. Like some years the girls would be "oh you're here" and they wouldn't even look at the board ..*

Pupil: *But there is the fact that we knew some of them*

Pupil: *I like knew the whole class and I'd been in class with them before at Intermediate and stuff*

Pupil: *and some of us had met that…………*

Pupil: *We like met new people from it as well*

Teacher A. *So it is a group of social gatherers*

Pupils: *giggles*

Pupil: *I reckon you should keep them .. especially since we are like stuck in the study school…..*

Teacher A. *… That is the sort of thing I do think about. I did think about that years ago.*

Pupil: *No I reckon that we should do it.*

Themes that emerge from the focus groups interviews:

Pupil expectations of the school-industry link.

A mixed response, suggests that the students were not primed or aware of the rationale for the school-industry link. The pupil responses ranged from, "I thought it was going to be difficult" to "I just thought it would be different". Basically they saw it as just another class, which might be more specialized. Had the rationale for the link been explained to the pupils before it was undertaken perhaps the pupils would have been more evaluative of the outcome.

Views of friends and family towards the link.

The evidence suggests that the school had not made parents aware of the school-industry link. Pupils that discussed it with family members or friends had done so incidentally and had received little guidance from them. This again appears like a missed opportunity to discuss with the pupils on this course other people's attitudes towards technology education and the involvement of business and industry in schools.

Gender issues to do with school-industry links.

Pupils were aware of the stereotypical engineer, they were also aware of the disproportionate number of males to females working in the technology sector. Some pupils even recalled instances where this was reinforced. " There aren't really any women in the industry"... "It must be harder for a woman to get into the industry". Had the school considered the gender issue and looked for a positive role model perhaps the cycle might be broken. "I think we would have been more interested to see what it would have been like" was a response to the suggestion made by the researcher that it could have been a female engineer.

Attitudes towards an outsider contributing to a school programme.

The pupils commented that they thought it would be refreshing to have a different person other than the class teacher taking the course. They also suggested that it would be beneficial having someone from industry with current and specialized knowledge who really knew what went on in industry. It appears that the pupils would acknowledge the need for teachers to gain experience in this area. There are a number of schemes available for teachers to be seconded and work in industry. The viewpoint expressed by the students suggests that they would appreciate this.

The pupils were also able to identify some possible negatives for school-industry links. Firstly they noted that it would be difficult to contact the industrial person outside of class time if they needed clarification etc. A second point was that the pupils felt "uncomfortable to ask questions and stuff". This was not a reflection of Engineer A's communication skills or his persona. Rather, it was an identification of the relationship which is built up between a class teacher and the pupils over a period of time. This relationship can encourage an atmosphere of trust and security whereby the pupils are comfortable enough to ask questions .

Specialized knowledge versus pedagogical knowledge.

The evidence collected suggests that the pupils were aware of the difference between specialized and pedagogical knowledge. For example, the comment: "like I can't understand what he is trying to say so he goes into too much depth sometimes and I'm like I don't know what you are talking about." Or the comment: Yeah he sort of goes beyond what is needed because he thinks you know exactly what is needed for the practical but we obviously don't." The question was asked whether the pupils felt technology education should involve people from outside of the school. A collective "yes" was the response and justified because of the specialized knowledge but... "I was just going to say yes to the industry people but not necessarily to teach."

The evidence acknowledges the awareness of pupils that the classroom teacher has to take the knowledge and make it accessible to them, showing a cognisance of where their level of understanding is. Without this the pupils identified that the level of understanding is superficial. For example, the comment: "I can see how these circuits and stuff work but I just don't know, actually doing it what is happening or anything."

The importance of the learning context in school-industry links.

The pupils were invited to discuss other experiences of school-industry links and make comparisons with the special topic course undertaken. The findings appear to highlight the significance of the context for both technology education and school-industry links. Clearly the pupils were more in favour of the project based relationships they had with industrial partners as part of the CREST projects. Real life contexts do motivate pupils more than abstract learning in the classroom.

Additionally the pupils identified the personal contextualised problem-solving experience as more stimulating than the traditional classroom experience. One pupil commented: "I liked it better than the class because it was an area I was interested in and I was planning on myself but you know it was quite different from this situation." It was not just the change in the personnel as some of the pupils reporting had used Engineer A as their industrial link. For example: " I worked with Engineer A ... and I liked that heaps better then the classes." They also identified the individual attention that CREST type projects bring as a benefit, with the comment that: "..I think he was more interactive, like in class we kind of tune out a little bit after a while in class you can pretend that you have got it... but when it is one to one you kind of have to listen."

4.4 Small scale questionnaire.

The final data collection tool was a questionnaire which contained a schedule of varied questions. Obviously this method of data collection relies on the respondent to identify and disclose the relevant information. While it is unlikely that the results will be exhaustive it is assumed these respondents were mature enough to offer significant views.

The total number of respondents was 14 and the response rate was 100%. The questionnaire was given out at the end of one of the classes and the pupils were asked to take it away and complete it for the next class. The results will be presented in a table format with one for each question. Each table will have a set of response statements. These are the most commonly given responses summarized by the researcher. This will be followed by a frequency number which indicates the number of responses using that statement. Each table will also contain a 'no response' indicator. This is a genuine blank response. Where a respondent gave more than one response the researcher selected the statement which received the most attention.

The questionnaire was in two parts; A and B. The first page part A was about perceptions and attitudes before the experience. The second page part B contained questions about their actual experience.

1.) Before you became involved in school-industry link what was your attitude to having industry people in schools?

Respondent statement:	*Frequency*
No response	1
Never thought about it not bothered	9
Positive	4
Negative	0

(Table 1 findings from question1)

2.) Did you perceive that there would be benefits to you as a student, if so what were they?

Respondent statement:	*Frequency*
No response	2
Improved learning	5
Bring experience applied knowledge	4
Different teaching style	2
No benefits	1

(Table 2 findings from question2)

3.) Did you perceive that there would be negatives to you as a student, if so what were they?

Respondent statement:	*Frequency*
No response	2
More complicated, more work	2
Lack of teaching expertise	1
Different teaching style	2
Lack of access outside of class times	1
Timing of class (night time)	2
No negatives	4

(Table 3 findings from question3)

4.) Were any views expressed to you about working with industry in schools by friends or family?

Respondent statement:	*Frequency*
No response	3
Positive views expressed	1

Negative views expressed	0
No views expressed by friends or family	10

(Table 4 findings from question 4)

B1.) What were the actual benefits (if any) to you as a student having this industry person in your class? Please be specific.

Respondent statement:	*Frequency*
No response	0
Improved learning	2
More interesting	1
Relating to real life	3
Access to expert knowledge	8
None	0

(Table 5 findings from question B1)

B2.) What were the actual negatives (if any) to you as a student having this industry person in your class?

Respondent statement:	*Frequency*
No response	1
To confusing	2
Not as good a teacher	2
Did not know what we knew already	2
No access to them outside class	1
Evening class timeslot	4
None	2

(Table 6 findings from question B2)

B3.) Do you think that technology education particularly should involve working with people outside of school?

Respondent statement:	*Frequency*
No response	0
YES Quality of teaching	2
More recent knowledge	2
Real life situations	1
Specialist expertise	5
NO	1
Not bothered either way	3

(Table 7 findings from question B3)

B.4) Which areas of technology education would benefit most from school-industry links? Biotechnology, Electronics and Control, Food, Information Communication, Materials, Production and Process, Structures and Mechanisms.

Respondent statement:	*Frequency*
No response	1
All of the technology areas	6
Electronics and control technology	4
Biotechnology	1
Food technology	1
Materials technology	0
Production and process technology	0
Structures and mechanisms technology	1
Information and Communications	0

(Table 8 findings from question B4)

B5.) Based on your experience would you recommend that industry should be involved in technology education in schools or not? Yes or No answer.

Respondent statement:	*Frequency*
No response	0
No	0
Yes	13
Undecided	1

(Table 9 findings from question B5)

Themes that emerge within the small scale questionnaire.

Prior to their involvement in school-industry links the majority of pupils expressed little interest or consideration of them. However, when considering what the benefits of a link might be the pupils noted two points; firstly, that the link person would bring experience and an applied knowledge. Secondly that being involved in a school-industry link should result in improved learning. Overall the pupils prior expectations could be described as very positive. There appeared to be very little influence from friends or family.

Ignoring the timeslot factor (late evening class) the results obtained after the course indicate a spread of identified negatives. These could be classified as lack of pedagogical knowledge, with responses such as *confusing, not as good a teacher, did not know what we knew already.*

When responding to whether technology education should involve working with people outside of school the majority of responses were positive. The main reason identified was the specialist expertise the external person brings. When asked to identify the technological areas that would benefit most from school-industry links the pupils identified all of them plus a special mention for electronics and control. The latter may reflect their own recent experience.

CHAPTER 5 - DISCUSSION

Introduction:

The main focus of this study has been to ascertain what actually goes on in a school-industry link. This type of study is often called an 'exploratory study', i.e. a study in which no hypothesis is being tested (Bouma 1997) but there are research questions. The main area of focus has been on a programme funded through the Secondary Tertiary Alignment Resource (STAR) in which an industry person came into the case study school and taught part of an electronics course. Additional aspects of school-industry links particular to this study school have also been studied. The findings of the research and the viewpoints of those involved are discussed below.

A further focus has been to identify possible reasons for the association of school-industry links with the new curriculum area of technology education. This involved investigation into the policy directions behind the technology curriculum's development and implementation. A summary of the findings of this investigation will be presented and discussed in the next chapter, together with implications from this study and suggestions for further research. Conclusions from this study will also be presented.

5.1 Student viewpoint.

All of the students involved in the study have been involved in school-industry links some on more than one occasion as part of different initiatives. When asked the question, "Based on your experience would you recommend that industry be involved in technology education in schools?" the majority (93%) responded positively. Although the students expected improved learning to occur during the focus course, their reflection on what actually took place was significantly less positive. Their responses reflect a concern about the teaching abilities of the industrial partner, and a lack of access to this tutor outside of the course time. In addition, although the field notes did not identify this as a problem, during the interview the students mentioned that they were apprehensive about asking the industry person questions.

They were, however, much more positive with regard to the links, such as the schemes run by CREST, in which the industrial person was used in a consultative as opposed to a teacher role. They also pointed out that they preferred the approach of programmes like CREST because it was a more independent type of study. The contextualized problem or issue they were trying to solve was selected by themselves and this they favoured. They liked the one-to-one relationship they developed with their industrial consultant. They also expressed a preference for the more practical type of activity involved with CREST projects. The other major positive identified was the equipment that the industry person could make available for the students to use. Engineer A, the industrial person, usually turned up with a box of "bits" that the school simply did not have.

This CREST approach is similar to a technological or design process which is used as a framework for technological practice. There certainly was a motivational aspect identified by the research which should be a valid consideration for the introduction of a school-industry link. Another positive expressed was the association of technology education and the real life emphasis that an industry person brings. The study mainly involved female pupils and it was clear they identified the gender issue within technology professions. The pupils in this study indicated that a positive gender role model would have been an additional motivating factor.

5.2 Teacher viewpoint.

Teacher A, the teacher in this case definitely believes in the value of school-industry links. He expressed this as follows:

> *There is a hell of a lot of people out there(outside of school) that know stuff which students can use. Basically I see it (the outside world) as a massive resource and it seems reasonable that students (a) Get access to the resource and (b) Get access to people out there that are actually doing things. So they get a better appreciation of what the real world is about.*
>
> (Teacher A, Personal communication 1999).

When talking of this particular case, Teacher A spoke favourably about Engineer A being a practising Engineer And that the students should know what someone who earns his living in a technology field is like to work with. Teacher A suggested that teachers offer an "artificial" model of technological practice or a "sanitised" approach. This approach he described as "text book". He elaborated by saying that Engineer A used a different language and his approach was experiential. It was also interesting to note that Teacher A worked independently on the links with little support or recognition or monitoring from the board or the principal. Teacher A was not unduly worried by the possibility of this particular link coming to an end. His attitude was that he would simply go out and find a different industrial link. His confidence proved to be well founded when in fact this is exactly what he did.

The company involved with the case study school went through an amalgamation and relocated its business and staff to a different location. Teacher A has already approached a different link person from a different source. This school-industry link will continue with new partners. It was somewhat surprising that Teacher A did not go beyond the motivational aspects and the "real life" perspective that the students were exposed to. It appears that there were few educational goals identified before the school-industry link was created and there has been little critique of it as an educational experience afterwards.

5.3 Principal viewpoint.

The principal acknowledged the expertise that the industry people bring in to the school. The principal also acknowledged that it is refreshing for the pupils to have people from outside of the school come in and be involved in the pupils' education. Other merits identified included the financial, which were identified as things the school was not charged for. For example in this school industry link Engineer A gave a significant amount of his own personal time to helping students with their technology projects. Engineer A has also fixed school equipment and helped with the manufacture of apparatus required. When Engineer A takes the special topic in the classroom he brings equipment and components with him at no extra charge to the school.

The principal did not have an understanding of how the scheme operated or how long it had been running. All of these concerns were "delegated" to Teacher A. The researcher noted that, the principal trusted and had confidence in Teacher A. However, some additional monitoring or evaluation of the programme from another member of the senior management team of the school might have been necessary, to ensure educational goals as well as financial ones were being met.

The principal did attend the BRANZ award ceremony held at the Royal Society in Wellington. This was seen as a positive publicity coup for the school and the principal wished to make the most of the event. On the day most of the attention went on the two main partners in the link, Teacher A and Engineer A.

When asked about the negatives of school-industry links The Principal's reply was "there aren't any unless it collapses." The principal identified the financial rewards, the motivational aspects of having someone in from the community and the possible publicity benefits. However, little educational consideration or rationale was expressed by the principal. Possible negatives or positives for the pupils i.e. teaching and learning were not identified as a cause for concern. The researcher observed that the principal clearly placed the expectation of a quality outcome on Teacher A. However, it would be reasonable to expect that there should be a least some external monitoring of the link from other senior members of staff at the school.

5.4 Industrial link viewpoint.

Although quite a private and reserved person, Engineer A did make some interesting comments. The most pertinent being that he was involved because he enjoyed it. He also expressed that it was his intention to help students gain some understanding of electronics, which in his words "is part of everyday life". He was not concerned personally with whether students went on to study electronics beyond this introductory course. He wanted the students to be exposed to electronics based on real life practices. Interestingly he did point out that the link with the tertiary students from Massey University was a valid source of new recruits for The Company. This suggests that a link with educational establishments was identified as a positive association for The Company. One that might reward The Company with a fresh supply of qualified employees. This may also have been put forward as a rationale for their involvement in school-industry links.

Engineer A felt supported by The Company initially to engage in the link, but once established it had become something he had chosen to continue with. When asked what the positives were for The Company he mentioned the BRANZ alpha award as a positive publicity relations exercise. Finally he described The Company's involvement with CREST as "good for morale". These are two reasons which are unrelated to the educational propositions for school-industry links which should be behind a school's involvement.

Overall the viewpoints expressed by the industrial link person had little to do with any educational rationale. Moreover, they reflected Engineer A's passion for electronics and The Company's desire to attract future qualified employees.

CHAPTER 6 - CONCLUSION

The methodology used in this research reflected a qualitative approach, which included the use of document analysis, interviews and questionnaires to ascertain what actually occurs in a school-industry link. The study has been partly exploratory and partly descriptive. The study focussed on a particular externally funded programme (STAR) and involved 14 students from two schools. The rationale behind such links has been investigated from a policy perspective and additionally their connection to the development of technology education has been discussed.

There has been little research done in this area within New Zealand and the findings of this study can contribute to our understanding of the perceptions of the parties involved in school-industry links. The findings also help to clarify the rationale behind the development of the technology curriculum and how school-industry links fit within that broader policy. The results obtained indicate that some of the rationale behind the links is indeed reflected in practice. There is definitely a perception that the students will have a greater access to more specialised knowledge than the teacher can offer, and that this knowledge will be more up-to-date. This was confirmed by both the teacher and the students involved in the study.

However, the structure of this particular 'link' did not make the best use of any learning potential. It is difficult to conclude from this research that the school-industry links programme at the study school either encourages or discourages students to pursue a career in technology professions. It is interesting to note however, that of the nine girls involved in the study, three have subsequently gone on to study technology related programmes at University (personal communication, Teacher A, 2000). One has enrolled at Massey University to study technology. One has enrolled at Auckland University to study engineering. The third, after a year off, is enrolling at Sydney University to study engineering. The research indicated that this was clearly an intention of the national policy behind the school-industry links and the development of the technology curriculum to encourage students to pursue such courses. However, there was little or no evidence of this being the focus from the school's perspective in this case.

Teacher A is an experienced teacher who has a senior role in the study school as a head of department, he has also had significant involvement with school-industry links outside of this focus programme. He was, at the time of writing, a trustee on the management board of the national CREST organisation. It was interesting to note that he saw the links as tenuous. The initiative was dependent on Engineer A and his company having a favourable disposition towards the programme. He expressed a fear about The Company's long term future. This proved to be correct as The Company has been involved in a merger (take over) with a larger company based in another centre. The new company has shifted both Engineer A and his work to the new location. Such is Teacher A's commitment to school-industry links that he has already found a replacement and the course will continue to run.

It is evident from the research that in this case the success or failure of the link has a lot to do with the commitment of the individuals concerned. Although it is identified as a school-industry link, the link in this case is in fact a link between the two main people, the teacher and the industrial person. In principle, management of The Company and Waterborough school are supportive of the link but in reality they have little to do with it. From a policy perspective it is a matter of convincing the individual class teacher and industrial partner that the link is worthwhile. The researcher suspects that, in this case, the greater onus is probably on the teacher and should he leave, the link would be difficult to maintain.

It is difficult to gauge the learning that has resulted from the link. However, it is clearly a perception and probably a reality in this case that motivation of the learners was increased. Clearly many pupils came to believe that the industry person was an "expert" and had a lot of current knowledge to impart. How much of this the pupils actually absorbed is more difficult to ascertain. What was evident is that in this case the school is seen as the receiving partner and that although payment was made it was tokenistic in comparison to the endeavours of the industrial link person. This relationship needs to be revised if the aims of the technology curriculum are to be met.

Dewey's (1935) advocation of a connected curriculum and Young's (1998) concept of connectedness was not really supported by this case. There was little insight gained into how technologists work, and the programme itself did not allow for the students to experience real technological practice. It was, however, noticeable that an improved relationship was achieved through the CREST style project.

There was little critical evaluation of what goes on in the industrial link company. Perhaps it was outside the scope of this particular STAR funded course. That said, the research here reports that with the current exemplars, such as Delta from the Royal Society, this is an area of weakness of many link programmes. Yet Pacey's (1983) model of technological literacy argues the importance of social critique.

One of the latest publications from the Ministry of Education which was produced in consultation with teachers on this very technological area i.e. electronics and control technology states:

> *Students should work in an environment that encourages creativity and calculated risk taking. They should be encouraged to examine the relationships between changes in society and developments in electronics and control technology and to consider the historical impacts and social implications of such developments.*
>
> (Ministry of Education, 1999, p.5)

In this particular case there was little evidence of critical examination of practice, past or present. For technological literacy to be obtained and if a matching to Pacey's model is to be achieved this aspect must be included. Perhaps two of Watts (1983) 'functions' can be attributed to the study programme. Firstly *orientation*, which is the process in which the pupils were introduced to how the engineer in this case works in analogue electronics. This was done with no critical or evaluative component. Secondly *preparation,* where the students in this case were clearly exposed to knowledge and skills that would be of little use outside of the scientific and technology fields. The divisive curriculum is more of a contradiction in this case, Teacher A, by his own admission is anti-technology education. Yet his involvement in this particular aspect, i.e. school-industry links has been substantial and award winning. Teacher A would argue that he is delivering a more general science course which might be part of a liberal curriculum, yet here again the contradiction the case observed was much more like training and was clearly vocational.

The intention of this thesis was not to dismiss or encourage the idea of school-industry links but to ascertain what actually takes place and perhaps make sure that teachers, particularly technology teachers who are at the forefront of this movement, consider such arrangements from an informed position. Obviously trying to enhance the teaching and learning for pupils in their charge should be their reason for taking part. Technology educators are particularly encouraged to engage in these links as stated in *Technology in the New Zealand Curriculum* (TINZ95). However, for some people, any involvement of industries in school is a concern. This may be due to a deep-seated mistrust or possibly a misunderstanding of what actually goes on. However, social justice is an important aspect of the education system. If we are to prevent children being seen as a "cash crop", or "industry fodder" the critical component of technology education must not be ignored.

This topic is seen as a battle between a functionalist or utilitarian view of education and the liberal ideals which have underpinned the historical development of New Zealand schooling system (ERO 1996)

What are the values we hope to instil via the medium of technology education?

> *By their very nature societies are complex,. Compared with neat, predictable pieces of technology, people are messy and unpredictable. It is fairly straightforward project to build roads and cars, but to combine them into a successful city traffic scheme that meets the needs of local traffic, commercial traffic and the national network is no mean feat.*
>
> (Mulberg cited in Meakin, 1992, p. 27)

Mulberg goes on to describe how technological activity must be undertaken with ***responsibility***: how can we expect students to accept responsibility for their actions in the future unless we teach them the values to judge what technological activity has done in the passed. "Technology" and "people" go hand in hand, so that to study the technology without studying its relationship to people/society and vice versa is extremely limited if not foolish. For pupils to be successful in a future, which we know will be even more technological than at present, we have to prepare them with a value-laden knowledge and understanding of technology. That principle is one of the main goals of technology education.

Because technology is concerned with the everyday world there are many constraints and often a variety of conflicting expectations and values which have to be taken into consideration.

(Conway and Riggs cited in Banks, 1994, p. 232)

Layton, who has been cited extensively in this thesis, describes the values which run through technological activities.

Value considerations are central to all aspects of technological activity - its initiation, the course of its development and the evaluation of its results.

(Layton, 2, 1993, p. 83.)

The notion of technological literacy which seems to pervade most technology curricula can only be achieved when studying technology with society and values in mind. Technology expertise (technique or skill) is still important and the definition of the art of craft still has merit, but a technology course must require more than that. This is a view supported by the DES (Department for education and science UK) Which has stated that:

...a good course gives insights into the general nature of technology in society and its current importance in adult affairs .... technology is therefore , first and foremost a cultural study.

(DES, 1982, pp. 27-8)

In fact there can be seen to be technological discrimination, where societies that have technology and technological awareness are literate and those that do not are illiterate. This is one of the reasons why the debate for technology education is so visual; the debate is about society in general. The policy of the government reflects a desire for the children of New Zealand families to find a place in the technological society of the future, whatever that might be.

Ruth Conway describes a study called ***problem centred*** as opposed to problem solving.

> *The latter encourages a "technical fix" approach, whereas the former suggests a complex situation requiring sensitivity, wide sympathies and the need to judge between conflicting values.*
>
> (Conway, 1994, p. 139)

So the confusion about justification and the goals of technology education continues, Perhaps the end result will be a fluid curriculum which needs a re-write every five years just as was experienced in England. Although frustrating for teachers of technology these re-writes offer a chance to reflect on what has gone before and has been stated in this thesis that reflection is extremely important. Technology education has certainly brought the curriculum offering into this century, and many of the sacred truths about knowledge and understanding have been challenged as a result. Obviously, industry partners will keep their core business, whatever that might be, as paramount in any link, and that is quite understandable. So too must the school. Education of pupils is the core function of the school and any link must enhance that role. The technology curriculum has been under scrutiny from its implementation in 1999. However, to be the flag bearer for these partnerships or links is an additional burden. Implementation of a brand new curriculum area is going to be difficult enough without carrying the additional mantle of responsibility for school-industry links. It is obvious that a number of parties have already made that association and many links are likely to be formed in the future. Their success or failure, I suspect will be determined more by the individuals involved in the links than the political push of the government.

6.1 Implications for policy and practice.

A number of issues have been raised within this thesis. Reflection on these issues gives rise to some implications for policy and practice in technology education. The following implications merit further investigation.

- Educators must ensure the quality and integrity of any link or partnership. Taking a resource from an outside agency has to be considered carefully. Teacher education organisations should include an awareness to the possible benefits and concerns surrounding these links in their technology education programmes. They must prepare teachers that are professional enough to critically evaluate materials prior to implementation and offer a balanced curriculum which considers the views of all interested partners, not just one.
- Government policies on school-industry links reflect the ideologies of the parties behind them. Closer scrutiny is required to see if these policies are in fact going to have the desired result, or will this be just another foray into the education system because of an economic downturn. Perhaps when the economy picks up again this issue will receive less favour.
- There is little indication from this research that improved learning has taken place. Consideration should be given to the learning outcomes of the school-industry links. Perhaps if these were identified first the links would become more meaningful and less of a novelty, or motivator.
- There are a number of agencies currently working in this field. Perhaps a code of conduct and some guidelines from government or teacher associations might prevent some of the worrying trends that have been noted overseas. It will be more difficult to prevent bad practices in the future if they occur unchecked today.
- The school-industry links highlighted by this research portray the schools in a receiving, almost subordinate, role to the "experts" in industry. This positioning is unhelpful if the challenge of a clearer understanding between the main parties involved in the link is to be achieved. The perspectives of each party have merit and they should be made overtly clear. For example, it should be stated that: the role of the industry is.... the role of school is....Where are the common grounds? where are the conflicts?
- There are some theoretical positions available, notably the work of Dewey, Saunders, Young and Marshall. Yet they rarely enter into the debate before school-

industry links are considered or promoted? The need for more research and publication in this area of technology education is clearly needed.

6.2 Limitations of this study.

The particular research methodology underpinning this thesis is an evaluative and exploratory case study. This methodology has been criticised by some researchers as being too vague to be a reliable methodology and therefore of little practical use (Atkinson and Delamont, 1985). However, there has been so little academic research in this area that it was felt important by the researcher to find out what is going on in an actual school-industry link. The case study methodology has been described as a method for answering that specific question (Bouma, 1997).

This particular case study suffered from many organisational problems, and the limitation of timing was evident throughout. When educational research is occurring at exactly the same time as curriculum innovation there are bound to be difficulties. This is compounded with technology education as there is in fact so much confusion about what constitutes technology education. Additionally, the school-industry link programme in this school began in earnest early in the academic year of the University when the systems of support for the researcher are less operational.

There were limitations from the company involved in the study which made access to the industrial setting difficult (e.g. the security products that the company is involved with producing meant that access was difficult to organise.) This, combined with the imminent take-over, made the workplace somewhat unsettled and perhaps wary of the possibility of any outside critique.

The perceptions and the role of the researcher are integral to research of this nature. For this reason, the researcher has attempted to fully disclose his personal views and attitudes towards technology education. Moreover, in reporting and interpreting the particular case study, the researcher endeavoured not to let these views influence the findings.

The particular case focused on in the study is probably atypical and does not lend itself towards generalisation easily. This fact was balanced by the recent successful exploits of the school as far as the wider community involved with school-industry links are concerned. The numbers of participants involved in this study are very small and the viewpoints expressed may not be repeated elsewhere. That said, the study school has had significant experience in school-industry links of different types and was selected on that basis. The willingness of all parties to be involved in the study led to a higher level of participation than would be expected in a much wider study. A variety of recording strategies were employed. These were deliberately kept simple and non obtrusive so as not to influence the events and behaviour of those being observed.

In any case study, the boundaries of the case might have been drawn differently. In this case, because of time restrictions and limitations of access and availability of participants, it was decided that the focus would be on those who were immediately involved in the particular programme that comprised this school-industry link.

6.3 Further research.

The nature of an exploratory case study is such that the researcher may end up with more questions to answer at the end of the research than when it started. Thus qualitative case study research is often used as a precursor to quantitative studies.

If the economic instrumentalist viewpoint is the rationale for promoting school-industry links as part of technology education in New Zealand more research is required. This thesis cannot conclusively find that a school's involvement in school-industry links encourages students to pursue technology careers beyond school. It does indicate a possible correlation proving this might be a target of further research. It would however, require time for the embedding of the technology curriculum to occur before the research could be carried out.

It has been suggested by government publications that the link is important and ultimately influential. Research of a longitudinal nature could be carried out to ascertain whether this is a sound policy or not. As yet the technology curriculum is too young to draw any conclusions. One might look overseas, but again little research has been carried out in this area.

An additional study of focussed and agreed learning outcomes could be used to ascertain whether or not school-industry links promote good teaching and learning. This thesis indicated that certain links might be more successful than others, further exploration would be required to confirm this possibility.

6.4 Final Remarks.

Clearly this research is only the beginning, and discussions on the value of school-industry links and their place within technology education looks set to continue. What this research explores is the rationale behind the current links, and highlights the viewpoints of stakeholders who are advocating the links in schools in New Zealand. Some of the potential benefits for those who engage in the links are reported along with a cautionary tale of acceptance without criticism.

The intention of the researcher was to expose the arguments for and against school-industry links and ensure that teachers particularly, were better equipped to make the most of a link should it be an endeavour they wish to pursue. Additionally keeping the central focus of teaching and learning is paramount. Technology education should involve much more than the economic instrumentalists focus which up to now seems to have been the driving factor for school-industry links. True technological literacy and the development of an inclusive technology curriculum may be some way away. However, the possibilities of schools achieving these laudable aims (literacy and inclusivity) should be enhanced with a greater understanding of school-industry links and what they can offer.

REFERENCES

Adelman, C. (1976). Rethinking Case Study. *Cambridge Journal Of Education*, Vol. 6, No. 3

Alcorn, P.A. (2000). *Social Issues in Technology: A format for Investigation.* Prentice Hall publishers, New Jersey USA

Atkinson, P. and Delamont, S. (1985). Bread and Dreams or Bread and Circuses? *A critique of Case Study Research in Education.*

Banks, F. (1994). *Teaching Technology.* Open University Press UK

Banks, F. (1994). Vocational education, general education and the place of technology. In Banks, F. (Ed.) *Teaching Technology*. Routledge London.

Banks, F. & Barlex, D. (1999). No one forgets a good teacher! What do good technology teachers know and how does what they know impact on pupil learning? Paper presented at *PATT-9 Conference*, Indianapolis, USA

Barlex, D. (1998). Design and Technology - the Nuffield Perspective in England and Wales. *International Journal of technology and design education* 8: 139-150 Kluwer Publishers, Netherlands.

Benson S. (1991). *Science and Technology School-Industry Links*: Report to the Ministry of Research, Science and Technology Wellington

Bouma, G.D. (1997). *The Research Process.* Oxford University Press, Melbourne Australia.

Bradford, M. (1999). In *Bright Future, five steps ahead, Making ideas work for New Zealand.* New Zealand Ministry of Commerce, Wellington.

Budgett-Meakin, C. (Ed.) (1992). *Make the future work.* London: longman

Burns, J. (1990). *Students Attitudes Towards and Concepts of Technology.* Report to the Ministry of Education, Wellington.

Burns, J. (1992). *Access to technology education.* Paper presented to the Ministry of Education Technology Education Consultative Meeting, Wellington.

Burns, J. (1997). *Technology in the New Zealand Curriculum Perspectives on Practice.* Dunmore Press, Palmerston North.

Cave, J. (1995). *Technology education briefing paper.* C.T.C. Trust London

Chidgley, J. (1994). A critique of the design process, in Banks, F. (Ed.) 1994 *Teaching Technology,* Open University Press. United Kingdom

Codd, J. (1981). Democratic principles and the politics of curriculum change in New Zealand, in Clark, M. (Ed), *The Politics of Education in New Zealand,* NZCER, Wellington.

Clark, J. (1997). *Educational Research: Philosophy, Politics, Ethics.* Palmerston North: ERDC Press.

Cohen, L. and Manion, L. (1990). *Research Methods in Education,* Routledge N.Y.

Compton, V. (1997). The Implementation of Technology in New Zealand Schools, in Burns, J. (Ed). *Technology in the New Zealand Curriculum Perspectives on Practice.* Dunmore Press, Palmerston North, New Zealand.

Conway, R. (1994). Values in technology education, *International Journal of Technology and Design education.* Kluwer, Netherlands.

Croft, V. (1991). *Technological Literacy: Refined For The Profession, Applications For The Classroom.* Unpublished paper presented at the 1991 annual conference of the International Technology Education Association.

Cross, N., Naughton, J. and Walker D. (1981). Design method and scientific method, *Design Studies* 2 (4), 195-200

Davies, J. (1998). Constructing Technology Education: Questions of Purpose and Fit. *New Zealand Annual Review of Education, 8.*

Davies, J. (2000). *'School-Enterprise Links': Two-way Flows. Developing Value Judgement in Professional Practice in Business and Industry*. Unpublished paper presented at QPEC conference Palmerston North.

Department of Education (1961). *Handcraft in Wood and Metal for Primary Schools*, Wellington.

Department of Education (1986). *Forms 1-4 Workshop Craft Syllabus for Schools,* Wellington.

Department of Education and Science (1982). *Technology in schools* , London HMSO

DES/DOE/Welsh Office, (1991). *Education and Training for the Twenty First Century,* DES/DOE/Welsh Office, HMSO: London.

De Vries, M. (2000). Technology education. Towards a New School Subject. *In Routledge International Companion to Education.* Moon, B. *et al* (Eds.), Routledge, London.

Dewey, J. (1916). *Democracy and Education,* New York: Macmillan

Dewey, J. (1935). 'The Need for Orientation' , reprinted in Dewey, J. (Ed.) (1958), *Philosophy of Education,* New York: Littleman Adams, pp.88-92.

Ditchfield, C. & Stewart, D. (1987). Technology and Science in the Curriculum, Secondary *Science Curriculum Review.*

Dyrenfurth, M. J. (1991). Technological literacy synthesised. In M.J. Dyrenfurth & M.R. Kozak (Eds.), *Technological Literacy,* 40th Yearbook of the Council on

Technology Teacher Education, (pp.138-183). Peoria, IL: Glencoe Division, MacMillan/McGraw-Hill. [Chapter 7].

Education Forum, (2000). *Policy Directions for School Qualifications*, Astra Print Ltd, Wellington.

Education Review Office, (1996). *School Business links*, no. 2, Wellington.

Feinerg, W. & Horowitz, B. (1990). Vocational education and equality of opportunity, *Journal of Curriculum studies* 22, 188-192.

Fitzsimons, P. (1997). *What difference does the National Qualifications Framework make for young people?* NZCER Wellington.

Fullick, P. (1992). Links with Industry and Employers, in *Managing External Relations in Schools, A Practical Guide.* Foskett, N. (Ed.) Routledge, London

Gall M.D., Borg W.R. and Gall J.P. (1996). *Educational Research an Introduction*, Longman USA

Gott, S.H. (1988). 'Apprenticeship Instruction for Real-World Tasks: The Co-ordination of Procedures, Mental Models and Strategies', in E.Z. Rothkopf (Ed.), *Review of Research in Education* 15 1988-89, American Educational Research Association, Washington DC.

Hawk K. (1997). *Technology Development Schools Evaluation,* Final Report, ERDC Massey University Albany Campus.

Hayden, M. (1989). What is technological literacy? *Bulletin Of Science, Technology And Society,* 119, 220-233, STS Press.

Hitchcock G. and Hughes D. (1995). *Research and the Teacher, a qualitative introduction to school-based research.*

Hoare, S. (1999). Times Educational Supplement. *Business Links June 4th*. United Kingdom.

Hood, D., Kerr, M., & Perris, L. (1996). Realising the goals for the national qualifications framework. *The New Zealand Gazette,* 75 (7), 1-2. Wellington.

Hyland, T. (1994). *Competence, Educational and NVQs : Desenting Perspectives*, Cassel, London.

Hynes, H.P. (ed.), (1989). *Reconstructing Babylon. Essays on Women and Technology.* London, Earthscan Publications Ltd.

Jessup, G. (1991). *Outcomes: NVQs and the Emerging Model of Education and Training,* Farmer Press Lewes.

Jones, A. and Carr, M. (1992). Teachers Perceptions of Technology Education: Implications for Curriculum Innovation, *Research in Science Education, 22,* 230-239.

Kemmis, S. (1980). *The imagination of the case and the invention of the study,* Simons, H. (Ed.) Norwich CARE

Layton. D, (1991). *Aspects of National curriculum design and technology,* Paper prepared for the NCC National Curriculum Council UK

Layton, D. (1993). A school subject in the making? The search for fundamentals, in Layton, D. (Ed.) *Innovations in Science and Technology Education.* Vol.5. Paris: UNESCO.

Layton,. D. (1993). *Innovations in Science and Technology Education* Vol. 5. Paris: UNESCO

Lee, G. & Hill, D. (1996). Curriculum Reform in New Zealand: Outlining the New or Restating the Familiar? *Delta* 48 (1), 19-32, Palmerston North.

Lynch, I. (1993). *Technology, Science education and the world of work,* CTC Trust Publications number 9, London.

Br. Pat Lynch, Trustee Partners NZ (1999). *'Working together building partnerships between schools and enterprises'* Learning Media Wellington.

Marshall, J.D. (1997). The New Vocationalism, in Olsen, M. et. al. (Eds) *Education Policy in New Zealand: The 1990s and Beyond,* Dunmore Press, Palmerston North.

McCormick, R. (1993). The Evolution of Current Practice in Technology Education, in McCormick, R., Murphy, P. and Harrison, M. (Eds.), *Teaching and Learning Technology.* Addison-Wesley Publishing Company England.

McCormick, R. (1997). Conceptual and Procedural Knowledge, *International Journal of Technology and Design Education* 7: 141-159. Kluwer Academic Publishers, Netherlands.

McKenzie, D., Lee, G. & Lee H. (1990). The Transformation of the New Zealand Technical High School, *Delta Research Monograph* No. 10 Massey University.

McKenzie, D. (1992). The technical Curriculum: Second Class Knowledge? In McCulloch G. (Ed.) *The School Curriculum in New Zealand History, Theory, Policy and Practice.* Dunmore Press, Palmerston North, New Zealand

Medway, P. (1992). Constructions of technology: Reflections on a new subject, in Beynon, J. and Mackay, H. (Ed.) *Technological Literacy and the Curriculum.* London Falmer.

Miles, M.B. & Huberman, A.M. (1994). Qualitative data analysis : *An Expanded Source Book* (2nd ed.) Thousand Oaks, CA Sage.

Ministry of Commerce, (1999). *Bright Future, 5 steps ahead, Making ideas work for New Zealand,* Wellington, New Zealand

Ministry of Education. (1992). *So This Is Technology!* Wellington: Learning Media.

Ministry Of Education (1993). *Working together, Building Partnerships Between Schools and Enterprises,* Wellington.

Ministry of Education (1995). Resource Entitlement for School Staffing. *Booklet G: Secondary Tertiary Alignment Resource,* Wellington.

Ministry of Education (1995). *Technology in the New Zealand Curriculum,* Learning Media Wellington.

Ministry of Education (1997). *Towards Teaching Technology: Know How 2 Guidebook for Facilitators,* Learning Media, Wellington.

Ministry of Education, (1998b). *Secondary School Qualifications Improved and Updated for the 21st Century, Media Release*, 5th November 1998.

Ministry of Education (1999). *Electronics and Control Technology, Classroom Practice in Years 1-8,* Learning Media, Wellington.

Molnar A. (1996). *Giving Kids The Business*, Westview Press Colorado USA

Monteith, W. (1992). *Wealth Creation*. Paper presented to the Ministry of Education Technology Education Consultative Meeting, Wellington.

New Zealand Government, (1999). *Press release, Bright Future package,* Wellington.

Nicholl, J. (1940). *The Technical Schools of New Zealand.* NZCER, Wellington

Ontario Ministry of Education and training (1995). Volume 9, Number 2 Spring (1998) *Journal of Technology Education.*

Pacey, A. (1983). *The Culture of Technology.* Oxford Blackwell

Peddie, R. (1992). *Beyond the norm: An introduction to standards based assessment.* NZQA, Wellington.

Price B. (1991). *School-industry Links The Consequences of Minding Other Peoples Business,* ACER Australia.

Prime, G. M. (1993). Values in Technology: 'Approaches to Learning', *Design and Technology Teaching* 24(1), p.34-36.

Royal Society of New Zealand (2000). *New Zealand Science, Mathematics and Technology Teacher fellowship Profiles 1998-1999,* Peso Communications N.Z.

Royal Society of New Zealand (1997). *Technology Enterprise and Technology Education,* RSNZ Miscellaneous Series 44, Wellington.

Royal Society of New Zealand, (1999). *Delta Units*, Wellington.

Saunders, M. (2000). Understanding Education and Work, Themes and Issues, In Moon, B., Peretz, M.B. & Brown, (Eds.) *Routledge International Companion to Education, Routledge*, London.

Smithers, A. & Robinson, P. (1994). Technology in the National Curriculum getting it right, in Banks, F. (Ed.) *Teaching Technology,* Open University Press United Kingdom.

Snook, I. (1988). Unemployment and the Schools, In Corson (Ed.), *Education for Work: Background to Policy and Curriculum.* Dunmore Press, Palmerston North, New Zealand.

Snook, I. (1996). *Technology a new subject or an Ideological strategy?* Unpublished paper presented at *NZARE* Conference Nelson.

Stake, R.E. (1980). *The Case Study method in social inquiry,* Simons, H. (Ed) Norwich CARE

Stake, R.E. (1994). Case studies. In N.K. Denzin & Y.S. Lincoln (Eds.), *Handbook of qualitative research.* Thousand Oaks, CA: Sage.

Staudenmaier, J. (1985). *Technology's storytellers: Reweaving the human fabric. Cambridge,* Ma: MIT Press.

Steffens, H. (1986). Issues in the preparation of teachers for teaching robotics in schools. In J. Heywood & P. Matthews (Eds.), *Technology, Society And The School Curriculum*. Manchester, England: Roundthorn Publishing.

Stenhouse, L. (1981). *Case study in educational research and evaluation,* Geelong: Deakin U.P.

Sterry, L.F., & Hendricks, R.W. (1999). *Exploring Technology* T.&E. Publications, Wisconsin.

Stevenson, J. (1994). Vocational Expertise, in J. Stevenson (ed.) *Cognition at Work,* National Centre for Vocational Education Research, Leabrook, South Australia, 7-35.

Sullivan, K. (1997). They've Opened Pandora's Box: Educational Reform, The New Right and Teachers Ideologies. In Olssen, et al *Education Policy in New Zealand: The 1990s and Beyond,* Dunmore Press, Palmerston North.

Training Agency. (1989). *Education Business Partnerships: Lessons From America*. Sheffield: Training Agency.

Times Educational Supplement, (1999) *Business Links,* June 4th United Kingdom.

Todd, R. (1991). The Natures and Challenges of Technological Literacy. In M. Dyrenfurth & M. Kozak (Eds.), *Technological Literacy. 1991 Yearbook Of The Council On Technology Teacher Education.* Peoria, IL: MacMillan/McGraw-Hill.

T.V.E.I. (1990). *Guidance for Preparing TVEI Extension Proposals for the 16-18 Phase*, London Training Agency.

Walker, R. (1993). *Doing Research: A Handbook for Teachers.* London: Routledge.

Watts, A. (1983). *Education, Employment and the Future of Work,* Milton Keynes: Open University Press.

Wilders, M. & Pitt, J. (1999). Tell me what you want, what you really, really want. *Journal of Design and Technology Education* Vol. 4, No. 3

Williams, J. &Williams, A. (Eds.), (1996) *Technology Education for Teachers,* Macmillan Education, Melbourne.

Wright, J. R. (1980). Technological literacy: a primary goal for industrial arts education, (pp.35-39). *The Journal of Epsilon Pi Tau,* Vol. 6, No 2.

Yeomans, D. (1998). Vocationalising the Design and Technology Curriculum: A Case Study from Post- Compulsory Education. *International Journal Of Technology and Design Education* 8, 281-306, Kluwer Academic Publishers, Netherlands.

Yin, R.K. (1981). *Case study research: Design and Methods,* Beverly Hills U.S.A., Sage.

Young, M.F.D. (1998) *The curriculum of the future,* Falmer Press, London.

http://www.rsnz.govt.nz/education/science_schools/branz-alpha.php 14/3/99

Http:// webster.state.nh.us/governor/summit/p6.html 22/1/99

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APPENDIX 1

Appendix 1

TECHNOLOGY in the NEW ZEALAND CURRICULUM

WHAT IS TECHNOLOGY?

Technology is a creative, purposeful activity aimed at meeting needs and opportunities through the development of products, systems, or environments. Knowledge, skills, and resources are combined to help solve practical problems. Technological practice takes place within, and is influenced by, social contexts.

WHAT IS TECHNOLOGY EDUCATION?

Technology education is a planned process designed to develop students' competence and confidence in understanding and using existing technologies and in creating solutions to technological problems. It contributes to the intellectual and practical development of students, as individuals and as informed members of a technological society.

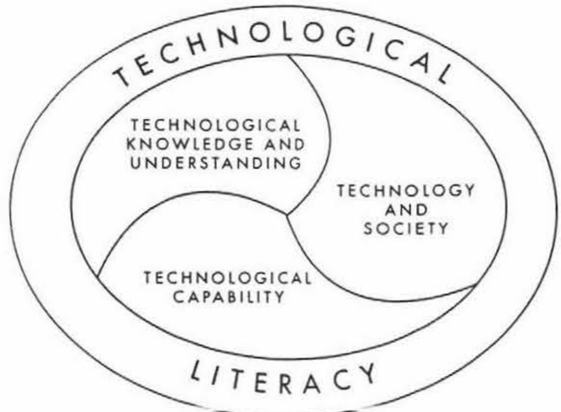
WHAT IS THE AIM OF TECHNOLOGY EDUCATION?

The aim of technology education is to enable students to achieve technological literacy through the development of:

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

HOW WILL STUDENTS BENEFIT?

- **Educationally**, students are motivated to apply and integrate their knowledge and skills from other essential learning areas in authentic ways. They will have opportunities for linking school experiences with the wider world of enterprise and the community. Technology education links theory with practice.



- **Personally**, students contribute to informed decision making about technological development. They learn to make decisions, take calculated risks, evaluate their own choices and develop ways of addressing real problems.
- **Culturally**, students become aware of the diversity of valid ways in which different groups of people respond to technology and to innovation, and appreciate the impacts that technological changes have on different people. They develop understanding of the influence of beliefs, values, and traditions on technological development. They can appraise the appropriateness of technological solutions to environmental problems.
- **Economically**, students learn to be innovative and to co-operate in working to translate their ideas into action. They develop the knowledge and skills needed to undertake many activities and to contribute to New Zealand's social and economic development.

TECHNOLOGY in the NEW ZEALAND CURRICULUM

HOW IS THE TECHNOLOGY CURRICULUM STRUCTURED?

The technology curriculum is designed around strands, achievement objectives, technological areas, and contexts.

The strands are:

Strand A: Technological Knowledge and Understanding

1 understanding the use and operation of technologies;

2 understanding technological principles and systems;

3 understanding the nature of technological practice;

4 understanding strategies for the communication, promotion, and evaluation of technological ideas and outcomes.

Strand B: Technological Capability

5 identifying needs and opportunities;

6 with reference to identified needs and opportunities:

- a generating, selecting, developing, and adapting appropriate solutions;
- b managing time, and human and physical resources, to produce technological outcomes — products, systems, and environments;
- c presenting and promoting ideas, strategies, and outcomes;
- d evaluating designs, strategies, and outcomes.

Strand C: Technology and Society

7 understanding the ways the beliefs, values, and ethics of individuals and groups:

- promote or constrain technological development;
- influence attitudes towards technological development;

8 understanding the impacts of technology on society and the environment:

- in the past, present, and possible future;
- in local, national, and international settings.

Achievement Objectives

Achievement objectives provide a basis for planning, assessment and reporting student progress to parents. The achievement objectives specify eight levels of achievement which are not tied to year levels.

Students will be working towards the achievement objectives over a period of time, through activities in a range of technological areas and in different contexts.

In practice, most units of work in technology will include objectives from all three of these strands.

An example of an achievement objective at level 1 (the starting level) is:

> Within a range of technological areas and contexts, students should share ideas about the ways in which familiar technologies affect their lives, such as cooking appliances; play equipment.

An example of an achievement objective at level 8 (the highest level) is:

> Within a range of technological areas and contexts, students should: investigate and analyse how beliefs, values, and ethics of individuals and groups promote and constrain technological developments in specific communities, such as the 1960s space race; reproductive technologies;

Technological Areas

Students will achieve the objectives of the technology curriculum in a range of technological areas. The areas are not mutually exclusive: most technological developments and learning experiences encompass more than one area.

Whichever technological area is selected, **design**, including the processes of specification and development and testing of prototypes, is an essential component of the activity.

Drawing and graphics, including freehand and technical drawing and the use of computer graphics packages, are also essential in technological practice to depict and clarify ideas and proposed solutions.

The technological areas are:

- **Biotechnology** involves the use of living systems, organisms, or parts of organisms to manipulate natural processes in order to develop products, systems, or environments to benefit people. These may be products, such as foods, pharmaceuticals, or compost; systems, such as waste management or water purification; or environments, such as hydroponics.

- **Electronics and Control technology** includes knowledge and use of electrical and electronic systems and devices, as well as their design, construction, and production. These may be simple electrical circuits or complex integrated electronic circuits, or robotics. Control technologies may be electronic, pneumatic, hydraulic, or mechanical.

- **Food technology** includes understanding and using safe and reliable processes for producing, preparing, presenting, and storing food and the development, packaging, and marketing of foods.

- **Information and Communication technology** includes systems that enable the collection, structuring, manipulation, retrieval, and communication of information in various forms. This includes audio and graphical communications, the use of electronic networks, and interactive multimedia.

- **Materials technology** includes the investigation, use, and development of materials to achieve a desired result. It involves knowledge of the qualities and suitability of different types of materials, including wood, textiles, composites, metals, plastics, and synthetics, and fuels, as well as the processing, preservation, and recycling of materials.

- **Production and Process** technology includes both the manufacture and assembly of products from individual components in, for instance, a furniture or appliance factory or a motor vehicle assembly line; and the processing of fluid-bulk raw materials — gases, fluids, and fluidised solids — into products such as paints, fertilisers, and petrochemicals through a continuous process. This area also includes large-scale primary production of agricultural and forest products.

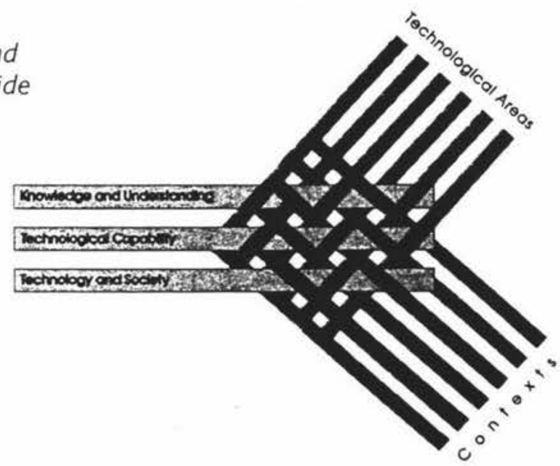
- **Structures and Mechanisms** includes a wide variety of technologies, from simple structures, such as a monument, or mechanical devices, such as a mousetrap, to large, complex structures such as a high-rise office block, or mechanical devices such as a motor car.

Contexts

Technological activities are carried out in a variety of broad overlapping contexts, which include:

- **Personal** eg, clothing; personal health; jewellery.
- **Home** eg, preparation of food; interior design; furnishings; home security.
- **School** eg, a drama production; school litter and waste management; the school canteen.
- **Recreational** eg, water sports, such as sailing; ball games; orienteering; games of chance; playground planning.
- **Community** eg, waste management; traffic control; town planning; transportation.
- **Environmental** eg, water management; forest regeneration; tourist facilities.
- **Energy** eg, solar power; co-generation; the use of fossil fuels; and renewable energy applications such as water and wind turbines.
- **Business** eg, desktop publishing; financial reporting; marketing presentation; ergonomics.
- **Industrial** eg, workplace safety; woodworking; plastics; production line planning. An industrial context might range from the smallest in scale — based in a home or garage — through to a major industrial plant.

Technological areas, contexts, strands, and achievement objectives combine to provide a framework for technology education



WHERE TO GET MORE INFORMATION?

Information about the technology curriculum and technology education developments is available on the Ministry of Education's Curriculum website:

www.minedu.govt.nz/curriculum by E-mailing: curriculum@minedu.govt.nz

or by phoning your nearest School Support technology adviser;

Whangarei: 09 438 8069	Auckland: 09 377 0881	Hamilton: 07 846 9055	Palmerston Nth: 06 357 9269
Wellington: 04 476 8699	Nelson: 03 548 7590	Christchurch: 03 349 1350	Dunedin: 03 477 2281

The national association Technology Education New Zealand also provides useful information for technology educators: www.sunsite.net.nz/orgs/tenz/

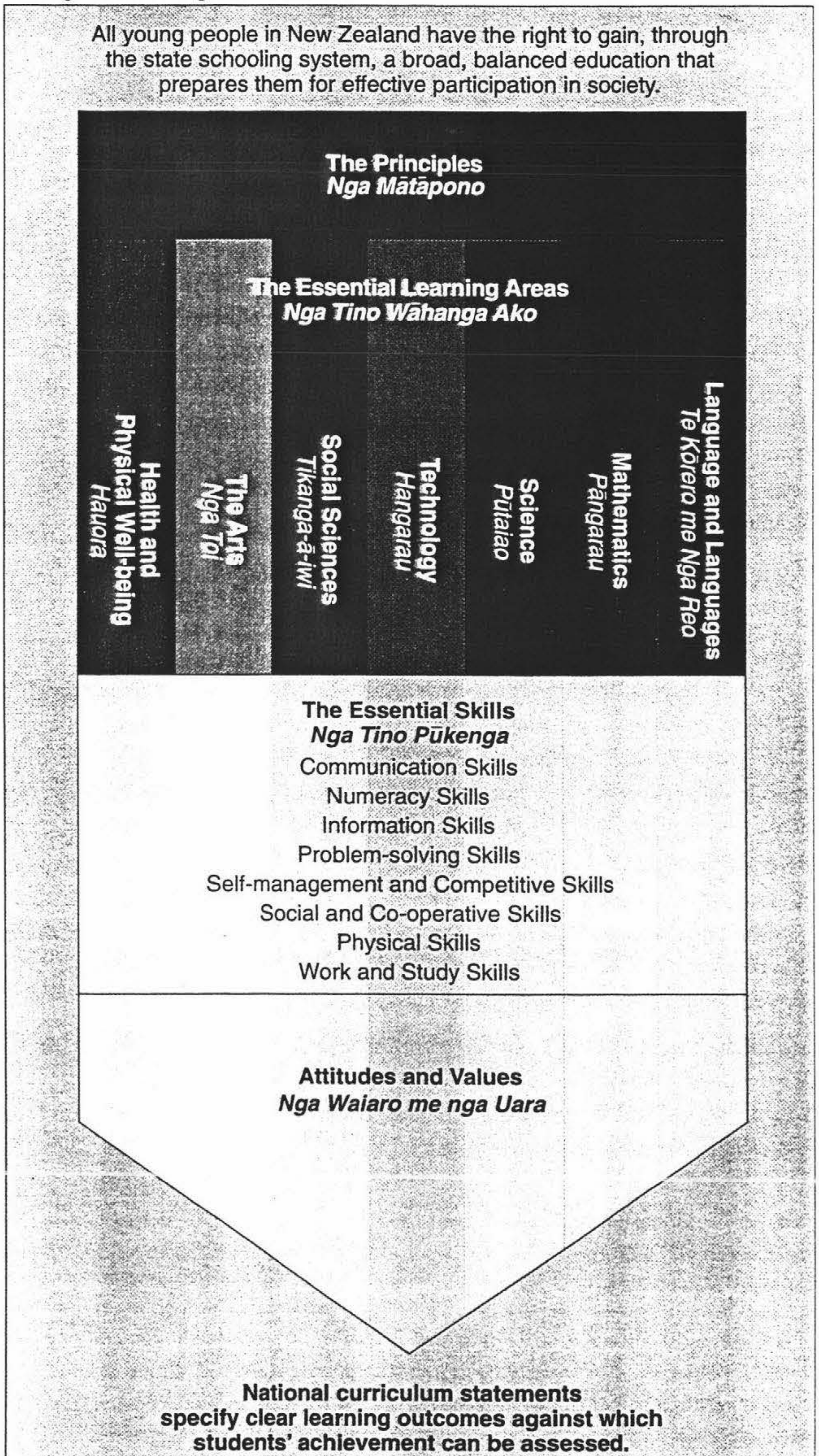
MINISTRY OF EDUCATION

Te Tahuhu o te Matauranga

APPENDIX 2

Appendix 2

The New Zealand Curriculum Framework
Te Anga Marautanga o Aotearoa



APPENDIX 3

Appendix 3

Massey University
COLLEGE OF EDUCATION
Te Kupenga o Te Mātauranga

Technology Education
Department of
Educational Studies
and Community Support
Private Bag 11 222,
Palmerston North,
New Zealand
Telephone: 64 6 356 9099
Facsimile: 64 6 351 3385

11 February 1999

Attn:

Dear

My name is Gary O'Sullivan and I am a Technology Education lecturer at Massey University College of Education. I have recently been in contact with with regard to your school being involved in a research project looking at the links created between schools and industry. Your school was selected by TENZ (Technology Education New Zealand) as being a good example of this type of link. The staff I have spoken with in the schools concerned are keen to participate.

The extent of the research is such that it can remain quite low key and should not involve any disruption to classes or the staff involved. The research will have an exposure to others interested in the field, as a case study. (Confidentiality will be paramount). It will include some observations, questionnaires and interviews, all of which will be arranged to best suit the schools and industries involved. This will Comply fully with the Massey University regulations regarding ethical research.

The basis of this research is to look at current practice here in New Zealand and compare it with the literature and practice from overseas.

The advantage to your school is the recognition of your involvement in this area and having a technology education link at the University. This exchange of information should be of benefit to both parties. My recent experience as a director of technology and senior management team member in the first girls Technology College in the UK gives me a useful perspective on technology education - one of curriculum implementation and also management and innovation.

Please consider your involvement (should you accept) in this research as a positive step with regard to technology education and its implementation in New Zealand.

Regards

Gary O'Sullivan

APPENDIX 4

(Sample recording sheet for observations of classes at case study school.)

Date		Time		Place		Pupil #	

Adults present	

Time	Action	By	Response	Comment	Code

APPENDIX 5

Appendix 5

SPECIAL TOPIC

ANALOG ELECTRONICS

PRACTICAL SESSION 4

THE BIPOLAR TRANSISTOR AS AN AMPLIFIER

OBJECTIVE: To see how a Bipolar Transistor can be used as an amplifier of AC signals and to introduce the idea of feedback.

EQUIPMENT:
DC Power Supply
Breadboard
Oscilloscope
Multimeter
AC Signal Generator
Resistors (various)
Transistors (various)

METHOD AND RESULTS:

A. The single stage "Class A" Audio Amplifier.

In the previous practical session we looked at how we could think of a transistor as a controlled variable resistor. We looked at how we could use this idea by connecting a transistor into a voltage divider circuit and that by small changes of the base voltage we obtained large changes of collector voltage.

This leads us to the idea that a transistor used in this way exhibits voltage gain. If we consider that the base voltage is the input and the collector voltage the output then the small change in base voltage has been "amplified" to a large change in output or collector voltage.

Note that we have talked about changes in voltage this implies that we could amplify AC voltages (AC is a changing voltage). We already know that AC goes positive and negative and if our Transistor Ampifier is to handle AC it must be set up so that the output or collector voltage can vary both positively and negatively from its no signal position.

From our voltage divider ideas that we have looked at previously we know that for variations in voltage to be only dependanton the signal we must connect our circuit to a DC supply which must remain fixed. If it does not remain fixed then we get an output that is not a reproduction of the input and any differences between the input wave and the output wave is noise.

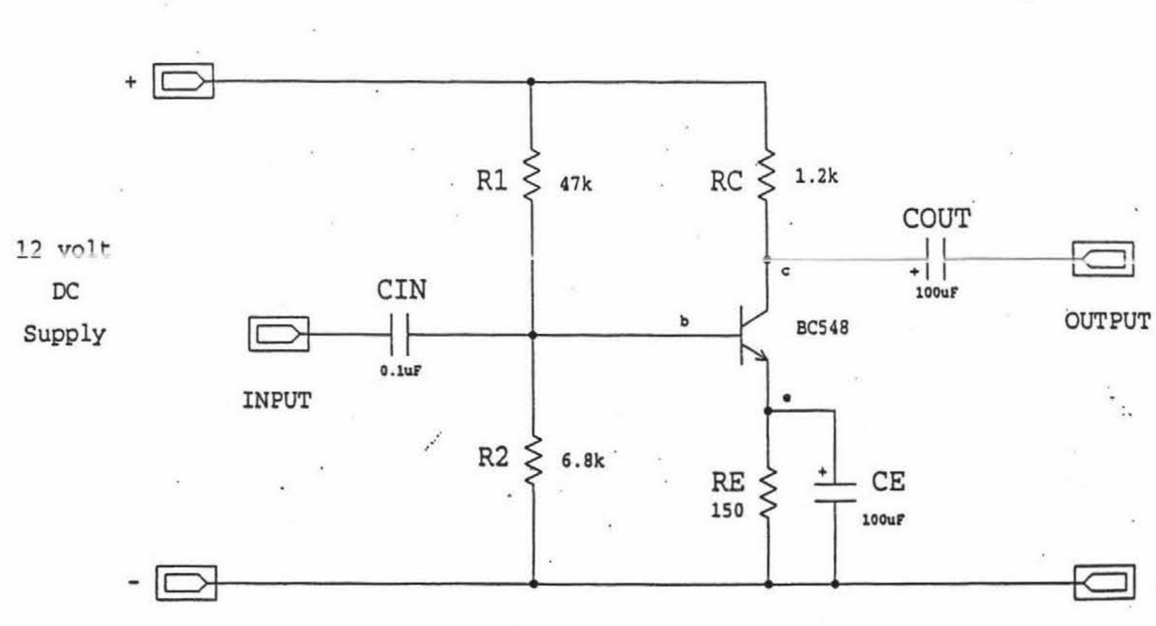
To enable our transistor to operate as an ac amplifier we must set it up so that the collector voltage is approximately half the DC supply voltage so that when the ac signal is connected to the base the collector voltage can move both up and down (or positively and negatively) with respect to the no signal state.
When we set the transistor up in this way there will be current flowing through it all the time and this type of set up is called "Class A".

We set the collector voltage to about the midpoint (Midrail) by employing voltage divider techniques and we call this biasing the transistor.

Biasing is achieved using the Resistors R1, R2, Rc and Re (Refer to the amplifier diagram below). R1 and R2 provide base bias such that collector current flows and Rc and Re set the level of collector current and thus the value of collector voltage and emitter voltage.
Re provides what we call negative feedback and thus provides some level of stability of the bias.

To prevent any external circuits having an effect on the bias setup the input and output of the amplifier are connected by capacitors which block DC voltages but allow the AC signal through.

The capacitor across Re (Ce) is called the emitter bypass capacitor and allows the AC signal to be unaffected by the resistor. Removing this capacitor introduces negative feedback to the AC amplifier.



1. Select the components you require and using one of the breadboards construct the circuit as shown above.

2. Check the connections of your circuit particularly the transistor leads and the 100uF capacitor.

3. Connect the 12 volt DC supply to your circuit and again after another check switch the supply on and measure the following DC voltages (all with reference to the common or negative side of the supply).

   Emitter Voltage =

   Note if this is not approximately half of the 12 volt supply you have a problem with your circuit and should switch it off and check for correct connection.

   Base Voltage =

4. Comment on the difference between the Base Voltage and the Emitter Voltage.

5. When you have verified that the transistor is correctly biased connect the oscilloscope to your circuit. Use both channels. Connect the earth leads of each probe to the common (negative) and connect one probe to the input of the amplifier and the other probe to the output of the amplifier.

6. Connect the output of the signal generator between the input and the common of the amplifier (Note if the signal generator has a ground as one of its outputs this should be connected to the common).

7. Set the signal generator frequency to 1kHz and with the output at a low level switch the generator on. While watching the output of the amplifier on the oscilloscope gradually increase the signal generator level until the amplifier output wave just starts to distort.

8. Reduce the signal generator level slightly and take the following measurements.
   using the oscilloscope.

   AC Input P-P Voltage =

   AC Output P-P Voltage =

9. Calculate the Voltage Gain of the amplifier

Voltage Gain Av = AC Output Voltage/ Ac Input Voltage

=

=

10. Comment on the result.

B. The Effect of Negative Feedback

1. Set the signal generator back to 1kHz and remove the capacitor Ce from your circuit.

2. Again adjust the input level from your signal generator until the output of the amplifier is just below the distortion point and measure the input and output voltages and calculate the gain.

   P-P Input Voltage =

   P-P Output voltage =

   Voltage Gain =

3. Compare the gain of the circuit with the capacitor connected and with the capacitor disconnected (negative feedback).

   Gain without feedback =

   Gain with feedback =

4. Comment on the effect of negative feedback.

C. Phase Relationships.

In all of the above amplifier circuits what did you notice about the differences between the input and output wavefoms in particular about the Phases.
What happened to the output wave when the input wave was going positive as well as the reverse.

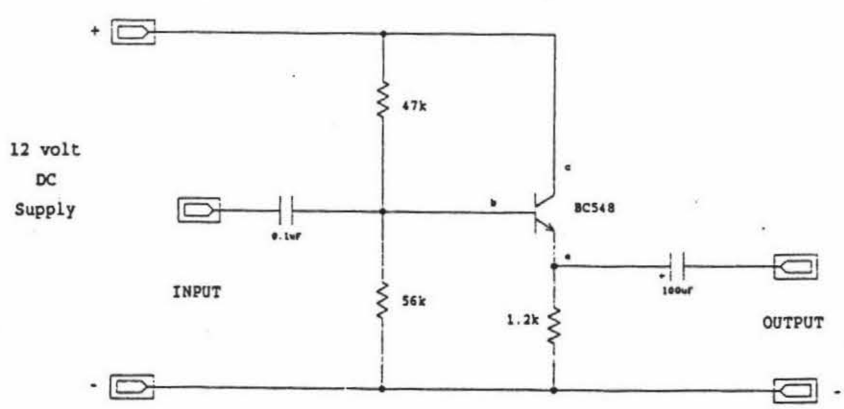
D. Emitter Follower

In the previous amplifier circuit the output was taken from the collector with the load resistor connected in series with the collector.

We also looked at the effect of putting resistance in series with the emitter (negative feedback).

The emitter follower circuit is one where the load is connected in series with the emitter with no collector load at all.

This circuit can be considered as a circuit that has 100% negative feedback.



1. Select the components you require and using one of the breadboards construct the circuit as shown above.

2. Check the connections of your circuit particularly the transistor leads and also the polarity of the two 100uF capacitors.

3. Connect the 12 volt DC supply to your circuit and again after another check switch the supply on and measure the following DC voltages (all with reference to the common or negative side of the supply).

   Collector Voltage =

   Note if this is not approximately half of the 12 volt supply you have a problem with your circuit and should switch it off and check for correct connection.

   Emitter Voltage =

   Base Voltage =

4. Comment on the difference between the Base Voltage and the Emitter Voltage.

5. When you have verified that the transistor is correctly biased connect the oscilloscope to your circuit. Use both channels. Connect the earth leads of each probe to the common (negative) and connect one probe to the input of the amplifier and the other probe to the output of the amplifier.

6. Connect the output of the signal generator between the input and the common of the amplifier (Note if the signal generator has a ground as one of its outputs this should be connected to the common).

7. Set the signal generator frequency to 1kHz and with the output at a low level switch the generator on. While watching the output of the amplifier on the oscilloscope gradually increase the signal generator level until the amplifier output wave just starts to distort.

8. Reduce the signal generator level slightly and take the following measurements. using the oscilloscope.

   AC Input P-P Voltage =

   AC Output P-P Voltage =

9. Calculate the Voltage Gain of the amplifier

Voltage Gain Av = AC Output Voltage/ Ac Input Voltage

=

=

10. Experiment with variations in both the input voltage and input frequency and take measurements and calculate the voltage gain for several different combinations of frequency and input level.
For each record the frequency and input level as well as the gain.

11. Comment on your findings.

SECTION 3
OPERATION

3.1 CONTROLS AND CONNECTORS

A. Front Panel, Fig. 1:

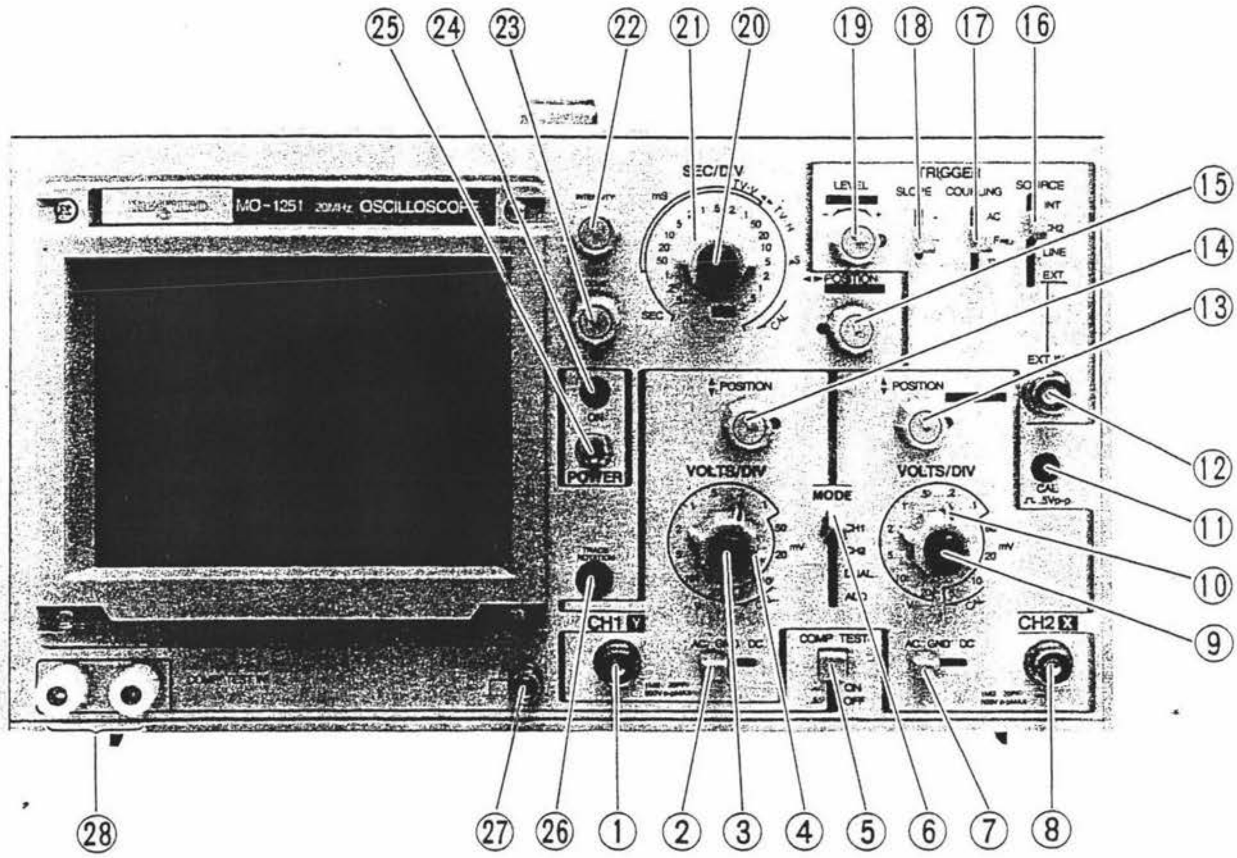


Fig. 1 Front panel controls and connectors

① CH1 (Y) Connector
For vertical input signal to Channel 1; BNC type.

② AC-GND-DC Switch (for CH1 input)
At AC, the DC component is blocked with a capacitor; at GND the internal amplifier input is grounded and the input circuit is at open circuit; at DC, the input signal is directly connected to the amplifier.

③ Knob for variable (uncalibrated) control of VOLTS/DIV; normally set to fully clockwise.

④ VOLTS/DIV Switch
Attenuator for CH1 input in 12 steps, 5mV to 20V per division on the CRT screen (Variable knob ③ at fully clockwise).

⑤ COMPonent TEST Switch
Set to on when making a test of a component. In use the SEC/DIV switch ㉑ is set to (X-Y) and AC-GND-DC switches ② and ⑦ to GND.

⑥ MODE Selector
CH1 and CH2 settings for display of respective inputs.
DUAL for simultaneous display of CH1 and CH2 inputs with alternate or chopped operation controlled with the SEC/DIV switch, chopping at approximately 200 kHz at 0.5s to 1 ms/DIV and alternate in the 0.5 ms to 0.2 μs/DIV ranges.

At ADD, CH1 and CH2 signals are added for the display. When the POSITION control of CH2 ⑬ is pulled, the display will be the difference of the two signals.

⑦ AC-GND-DC Switch (for CH2 input)
The function is identical with that of the switch for CH1 ② except that it applies to the CH2 input.

⑧ CH2 (Y) Connector
For vertical input signal to Channel 2; BNC type.

⑨ Knob for variable (uncalibrated) control of VOLTS/DIV; normally set to fully clockwise.

⑩ VOLTS/DIV Switch
Attenuator for CH2 input in 12 steps, 5mV to 20V per division on the CRT screen (variable knob ⑨ at fully clockwise.)

⑪ CAL 0.5 p-p Terminal
1 kHz square wave output; used in checking the amplifier gain, waveform compensation in a probe, etc.

⑫ EXT IN Connector
For connection to an external synchronizing signal; BNC type.

⑬ POSITION Control
For vertical positioning of the CH2 trace; at PULL INVERT setting, the trace is inverted.

⑭ POSITION Control
For vertical positioning of the CH1 trace.

⑮ POSITION Control
For positioning of the horizontal trace; at PULL X5, the sweep is expanded by a factor of 5 in the time axis direction.

⑯ TRIGGER SOURCE Selector
Selects the synchronizing source as follows:

- INT: CH1 and CH2 signals are added for triggering; in other word, one of the signals is used in the dual trace application.
- CH2: The CH2 signal is used; in single trace operation, the signal selected with MODE ⑥ is used.
- LINE: AC line frequency is used.
- EXT: Input connected to EXT IN connector ⑫ is used.

⑰ TRIGGER COUPLING Selector
Selects the triggering mode as follows:

- AC: For normal operation; the sync signal is fed directly to the trigger circuit.
- HF REJ: A lowpassfilter is used to cut off the high frequency components in the trigger signal.
- TV: For use in observation of TV signals. The TV-V (0.5s ~ 0.1 ms) and TV-H (50 μs ~ 0.2 μs) steps of SEC/DIV switch ㉑ are applicable.

⑱ TRIGGER SLOPE Selector
Selects the slope of the triggering signal to drive the trigger generator circuit.

⑲ TRIGGER LEVEL Control
For setting the starting point level on the waveform of the triggering signal. At automatic operation, the control knob is pulled for the free running condition.

⑳ Knob for variable (uncalibrated) control of SEC/DIV; normally set to CAL position (fully clockwise).

㉑ SEC/DIV Switch
For setting the sweep time; range is 0.2 μs to 0.5s per scale division. At the X-Y setting, operation is for the X-Y mode. The alternate, chop, and TV-V and TV-H operations are possible with the switching.

㉒ INTENSITY Control
For adjusting the beam brightness.

㉓ FOCUS Control
For adjusting the clarity of the beam.

㉔ Pilot Lamp
Lights when the AC power is on.

㉕ POWER Switch
For turning on the AC power.

(26) TRACE ROTATION Adjuster
Used when offsetting the effect of earth's magnetic field in the trace line.

(27) Grounding Terminal

(28) COMP TEST IN Terminals
For connection to a component under test or test leads.

3. Rear Panel, Fig. 1-a:

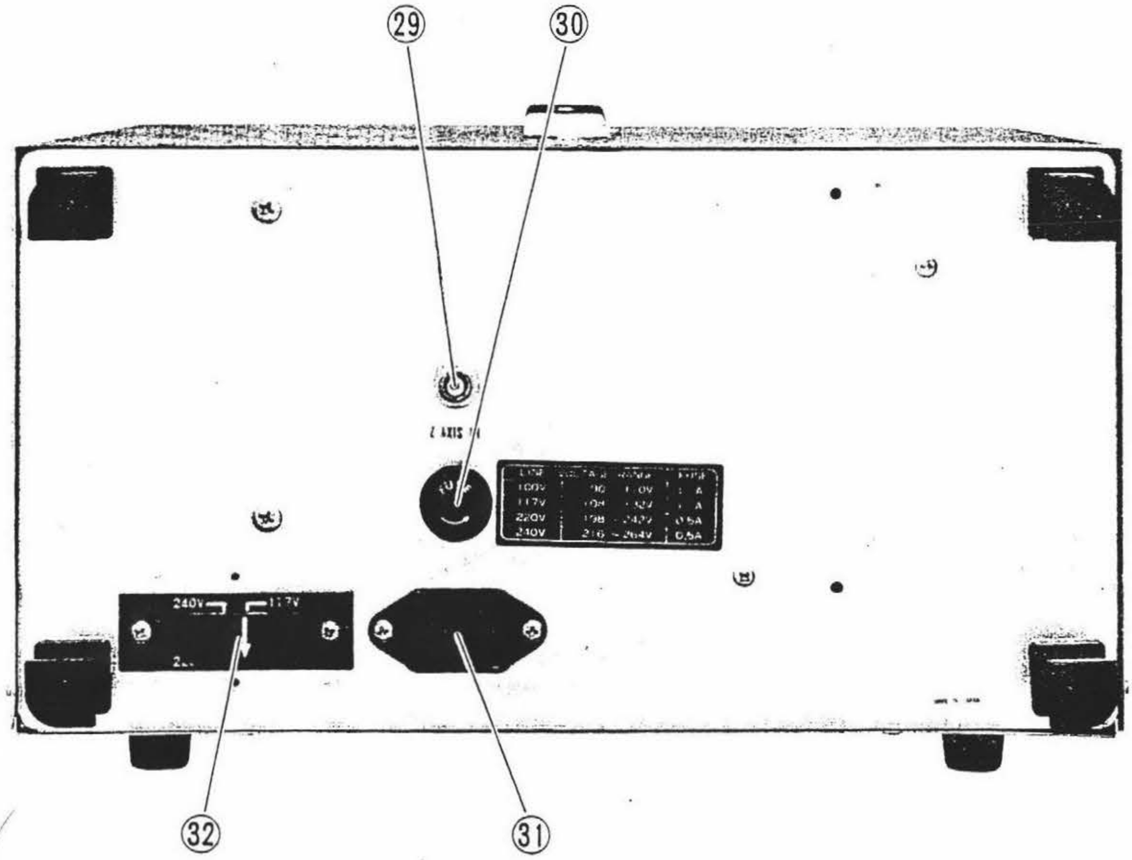


Fig. 1-a Rear panel

(29) Z-AXIS IN Connector
For connection of input signal used in intensity modulation of the beam.

(30) FUSE Holder
For the AC line fuse; rating given in the accompanying table.

(31) Receptacle for AC line cord.

(32) Voltage Selector Plug and Socket
The plug is inserted with the arrow mark in direction of the line voltage as shown in the accompanying table.

3.2 PRELIMINARY OPERATION

1. Control settings:
   1) Set the POWER switch to off (down).
   2) Set all three POSITION controls to mid-position.
   3) Set INTENSITY control to mid-position.
   4) Push the knob of horizontal POSITION (15) for normal condition.
   5) Pull TRIGGER LEVEL (19) control for AUTO mode.
   6) Other controls may be at any position.
   7) Check the AC line voltage and plug inserted direction on rear panel.

2. Connect the AC line cord between the AC receptacle (rear panel) and the local mains.
3. Set the POWER switch to ON. After about 20 seconds a trace line will appear on the screen. If not, adjust the INTENSITY control for proper brightness to suit local lighting conditions.
4. Adjust FOCUS and INTENSITY controls for a clear trace line.
5. Readjust vertical and horizontal POSITION control to place the trace line at the desired position on the screen.
6. Connect a 10 : 1 probe to the input of CH1 and hook the tip to CAL 0.5 Vp-p terminal.
7. Set the VOLTS/DIV switch of CH1to 10 mV and also the variable (inner) knob to fully clockwise. Next set the TRIGGER SOURCE selector to CH2. The square wave covering 5 divisions will then be displayed.
8. If the square wave is distorted, adjust the trimmer in the probe.
9. Remove the probe hook from the 0.5 Vp-p terminal. The instrument is now ready for use.

3.3 TRIGGERING THE SWEEP

In general, triggered oscilloscopes include circuits to display stable waveforms. The synchronizing pulse for the triggering is derived from the vertical or an integral number related signal. It is important that the triggering is exactly synchronized with the vertical input. The MO-1251 has four controls for this purpose.

1. SOURCE Selector ⑯
   INT: For internal triggering with the CH1 and CH2 inputs.
   CH2: For internal triggering only with the CH2 input signal.
   LINE: The AC line frequency is used in triggering.
   EXT: For an external triggering signal connected to the EXT IN connector. Three benefits are apparent depending on operating conditions.
   a. Triggering is not affected by vertical signals. For example, the triggering level is dependent on the setting of the VOLTS/DIV switch since the synchronizing source voltage changes. Unless the external trigger voltage is changed, triggering is very stable and free from vertical controls.
   b. The input signal can be delayed with use of the delaying function of a pulse generator.
   c. A composite or modulated signal can be easily triggered.
2. COUPLING Selector ⑰
   Selects the synchronizing circuit coupling. "AC" is for AC coupling and the DC component is blocked. At HF REJ, a lowpass filter is used to suppress any RF noise interference. The TV setting is for the TV signal triggering; selection is made for TV-V or TV-H with the SEC/DIV switch.
3. SLOPE Selector ⑱
   Selects the trigger slope, positive or negative, of the trigger signal. At TV synchronizing, the point is set to the rise or fall time of the pulse.
4. LEVEL Control ⑲
   For stable triggering control. When the knob is at PULL, the sweep is free-running, i.e., without the input signal for 0 level reference.

3.4 X-Y DISPLAY OPERATION

For special cases in using the X-Y apllication, set the SEC/DIV switch to X-Y. All CH2 functions will operate as a horizontal amplifier while CH1 operates as the vertical amplifier.

3.5 VOLTAGE MEASUREMENTS

Peak, peak-to-peak and DC voltages or a specific portion of a complex waveform can be measured with use of the instrument as a voltmeter. Either the CH1 or CH2 inputs may be used.

1. Set the Variable control of the VOLTS/DIV to the CAL position. Next set the VOLTS/DIV switch for the trace amplitude to be used. Adjust the vertical POSITION control to set the reference level.
2. For DC or complex signals, first set the input switch to GND and then adjust the vertical POSITION control for the reference level. A positive voltage will deflect the trace upward and vice versa. For the voltage, multiply the vertical (division) deflection by the setting of the VOLTS/DIV switch.

NOTE: When a 10 : 1 probe is used, the waveform display is only 1/10 of the actual voltage being measured.

3.6 DUAL TRACE DISPLAY

The MODE selector is set to DUAL. In this operating mode, procedures given above are the same.

3.7 SYNCHRONIZING TV SIGNALS

Set the TRIGGER COUPLING selector ⑰ to TV. The TV frame and line waveforms can be selected with use of the SEC/DIV switch.

3.8 ADDITION AND SUBTRACTION OPERATION

Set the MODE selector to ADD; the display will be the added waveforms of CH1 and CH2. The subtracted waveform is displayed when the CH2 vertical POSITION knob is pulled for INVERT.

3.9 APPLICATIONS

The MO-1251 has full capability of the single trace mode for two traces. In the single trace application, either Channel 1 or Channel 2 can be used. Channel 1 operation will be referred to hereunder for simplicity.

Control settings:

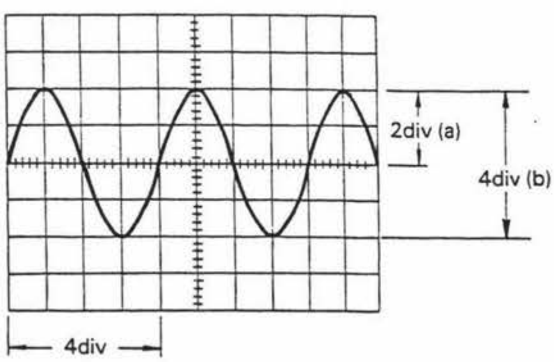
- AC-GND-DC switch .... AC
- MODE selector.............................. CH1
- COUPLING selector .... AC
- SOURCE selector.......................... INT
- Probe cable .... Connect to CH1 input

Connect the probe tip to the point of measurement and ground clip to the chassis or grounded part.

NOTE: The peak-to-peak voltage at the point of measurement should not exceed 600V.

3.9.1 AC Voltage and Frequency Measurements

Initially, set the Variable knobs (inner) of VOLTS/DIV and SEC/DIV switches ③ and ⑳ to the CAL positions. An example is shown in Fig. 2.



VOLTS/DIV .... at 2V
SEC/DIV .... at 5ms

Fig. 2 Voltage and frequency measurement

From Fig. 2:

- Peak voltage .... 2V/div × 2 = 4V
- P-P voltage.................................. 2V/div × 4 = 8V
- Effective voltage........................... Peak V $\div \sqrt{2}$ = 2.828V
- Frequency, Hz .... 1/Time (sec), or
  Time = No. of DIVs per cycle × value of SEC/DIV

For the waveform in Fig. 2, frequency $= \dfrac{1}{5\text{ms} \times 4\text{ (div)}} = \dfrac{1}{20\text{ms}}$

$= 50\text{Hz}$

APPENDIX 6

Appendix 6

Massey University
COLLEGE OF EDUCATION
Te Kupenga o Te Mātauranga

Technology Education
Department of
Educational Studies
and Community Support
Private Bag 11 222,
Palmerston North,
New Zealand
Telephone: 64 6 356 9099
Facsimile: 64 6 351 3385

(Principal's survey)

School information 1999: **Date:**

Date the school was established? ____________________

Founded by? ____________________

School designation.. type of school? ____________________

Number of Staff currently? ____________________

Number of students? rising / falling ____________________

How long have you been principal at the school ? ____________________

How would you describe the community served by the school? ____________________

____

____

____

In your opinion how does the community see ? ____________________

____

____

____

Why do parents select ? ____________________

____

____

____

What is the composite of your BOT? ____________________

____

____

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Survey 2 (Principal's survey)

School, technology education and industry links:

How long has the school had technology education industry links? (before/after your appointment) ______

Who intiated the current links? ______

______

What is your personal philosophy on these links in general? ______

______

______

What in your opinion are the merits of this specific link? ______

______

______

What in your opinion are the debits of this link? ______

______

______

What if any BOT comments about the links have you received? ______

______

______

The current link how does it operate? (funding/contracts) ______

______

______

Why does it operate this way? (monitoring) ______

______

______

Are you prepared for the school to be named in the report?

APPENDIX 7

Appendix 7

Massey University

COLLEGE OF EDUCATION
Te Kupenga o Te Mātauranga

Technology Education
Department of
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and Community Support
Private Bag 11 222,
Palmerston North,
New Zealand
Telephone: 64 6 356 9099
Facsimile: 64 6 351 3385

(Teacher's survey)

link information 1999: **Date:**

Date this link was established? ______________________

Established by? ______________________

Link designation.. type of link? ______________________

Number of Staff involved? ______________________

Number of students involved? ______________________

How long have you been a teacher at the school ? ______________________

How would you describe the community served by the school? ______________________

____

____

____

In your opinion how does the community see ? ______________________

____

____

____

Why do parents select ? ______________________

____

____

____

What is the nature of the link? ______________________

____

____

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Survey 5 (Teacher's survey)

School, technology education and industry links:

How long has the school had technology education industry links? (before/after your appointment)______________________________

Who intiated the current links?______________________________

____

What is your personal philosophy on these links in general?____________________

____

____

What in your opinion are the merits of this specific link?____________________

____

____

What in your opinion are the debits of this link?____________________

____

____

What if any BOT comments about the links have you received?____________________

____

____

The current link how does it operate? (funding/contracts)____________________

____

____

Why does it operate this way? (monitoring)____________________

____

____

Are you prepared to be named in the report?

APPENDIX 8

Appendix 8

SCHOOL INDUSTRY LINKS SURVEY.

STUDENT SURVEY:

Please complete the following questionnaire you are not asked to give your name but it would be useful if you could give your age and sex. Please be honest, this survey is part of research at Massey University individuals will not be identified.

AGE: MALE: FEMALE:

THESE QUESTIONS RELATE TO YOU **BEFORE** YOU BECAME INVOLVED IN THE LINK

1.) Before you became involved in a schools industry link what was your personal attitude to having industry people in schools?

2.) Did you perceive that there would be benefits to you as a student, if so what were they?

3.) Did you perceive that there would be negatives to you as a student, if so what were they?

4.) Were any views expressed to you about working with industry in schools by friends or family, if so what were they?

THESE QUESTIONS RELATE TO YOUR EXPERIENCE **AFTER** WORKING WITH SOMEONE FROM OUTSIDE OF YOUR SCHOOL.

1.) What were the actual benefits (if any) to you as a student having this industry person in your class? Please be specific.

2.) What were the actual negatives (if any) to you as a student having this industry person in your class?

3.) Do you think that technology education particularly should involve working with people from outside of school? ...Why or why not?

4.) Which areas of technology education would benefit most from school industry links? Why? Biotechnology, Electronics and control, Food, Information and Communication, Materials, Production and process, Structures and mechanisms.

5.) Based on your experience would you recommend that industry should be involved in technology education in schools or not.? Yes or No answer.