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Perceptions of lower secondary design and technology teachers about the utilisation of the design process

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USE OF THESIS

Perceptions of Lower Secondary Design and Technology Teachers about the Utilisation of the Design Process

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ABSTRACT

This study investigated the perceptions of lower secondary school teachers about the utilisation of a design process. Seven Design and Technology teachers from government and private secondary schools, situated in Perth metropolitan area, were selected. The participants have been using a design process in lower secondary school for at least eighteen months prior to the study. Each participant was interviewed individually and the interviews were audio-recorded.

The Education Department of Western Australia considers a design process as a central element in the Technology and Enterprise learning area of the Student Outcome Statements. However, not much is known about how this problem-solving process may be used in lower secondary schools. This study found that although the teachers may have encountered a design process in their teaching, they are not all convinced about its practicality in Design and Technology. The real issue which emerged from this study is that attention should be given to the teaching of a design process in schools.

DECLARATION

I certify that this thesis does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any institution of higher education; and that to the best of my knowledge and belief it does not contain any material previously published or written by another person except where due reference is made in the text.

Signature

Date 20 Dec. '95

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List of Abbreviations

AEC	Australian Education Council
CAD	Computer Aided Design
CDT	Craft, Design and Technology
DMA	Designing, Making and Appraising
EDWA	Education Department of Western Australia
IQ	Intelligence Quotient
LOTE	Languages Other Than English
NPDP	National Professional Development Program
NUD*IST	Non-numerical Unstructured Data Indexing, Searching and Theorising
SEA	Secondary Education Authority

CHAPTER ONE: INTRODUCTION

The Background to the Study

In June 1989, the Australian Education Council (AEC) endorsed a set of National Goals for Australian Schools. These goals sought to give education systems and schools a common sense of purpose (Australian Education Council, 1992). The framework became known as the Hobart Declaration. In the Hobart Declaration there were two aims expressed which are of particular relevance to Technology Education:

- To respond to the current and emerging social needs of the nation, and to provide those skills which will allow students maximum flexibility and adaptability in their future employment and other aspects of life.

- To develop in students
  skills of analysis and problem-solving;
  skills of information processing and computing;
  an understanding of the role of science and technology in society with scientific and technological skills;
  an appreciation and understanding of, and concern for, balanced development and global environment; and
  a capacity to exercise judgement in matters of morality, ethics and social justice (Australian Education Council, 1992, p. 1).

The Hobart Declaration was one of the first steps towards national 'collaborative curriculum' work (Willmott, 1994, p. 41). This resulted in the production of statements and profiles in eight broad learning areas, one of which was Technology. The statements and profiles reflected a framework for curriculum and for assessment and reporting (Curriculum Corporation, 1993; Hill, 1994; Mann, 1994). The work on the national curriculum continued for some years, and it was expected that at a meeting in Perth, on 2 July 1993, the Commonwealth and State Ministers responsible for education and training would endorse the national documents (Bowman, 1993). Instead, they decided to refer the national profiles to the States and Territories "for review and for decisions

about how they were to be used" (Education Department, 1994a, p. 9). Since then, each state has commenced work on tailoring the national profile to suit its own priorities (Mann, 1994; Mann, personal communication, April 4, 1995).

The Education Department of Western Australian (EDWA) has published its own version of the Student Outcomes Statements (Education Department, 1994a). It is expected that, in this state where the Student Outcome Statements and national profiles have become a multi-million dollar investment for the Education Department, the education system will be provided with a powerful tool for planning and accountability (McCreddin, 1993). Some other uses of the Student Outcome Statements mentioned in the literature were:

- to set targets for student learning (Hill, 1994),
- to analyse students' work (Using the technology profile, 1994),
- to highlight *positive* statements about what a student has achieved (McAlister, 1994),
    - in diagnosing student strengths and weaknesses
    - in identifying gaps in the areas needing further attention.
- to plan a curriculum, to plan an assessment program, to record student progress and to judge achievement (McLean, 1994).

In the Student Outcomes Statements, eight learning areas from the national profiles were selected. However, the Technology learning area was changed into the Technology and Enterprise learning area to include a wider variety of subjects. Design and Technology is one of the subjects which appear in this learning area. Design and Technology represents the adaptation of the traditional Industrial (Manual) Arts curriculum to the changes

which have occurred in society and the economy as a result of technological developments in the last decade.

The Technology and Enterprise learning area proposes four interdependent strands of learning as the base for the planning of technology programs in schools. These strands are designing, making and appraising; materials; information; and systems. Each strand defines the content, skills and processes of the curriculum (Curriculum Corporation, 1994), and the process of designing, making and appraising (DMA approach) is presented as central to Technology Education. Figure 1 shows how the strands relate to each other.

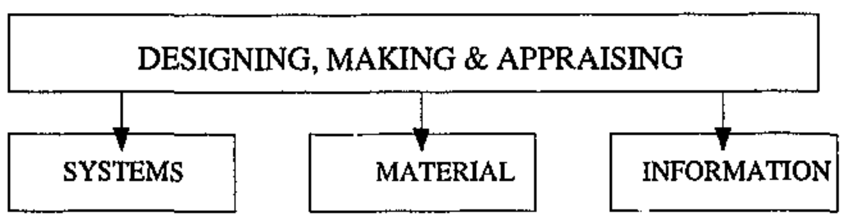


Figure 1. Strands in Technology & Enterprise Learning Area.

The DMA approach infers problem-solving without explicitly stating so:

> Designing, making and appraising is a process through which students develop ideas and create imaginative solutions for the learning tasks in which they are engaged. They participate in decisions about what to do, why it should be done, how it should be done, and how what has been done might be improved (Australian Education Council, 1994, p. 4).

The Purpose of the Study

This study investigated Design and Technology teachers' perceptions of the design process. It described what teachers knew about the design process, and how they

translated their knowledge and perceptions of the design process into their teaching. The study identified the different ways in which the design process might be used in Design and Technology and some of the challenges encountered in applying the design process within the learning environment of secondary schools. This study has also investigated how the selected Design and Technology teachers monitor and assess students' achievements in lower secondary schools.

The Significance of the Study

This study is significant for two main reasons. Firstly, it is done in a period when the Education Department of Western Australia is considering a long term goal - a vision of schooling in the year 2000. In this context, the habits, beliefs, attitudes and expectations of teachers are elements which should be looked at in order to understand the current reality and to smooth the process of change. Secondly, the study takes into account the curriculum change which is affecting Design and Technology teachers. This change consists of two concurrent moves: a move towards outcome-based education and a move towards Technology Education.

The possible implementation of the Student Outcome Statements in Western Australia is a factor which may affect the teaching of Design and Technology and the methodology used to teach the subject. The main argument for this assumption is that the design process being central to the Technology and Enterprise learning area, the methodologies used will be re-oriented towards the teaching of design.

Also, the Education Department (1994b) has indicated that in the near future, schools will be asked to demonstrate accountability using Student Outcome Statements. This

accountability exercise will automatically include the use of a design process because students' achievements may be demonstrated through a design process. Moreover, a design process may act either as a catalyst or as a hindrance to the new approach in Technology Education. So this study is appropriate as it focuses on a change which has a direct impact on the school curriculum.

Finally, as there is a perceived increased role for technology in today's society - including the Australian society, it is of prime importance that the teachers' perspective on the issue is reflected through empirical qualitative research.

The Problem

The problem was to investigate teachers' perceptions of how the designing, making and appraising approach in Design and Technology might be used to demonstrate students' achievements.

Research Questions

The following research questions were addressed in this study:

Question one: a) What is a design process?

b) How do Design and Technology teachers view the different elements of a design process?

Question two: How does the inclusion of a design process affect the teaching and learning process?

Question three: What do teachers look for when they assess students' achievements in Design and Technology?

Question four: How can a design process be taught in lower secondary schools?

Definitions of Terms

'Design and Technology'. Design and Technology is one of the areas of study in the Technology and Enterprise learning area.

'Design process'. The process used to solve technological problems. It contains elements such as investigating, designing, making, testing, using, and appraising. It is a creative problem solving tool.

'DMA approach'. DMA approach means designing, making, and appraising approach. It is also referred to as the design process.

'Student Outcome Statements'. Student Outcome Statements are defined by the National Professional Development Program - NPDP as a framework to describe student learning achievements (NPDP, 1995).

'Technology'. "Technology is a body of knowledge and actions about: applying resources; developing, producing, using, and assessing; extending the human potential; controlling and modifying the environment" (Wright & Lauda, 1993, p.3).

'Technology and Enterprise'. Technology and Enterprise is one of the eight learning areas of the curriculum in Western Australia.

'Technology Education'. "The development and application of ideas and practices by students through the process of designing, making and appraising" (Australian Education Council, 1991, p. 1).

CHAPTER TWO: REVIEW OF LITERATURE

Introduction

It is a widely accepted view that the purpose of school is to give children a broad and general education for life. The curriculum has been concerned with the "learning which is planned or guided by the school" (Kerr, 1968, p.16). In the planning of the formal curriculum, schools decide on priorities and devise ways and means of putting them into practice. The current literature on the issue indicates that Technology Education is appropriate for our time. The literature argues that Technology Education is evolving from a skills-based subject to a process-based subject. The literature also describes the methodology of technology as a design process (McCloy, 1984). The use of a design process in school may have considerable educational implications.

Different models of design processes are used in schools throughout the world. Some models may project a distorted view of how thinking and problem-solving develop in classroom situations. In fact, the question of how any design process should be taught in schools remains unanswered. On one side, the design process is considered as central to Technology Education, and on the other side, there is little empirical evidence to support the benefits of this process in learning.

This literature review also looked at the rationale for Technology Education, the aim and nature of Technology Education, the methodology of technology, and outcome-based education and competence-based assessment.

Technology

Technology deals with the human-built world. Nowadays, technology permeates every aspect of our life (De Bono, 1971; Down, 1989; Mattick, 1987). A simplistic and largely historical view of technology is to see technology as the application of science. However, the nature of this link is now disputed (Gardner, 1994; Gilbert, 1992; Turnbull, 1991). There exists some fundamental differences between the scientific method used in science and the design method used in Technology Education. In fact, science is motivated by curiosity and its outcome is the confirmation, modification or rejection of a hypothesis, whereas design is motivated by a need and its outcome is the development of a solution (McCloy, 1984; McCrory, 1974).

Goetsch & Nelson (1987) described technology as "people using tools, resources and processes to solve problems or to extend their capability" (p. 4). The extension of human capability is indeed a striking element in technology. This has resulted in opportunities unimaginable only a few years ago. For example, computers and machines carry out work with more precision, in less time, and without fatigue in comparison with people. Still, technology should not be equated solely with machinery or artefacts.

A generally accepted definition of technology implicitly includes the design process: "technology is a body of knowledge and actions about applying resources; developing, producing, using, and assessing; extending the human potential; controlling and modifying the environment" (Wright & Lauda, 1993, p.3). In this definition, reference is made to developing, producing, using, and assessing. These elements of technology are

also the main elements of numerous models of design processes (Hanks, Belliston, & Edwards, 1978; McCrory, 1974; Schon in De Vore, 1980; Toft, 1987; Ullman, 1992).

Technology Education

Wright & Lauda (1993) describe Technology Education as "an educational program that assists people develop an understanding and competence in designing, producing, and using technology products and systems, and in assisting the appropriateness of technological actions" (p.4). The main objective of this educational program is to develop technological literacy and technological capability. There is a need for people to be technologically literate. According to Booth (1989), technology literacy can be described as "the need for students to see how society is being reshaped by our inventions" (p. 84). Indeed, this fast changing society needs people who are equipped with a new set of competencies which would help them understand, and have control of the new social, economic, cultural and technological issues: "Today's and tomorrow's society will require an educated, informed, and technologically literate citizenry to function in a meaningful way" (Benzie, n.d., p. 10). This view reflects that of De Vore (1988).

Williams (1993 & 1994) stated that the social focus on Technology Education has shown that Technology Education is vital for students, and that it is an important issue in the designing of a core curriculum. Indeed, Technology Education is a unique subject in the school curriculum. In this school discipline, knowledge, creativity and resources are applied to extend human potential and to solve problems (The Technology Education Curriculum K-12 cited in Booth, 1989). Thus, problem solving, while not being the

major component of technology, remains nevertheless an important one. Consequently, students may be expected to learn about designing, producing, and using.

The need for Technology Education was identified in the document Technology for Australian schools:

> Technology contributes to changes in cultural, social, environmental and economic circumstances as well as to changes in perceptions, attitudes and values . . . Changes occurring in societies and environments demand that people in Australia become more innovative, knowledgeable, skillful, adaptable and enterprising. Meeting these needs enhances personal fulfilment and empowers all members of the community (regardless of gender, cultural background or age) to participate in and make worthwhile contributions to society (Australian Education Council, 1992, p.1).

Technology Education is a relatively new component in the curriculum, and because of this situation, no one has 'the' model which should be implemented in schools. Technology Education programs "encourage students to use technology productively and to become enterprising people" (Education Department, 1994b, p. 2). The aim of Technology Education is to make people in Australia technologically literate, innovative and resourceful, skillful and responsible (Australian Education Council, 1991 & 1992). Much emphasis is put on the ability of students to develop their capabilities to:

- take independent and interdependent action;
- understand the principles and concepts that underpin innovations;
- use processes and products with skill and confidence;
- devise imaginative responses to challenges;
- think critically about personal, local and global consequences;
- be conversant with technical language and conventions;
- work individually and co-operatively with others;
- produce appropriate social, environmental and economic outcomes;
- appreciate the contribution of technology to society;
- reflect on past practices and future opportunities; and
- understand the influence special interest groups can exert.
  (Australian Education Council, 1991, p. 2)

Practical Education

Formerly, the school curriculum was designed to cope with two categories of students: the academically inclined students and the students considered as being less able. The academic students were directed to study languages and sciences, whereas the other students were directed to the workshops to do practical (or vocational) subjects. In the practical subjects, there was much emphasis on the development of psycho-motor skills. "The emphasis was on the development of the student's sensori-motor system with generally little attention being paid to what was being gained in the cognitive/process area" (Brown & Hegney, n.d., p. 2). Manipulative skills were taught in a way reminiscent of the Swedish Sloyd system where students had to master progressively a set of specific skills according to a pre-established plan (Salmon, 1980; Salomon in Householder, 1972).

Formerly, manual work was recommended as a practice to shape the characters of the working people and to instill in them values such as honesty, integrity and the dignity of labour (Dodd, 1978). According to this belief, manual work would lead to an improvement in moral behaviour (Penfold, 1988). However, in the process of its evolution, training in manual work has only been associated with the working class and the criminal classes (Penfold, 1988; Smithers & Robinson, 1992). As a result, the practical subjects have remained at the bottom of the academic hierarchy (Dodd, 1978; Penfold, 1988).

In Western Australia, Deschamp (1991) noted, in a review of Manual Arts, "the fact that in many schools few of the academically able students enrol in Manual Arts adds to the perception that it is an area for less able students" (p.5). Because of the historical

background of Manual Arts, it was not astonishing to learn that Deschamp' findings mirrored the comments made in England by Penfold (1988) about the identification of practical subjects with the less able pupils. To express it in lay terms, practical subjects were viewed as dirty subjects for dumb people.

In fact, the real issue was the sharply defined division of human-kind's ability into two, namely: intellectual ability and manual ability. And for unknown reasons, those who worked mostly with their heads had a higher respectability than those who worked mostly with their hands. Consequently, the head was given more consideration in formal education: "It is a criticism of our modern technological education that it concentrates on the head, to the detriment of heart and hands" (McCloy, 1984, p. 239). Thus, practical education (including Manual Arts) has been associated with working with the hands only and with the making of concrete objects.

Marsden & Marsden (1994) do not believe in the dichotomy of head and hand. They used a graphical model of interaction between mind and hand, which was developed by Professor Richard Kimbell, to stress the essence of Design and Technology: "the dynamic interrelationship between modelling ideas in the mind and modelling ideas in reality is the cornerstone of capability in design and technology and is described as 'thought in action'" (p. 5).

While the "know how" is considered an important element in Technology Education, this does not restrict Technology Education to the teaching of practical or vocational subjects. In fact, Layton (1993) has noted that "general education is being

vocationalised, whilst vocational education is being generalised" (p.11) - meaning that vocational education is merging into general education. This implies that in practice, the compartmentalisation of subjects for vocational purposes is no longer relevant, even if one specific feature of Technology Education is practical action.

In this context, Marsden & Marsden (1994) point out that technological capability is concerned with two factors. The first factor is the use of resources. Resources include the concepts as well as the processes. The second factor is the task which must be structured to facilitate learning. Both factors are used in finding a solution to a human need. Accordingly, technological capability combined with practical action distinguishes technology from the other areas of the curriculum.

Approaches to the Teaching of Technology

A wide range of teaching strategies are used in Technology Education. These include brainstorming, and co-operative learning. All these techniques are appropriate for teaching problem-solving techniques. Co-operative learning, for example, is recommended by Christensen & Martin (1992) as "one of the most effective structures for teaching problem solving skills" (p.9). This recommendation is backed by the results of studies done by Johnson & Johnson in 1975 and by Nelson & Timpson in 1985 (Christensen & Martin, 1992).

Student-centred learning is compatible with Technology Education. The teacher is no longer an information giver but becomes instead 'a facilitator of learning' (Christensen & Martin, 1992, p.9; Williams, 1993, p. 46). This view is reminiscent of

that of Freinet (1976) who proposed a more active and democratic role for students in education.

In Technology Education, hands-on experiences are usually provided. Educational psychologists believe that any hands-on activity is an essential characteristic of Piaget's concrete operational stage of cognitive development (Woolfolk, 1993). It is observed that students understand more about what they have learnt through doing than from other learning modes. Therefore, the doing aspect plays an important part in Technology Education.

The impact of Technology Education on the school curriculum is felt in different ways. The learning styles, and the types of activities going on in the technological laboratories are distinct from what happened in old-fashioned workshops (Foster, 1995). Composite laboratories are used instead of traditional workshops which were compartmentalised to cater for either wood, metal, or plastics. Also, different materials and processes are used in Technology Education to teach the general principles behind existing technologies (Williams, 1987).

Team-teaching, a new concept in education, has became an alternative when teachers lack expertise in teaching some technical or scientific concepts in technology. This concept of cross curricular education has been highlighted by Down (1989) and Williams (1991). However, the literature review found little information on how team-teaching was being carried out in schools.

Finally, the approach used in Technology Education is consistent with the use of 'guided discovery learning' which has been adapted from Bruner's discovery learning (Woolfolk, 1993). Technology Education also favours the cognitive view (constructivist learning theory). In this theory, the students construct or add their own meaning to their learning experiences (Johnson & Thomas, 1992). In Technology Education, students move from the concrete to the abstract. This type of approach makes learning more meaningful. Also, the type of assessment used (for example criterion referenced assessment) could help students become more responsible for their own learning.

Design as a Problem-Solving Activity

Technology Education is referred to as Design and Technology in some countries including England, Mauritius and Australia. The basic assumption about design and technology education is that "design awareness and design ability are fundamental capacities of all human beings" (Standen, 1986, p. 88).

On his side, Papanek (1972) described design as "the conscious effort to impose meaningful order" (p. 17). Design is often associated with the abstract or with art but as with De Bono (1971), it can be seen as a form of problem-solving. However, Pye (1978 & 1986) argues that design is neither a problem-solving activity nor an art, but that it is both.

Design is seen as being relevant in the school curriculum for two reasons. First, it is motivated by needs and wants of people. And second, through the design method, the needs are answered in a constructive way. Design is seen as "a means of enabling

children to think, to understand and to take action" (Adams, 1989, p.11). Therefore, the design method may help the students to develop their thinking and to participate creatively in solving problems. Thus design occupies an important place in any technological program.

Design Process

The design process is commonly viewed as a problem solving process which represents the finding of a solution for an identified need or problem. A review of relevant literature has shown the multiplicity of views which exists on the design process. Models of different complexities have been proposed.

The models which have been presented could be easily grouped into three categories: linear models, cyclic models, and non directional models. However, it is not apparent which type of model would best suit a teaching and learning environment as a lack of empirical research on the topic has been noted.

Models of Design Process

Linear Models. In the first category, the process is presented as a linear sequence (Mauritius Institute of Education, 1990, p. 1). The elements or stages of the design process are sometimes placed in a certain order without any indication whether or not there is room for 'regression' (Dodd, 1978, p. 45).

In general, the linear models present the design process as a one-way process where students are expected to move from one stage to the next in a rigid way.

Figure 2 illustrates a simple linear model of a design process.

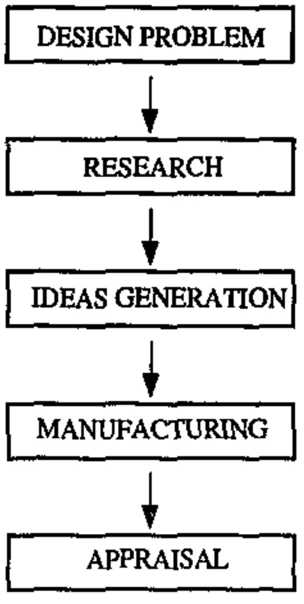


Figure 2. Example of a Simple Linear Model of a Design Process.

Cyclic Models. In the second category, the design process is presented as a cyclic model. This category is common in many textbooks on Design and Technology.

Some models provide for a 'restart' or 'loop' within the process (Chapman & Pearce, 1988, p. 7; Dodd, 1978, p. 45; New Jersey State Department of Education, 1987, p. 12).

Some others detail the various elements of the design process and show them as a continuous process (Education Department of South Australia, 1978, p. 9; Midland Examining Group Syllabus for 'CDT: Technology' in Marsden & Marsden, 1994, p. 4; Schon in De Vore, 1980, p. 67). These models appear to be more flexible than the linear ones. They give the teacher the opportunity to plan learning experiences which are

relevant to the students' needs. Figure 3 illustrates a simple loop model of a design process.

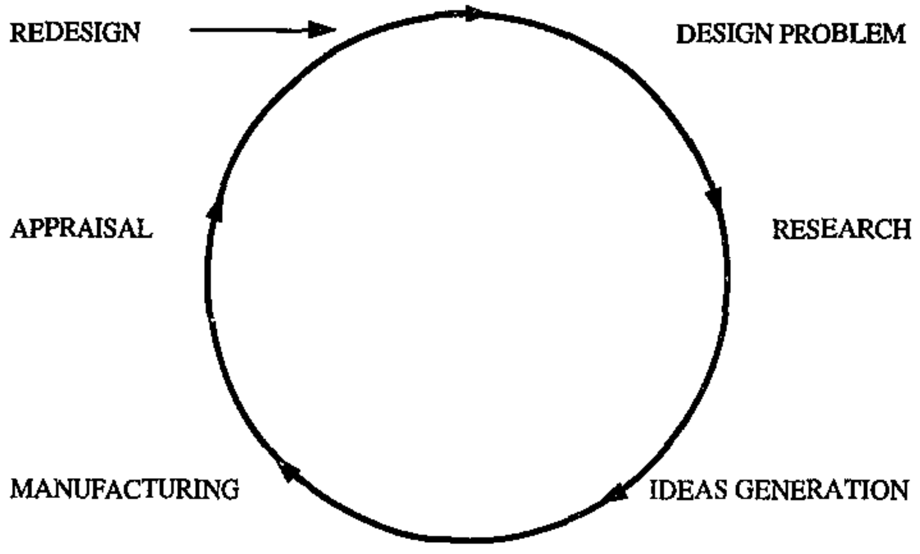


Figure 3. Example of a Simple Loop Model of a Design Process.

Non-directional Models. In the third category, the models are non-directional. It has been argued, in the literature review, that the neat subdivisions of the designing procedure present an attractive but artificial interpretation of the design and technological activity (Kelly, et al., 1987). The challenge for teachers and students is that the real design and technological activity is different to either the linear model or to the cyclic model. The non-directional model can be used flexibly without any necessity to go through all the stages in the process. In a non-directional model, permutation is possible. For example, one may move from the research stage directly to the appraisal stage or from the manufacturing back to the ideas generation stage.

The DMA Approach

The degree of emphasis put on the different stages or elements of the design process differs from country to country. England uses 'Designing' and 'Making' as organisers of the curriculum in Design and Technology (National Curriculum Council, 1993). The Netherlands concentrates on a designing, making and using model (de Vries, 1991). In America, some states are currently using a develop, produce, use and assess model (Wright J.R., 1993), while Western Australia is aiming at using the designing, making and appraising approach (Education Department, 1994a) or the designing, making, appraising and marketing approach (Technology & Enterprise, 1995).

Designing, making and appraising is the process strand of the Technology and Enterprise learning area and it is central to learning in Technology. The designing, making and appraising strand is divided into four sub-strands. These are investigating; devising; producing; and evaluating. These sub-strands are also the same elements found in the different models of design processes described earlier in this chapter.

The Education Department of Western Australia emphasises the DMA approach (Education Department, 1994a & 1994b; Working document, 1994). It specifies that:

> The process inherent in the DMA strand is not linear, i.e. from *investigate* to *evaluate*, but cyclic. The DMA cycle can commence at any point and different aspects of the cycle may be returned to, if appropriate, to develop a solution to the problem(s) (Education Department, 1994b, p. 1).

However, there is little indication as yet, about how the approach should be used in schools. The literature review found no information on how a problem-solving technique which tends to put emphasis on cognitive skills, could be applied in an area which has

traditionally been left to students 'of poor academic ability' (Slater, 1989, p. 56), and to teachers who are stereotyped as 'shed men' (Deschamp, 1991, p. 4).

Critics of the Design Process

Most of the criticism of the design process relates to the types of activities which are done in schools. Some people fear that with the design process there will be a decrease in practical work and an increase in paperwork (Slater, 1989; West, 1989). There has also been public concern about how Technology Education is being implemented through the design process. In England, for example, newspapers criticised the way in which sticky-backed plastic, paper and sticks were used to teach Technology (Massey, 1992; Wright R.T., 1993).

Smithers & Robinson (1992) argued that by putting emphasis on the design process, ordinary tasks like writing a report or finding one's way to the railway station have been wrongly associated with Technology. Along similar lines, Wright (1994) has also argued that by putting emphasis on the design process all that could be expected would be "a familiarity with the steps in the design process and haphazard exposure to the knowledge of technology" (Wright, 1994, P. 8).

Assessment

Assessment is a concern to the teachers who are involved in the teaching of Design and Technology, and to those responsible for the formulation and implementation of the curriculum.

Williams (1991) remarked that "holistic marking is more reliable than marking each separate component of the design process" (p. 23). This view is shared by Borthwick (1992) who said that "assessment should be undertaken as an holistic process which integrates knowledge and skills with their practical application" (pp. 4-5). This aspect of holistic assessment is highlighted by some other writers. McCormick (1993) recognised that Eggleston - a proponent of design education in England, was the one who pointed out holistic assessment as an issue. However, McCormick said that the issue has not yet been addressed properly.

The issue of holistic marking is pertinent in Western Australia because of the move towards outcome-based education where students are assessed on whether or not they have demonstrated certain outcomes in their specific learning area. "Outcomes are high-quality culminating demonstrations of significant learning in context. Demonstration is the key word; an outcome is not a score or a grade, but the end product of a clearly defined process that students carry out" (Spady, 1994, p. 18).

Grundy (1994) proposed that the profiles and statements do not focus on the inputs to learning but on the outcomes of pedagogy. This view is shared by McAlister (1994) who noted that "the difference is subtle but highly significant" (p. 9). Nevertheless, the assessment of outcomes is a complex activity. On one side, Masters (1994) and Grundy (1994) argued that holistic judgement about the students' broad levels of achievement can be useful, and on the other side that the use of behavioural objectives does not simplify the complexity of the assessment process.

Still, the Student Outcome Statements should not be viewed solely as an assessment tool. According to its proponents, the Student Outcome Statements can also be used as a framework for course development and lesson planning. They allow teachers to communicate student progress to parents through a language and standards which are consistent across classrooms, schools and school systems (Hill, 1994). But, how this reporting will be done is not clear.

Collins (1994) questioned the validity of using levels which are based on the myth that school learning can be treated as a natural path for all students. In other words, Collins pointed out that levels may be used arbitrarily in a multicultural society such as Australia. The assessment of students who come from different cultural backgrounds in Australia was linked to the 'IQ mess' which did not take into account inborn differences or cultural differences or learning styles. This situation is of concern to Design and Technology teachers in Western Australia as students utilise a wide range of processes and products which may be difficult to evaluate and assess in a fair way.

In the United States of America, there has been a considerable amount of writing on the assessment of outcomes. Guskey (1994) and Jamentz (1994) have been concerned about how assessment may improve performance or bring change in instructional practice. McGhan (1994) put forward arguments to support his view that the weakest element of the outcome-based education approach has to do with the perceived value of effort over ability. McGhan fears that with outcome-based education, students will not be asked to make reasonable effort in their work.

Also, according to the critics, outcome-based education is creating problems for parents of high-achieving students who see the outcomes as nebulous. O'Neil (1994) argued that outcome-based education will create difficulty in selecting "[the students] who will go on to Harvard [by contrast with] those who will clerk at K-Mart" (p. 9).

Hedson (cited in Zitterkopt, 1994) went as far as to describe outcome-based education as a method of manipulating student's behaviour through modification based on Skinner's methods of repetitive reinforcement. Even if the above are general criticisms which can apply to Technology Education, there is a lack of research on the results of the implementation of outcome-based education. This observation has been highlighted by Evans & King (1994) and Slavin (1994).

Literature on Previous Findings

In Western Australia, McGirr (1985) did a study on how adult and student designers plan their design activities in view of solving a design problem. She found that given a situation that required a solution, the students did not analyse that situation carefully. Students misunderstood the situation itself and also its limitations; and they tended to defer decision making while spending much time generating and developing their ideas. The study showed that students needed proper strategies to be able to solve problems efficiently.

Also in Western Australia, Slater (1989) found that a model of design process (in a form similar to that illustrated in Finney & Fowler, 1986, p. 5) was being used in lower school Industrial Arts units. He also found that there had not been any obvious development in

design education in spite of the recommendation number 9 (ii) made by Beazley (1984). A few years later, Congear (1993) pointed out that even if 20% of Manual Arts teachers had studied the basics of design, they did not study the methodology of how to teach design. Congear developed and presented two Design Studies units together with relevant curriculum support materials to assist teaching. There is at present no information readily available on the use of these two units in lower secondary schools.

In a study on the role of metacognition in Technology Education, which was done in the United States, Stevens (1993) found that while the need to teach problem solving skills within the framework of technology is widely accepted, the teaching of problem solving remains a difficulty because its means are not clearly defined. In another study, on the efficacy of developing critical thinking and problem solving skills through Technology Education, Mahoney (1993) did not find a link between Technology Education and the development of critical thinking and problem solving skills.

One of the educational implications of the findings made in the United States is that the use of a design process may not guarantee that students would necessarily learn problem-solving skills. This is relevant to the curriculum builders in Western Australia because a design process is being presented as the central element in Technology Education in the Student Outcome Statements.

Summary

Technology Education is already present in one form or another in the actual school curriculum. While the rationale for its inclusion is not questioned, there are still certain

elements within the curriculum which need to be addressed properly, if not urgently. These include assessment and the validity of outcome-based education.

The literature review has shown that:

a) Technology Education is a vital component in the school curriculum; it is appropriate for this era. Technology Education is also an educationally valuable subject as it combines technological literacy with practical action. Still, it is of concern that too much emphasis is put on the design process in the Student Outcome Statements in Western Australia. Moreover, the literature review has shown that in practice little is known about the use of the design process in schools and how the design process could be linked to student outcomes.

b) Different models of the design process are being incorporated in school curricula around the world. It is noted that some of the models used in schools may project a distorted view of how thinking skills and problem-solving skills should be taught. In fact, the question of why the design process should be taught in schools and how it should be taught remains unanswered. On one side, evidence to support the benefits of this process in learning is lacking, and on the other side, the process itself is considered as central to Technology Education in many school curricula including the Western Australian school curriculum. The lack of information about the utilisation of the design process provides the motivation for this study.

CHAPTER THREE: METHOD

Conceptual Framework

The emphasis put on the design process as the central element of the Technology and Enterprise learning area may have a direct influence on some elements of the school curriculum and repercussions on what students may achieve in Design and Technology. A design process may be influenced by the perception of teachers about curriculum changes and students' needs. Also, the technology curriculum used in school may have an impact on the teaching methodology and the learning strategies used in the classroom. Consequently, the design process influences indirectly learning experiences and student achievement. A framework has been designed to explain the main things to be studied in this research and also the anticipated relationship among them. Figure 4 is a graphical representation of this conceptual framework.

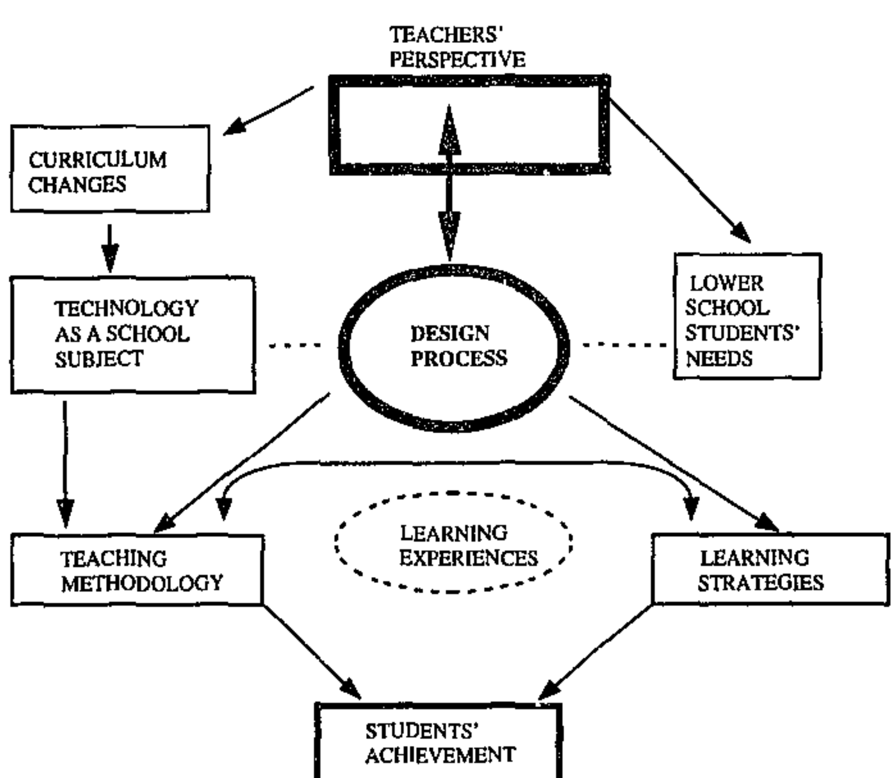


Figure 4. Conceptual Framework for the Study of the Use of the Design Process

This conceptual framework which is "the current version of the researcher's map of the territory being investigated" (Miles & Huberman, 1994, p. 20) shows that the central element under investigation is the teachers' perspective on the design process. The teachers' perspective on issues such as curriculum change or students' need are also investigated as it is suspected that these may have an indirect influence on the way the teachers teach the process. Similarly, in order to understand the outcome of the use of the process and consequently the students' achievement, the researcher found it necessary to question the teachers on the teaching methodology and the learning strategies used in class. This could also be deduced from the type of learning experiences designed for the students. In summary, it was expected that the teachers' perceptions about the use of a design process might emerge naturally from the way they perceive technology for example or from their actual teaching practices or students' learning experiences.

Subjects

It is hard to determine precisely the number of Design and Technology teachers in lower secondary schools in Western Australia. A study of design education by Slater (1989) reported that thirty six percent of Manual/Industrial Arts teachers taught a design process in lower secondary schools. The present number of teachers who use a design process in lower school in Western Australia is unknown. So, it was important before doing this research to identify the potential participants. This identification of potential participants involved two stages. In the first stage, the potential schools where teachers could be recruited were identified. In the second stage, the teachers themselves were selected. A sample of seven teachers was finally chosen.

Stage One: Identification of Schools.

The first stage was the identification of the schools. The geographical boundaries for the research were chosen and limited to the Perth metropolitan area. For practical reasons, the schools were to be located inside a bezier curve having the four major train terminals as the co-ordination points. Then, schools were identified. This identification was based on the technical/technological subjects offered by the schools. This information was obtained from the "1995 - Secondary School Index Questionnaire" file, compiled by the Department of Teaching and Curriculum Studies, Edith Cowan University, Mount Lawley campus. This file is typically used to provide the university with an up-to-date databank on schools which collaborate with the university for teaching practice of student-teachers. The information was easily accessible and it provided detailed and reliable data. Fifty-six schools were identified.

The researcher organised the information in a database. An overview of the Manual Arts and Design and Technology subjects offered by the schools showed that the subjects could be classified into four distinct groups according to the number of schools which offered them. The first group included the traditional triad Metalwork, Woodwork, and Technical Drawing. These subjects were being offered by most schools. Some other popular subjects were Applied Industrial Arts, Furniture Woodwork, Industrial Workshop and Photography. The less popular subjects were Plastics, Metal Construction, Motors and Machines, Electricity, and Mechanical Workshop. The last group included the rare subjects which could be further divided into four sub-categories: the drawing-oriented subjects (e.g. Graphic arts, Graphics design), the computer-oriented subjects (e.g. Robotics), the skills-oriented subjects (e.g. Jewellery and Model making), and the technologically-oriented subjects (e.g. Technology Studies, and Applied

Technology). Some of the subjects (the drawing-oriented subjects for example) were offered either by one school only or at most by five schools. The total number of schools offering the two subjects clearly defined as technological subjects - namely Technology and Technological Studies, was five.

On the advice of lecturers from the Department of Vocational Education, three other schools, not found on the list from the Edith Cowan Teaching Practice file, were added to the list. These included one senior high school, one senior campus and a newly built community school. At this stage, there were fifty nine schools on the first short list.

This list was further reduced to thirty three by using the following criteria:

1. The name Design and Technology was being used on the school profile documents submitted to Edith Cowan University (refer to Appendix A).

2. A wide range of technical subjects was offered by the school. These included subjects commonly known as Metalwork, Woodwork, Technical Drawing, Plastics, Applied Industrial Arts, Furniture Woodwork, Industrial Workshop, Mechanical Workshop, Photography and Electricity. Also a technological subject (e.g. Information Technology, Technology, Technology Studies or Energy Technology) was being offered by the school (Appendix B).

3. The school has been identified by the Education Department of Western Australia (EDWA) as being potentially suitable for this type of research on Technology Education (Appendices C & D).

Stage Two: Identification of Participants.
The second stage consisted of the identification of the potential participants themselves. Phone contacts were made over a three-week period with Design and Technology teachers from the thirty three identified schools. The researcher phoned the Design and Technology Department of each school and informed about the research being done. The person contacted on the phone was asked whether or not anyone would be willing to participate in the research. In some cases, the person on the phone suggested the names of other colleagues. The names of all the fifty nine schools on the original short list are given in Appendix E. In total, fifteen teachers agreed to participate on the phone. Eight schools could not accept as either they were not teaching the design process yet or they did not want to be involved. Several unsuccessful attempts were made with the ten remaining schools.

A Participant Profile Form was sent to each of the fifteen teachers together with a prepaid reply envelope (Appendices F & G). The form contained questions about the subjects taught at the school and the year in which a design process was used. Replies were sent back by thirteen full-time teachers who were willing to share about their teaching experience. However, two of these replies were discarded as they were incomplete.

A sample of seven teachers was selected out of the eleven volunteers. In this final selection, the judgement of the researcher was used to ensure the sample was fairly chosen. The researcher found it useful to plot the position of the eleven schools on a map to facilitate the selection exercise to ensure that the sample is dispersed inside the metropolitan area. At this stage, the researcher felt that the inclusion of at least three

private schools could contribute positively to the research, even if initially, no mention was made in the research proposal concerning the religious denomination of schools from which the teachers would be selected.

Table 1 has been compiled from information obtained through the Participant Profile Form, Section B, concerning the use of a design process by the eleven teachers.

<u>Table 1</u>

<u>Information About Eleven Teachers' Use of a Design Process</u>

Teacher's Response

	1	2	3	4	5	6	7	8	9	10	11
Respondent has integrated a Design Process during											
these past four years	*					*					
these last three years			*	*	*		*	*			
these last two years									*	*	*
this year		*									
Respondent is using a Design Process in											
Year 8	*	*	*	*	*	*		*	*	*	*
Year 9	*	*		*	*		*	*	*	*	
Year 10	*	*		*	*		*	*	*	*	

NOTE: The highlighted teachers' numbers indicate those who have been chosen for the research.

The final sample consisted of teachers from four government schools and three private schools. The four government schools included two schools which were trialing the Student Outcome Statements. The private schools consisted of two Catholic schools and one Anglican school.

All participants had been using a design process in their teaching for a period of at least eighteen months. Five participants were using a design process in years 8, 9 and 10 while two were using it only in year 8. Please refer to Appendix H for a list of the subjects taught by the participants.

The breaking down of the selection process results is given in Table 2.

Table 2

Data for Selection Procedures as per School Category.

			CATEGORY OF SCHOOL			
		Total	Government	Catholic	Anglican	Other
Stage One SELECTION OF SCHOOLS	SCHOOLS ON FIRST SHORT-LIST	59	40	10	4	5
	SCHOOLS CONTACTED BY PHONE	33	19	6	3	5
Stage Two SELECTION OF PARTICIPANTS	POTENTIAL PARTICIPANTS	15	9	3	2	1
	ACTUAL PARTICIPANTS	7	4	2	1	0

Design

This research was a case study of Design and Technology teachers who use the design process in lower secondary schools. It was of a qualitative nature. The need for qualitative research in Technology Education was advocated by Williams (1994) and Gloecker & Gerst (1994). In this study, the participants were interviewed individually. The interviews were semi-structured and most of the questions were opinion/value and knowledge questions. The inquiry paradigm which has been favoured is constructivism.

The aim of this research was to understand what the teachers feel about a selected topic of the school curriculum. The teachers' perception on the issue was to be investigated in a qualitative way. The nature of knowledge in this type of research is the consensus formed by the combination of the individual reconstructions. Burns (1994) suggested that this method is appropriate to understand events from the perception or subjective viewpoint of the participants. De Bono used an alternative word for perception, he favours 'popic' a short word for 'possible picture' (De Bono, 1994, p. 135). The exploration of the research questions through the use a case study was appropriate to grasp this 'popic' about the use of the design process and to understand the way Design and Technology teachers are looking at the situation at present.

While it is of concern to the researcher that critics may see a case study as being subjective, invented, inconclusive or non-representative, the use of the case study approach for this study is quite valuable as a pilot study. Hitchcock & Hugues (1989) would describe a pilot study as "a short, preliminary, investigative study designed to reveal issues which can be explored in more depth later by means of a variety of techniques" (p.83). The case study approach is appropriate as it allows the researcher to explore the feelings, beliefs and emotions of the participants in a respectful way.

Materials

An interview schedule was prepared and pilot-tested at the first two interviews. The format of the interview schedule used was modified. The researcher used new fonts and spacing to reduce the original eight pages interview schedule to two pages only (Appendix J). Still, it should be noted that the interview schedule was used in a

flexible way for the rest of the interviews. This was essential as the personalities, knowledge and experience of the different participants varied. Furthermore, a flexible interview schedule allowed each participant to explore new ideas, to reflect on some teaching practices and to share her/his teaching experiences. The flexible interview schedule allowed the researcher to constructively prompt the participant. In fact, the interview schedule was used both as a framework to establish rapport and trust between the participant and the researcher, and as a tool to elicit pertinent information from which the research questions could be answered. The interview questions focused on what the teachers knew about the design process, how they felt about it and how they translated their perception of the design process in their teaching. The researcher used a cassette recorder to tape the interviews. This was appropriate as it freed the researcher from the necessity of noting down what was being said and it allowed for a fruitful interaction with the participant.

Procedure

Letters were sent to the fifteen teachers who agreed to participate on the phone to thank them for their interest in the research. Phone contacts were made with the seven participants and letters sent to them to arrange for a date and time for the interview to be held (refer Appendix K). The arrangements for the location and the time for the interviews were organised on the phone. The participants were requested to select a quiet place for the interview to be audio-recorded.

In order to allow the researcher to obtain relevant information from the participants, a planned sequence for the interviews was established. Table 3 shows the order and duration of the different interviews.

Table 3

Table Showing the Order and Duration of the Seven Interviews.

Interview	Duration (minutes)	Type of school
◊ First	60	private
◊ Second	60	government (trialing SOS)
◊ Third	50	government
◊ Fourth	90	government (trialing SOS)
◊ Fifth	90	private
◊ Sixth	90	government
◊ Seventh	50	private

At each interview, the participant was asked to sign two copies of the Statement of Disclosure and Informed Consent Form (Appendix L); and, one of the forms was given to the participant. The interview schedule was used as a framework for the interview. All the interviews were carried out at places selected by the participants themselves. Four of the interviews lasted for around one hour each while the three others lasted for one and a half hours each. The nature and the duration of the interviews allowed the researcher to establish a good rapport with the participants. The interviews were carried out over a fifteen day period in August-September 1995. A verbatim transcription of each interview was typed and sent to each participant for validation (Appendix M).

Data Analysis

The data analysis was done in four main steps. First, the data were categorised. Second, they were synthesised. Third there was a search for pattern. And fourth, the data were interpreted.

As soon as the first interview was done, the data were organised into themes and concepts relevant to the research questions and to emerging issues from the interview. From this first data analysis, the interview schedule was slightly modified. The process of collecting data, analysing them and adapting the questions from the interview schedule to collect new data remained an ongoing activity until all the seven interviews were completed.

After all the interviews were done, the information was classified and categorised. The NUDIST (Non-numerical Unstructured Data Indexing, Searching and Theorising) software system was used for managing and organising the research. The transcripts of the interviews were stored as on-line documents. NUDIST made it possible to study the documents in different ways. It was possible to index (code) segments of the texts using various indexing categories. This facilitated the search for words and passages of text. It also allowed for the re-organisation and extension of the indexing as the analysis proceeded. In fact, an index system was created to store the comments made by the participants. This index systems contained different categories which were put into appropriate nodes. It was then possible to build new indexing nodes out of these original nodes. NUDIST allowed for complex node building operations to be easily carried out

through retrieval operations. The node building and retrieval operations offered by NUDIST provided essential reliability.

The categorisation of the data was done according to the conceptual framework for the study of the utilisation of the design process shown in Figure 4 on page 27. The framework was used to identify relationship between categories using NUDIST, and to guide the interpretations of the data. An example of some of the hierarchical titles used for this study, together with their node addresses is given in Appendix N.

Limitations

This research has certain limitations. It is limited to metropolitan teachers of Western Australia who have been using a design process in the teaching of Design and Technology in lower secondary schools. In selecting potential schools for this research, the researcher referred to information compiled by Edith Cowan University. The information concerns only the schools which were willing to accept students for professional practice. Moreover, it was noted that there was a lack of information on how technology programmes were being implemented in Western Australian high schools. So, the subjective advice of Design and Technology lecturers and consultants has been taken into consideration at the early stage of the selection of potential schools where participants were to be recruited.

Another limitation is that the instrumentation used did not fully facilitate the participants in their explanations. For example, some of the interviewees had to use their mark books, the artefacts made by students, the worksheets produced by the teacher and other

support documents available in the eastern states to back their arguments. Copies of some of the documents were forwarded to the researcher to supplement the interviews.

The worksheets prepared by two of the interviewees helped the researcher to understand the importance the school placed on the design process. For example, in one case, the design process was linked with Stepping Out strategies, and in another case, students were using a design process to build a solar car for a competition organised by a Western Australian firm. However, none of the interviewees felt that it was important to either mention or highlight any of these points during the interviews.

The documents themselves replicated the ideas which the interviewees had been sharing about the design process. Because these documents were school-based documents, they validated what the interviewees shared about the teaching of a design process in the class.

As the researcher was investigating the perception of the teachers on the utilisation of a design process, it was not felt important to discriminate between knowledgeable or non knowledgeable respondents. The researcher lended an attentive ear to what the interviewees shared. On two occasions, interviewees mentioned the titles of publications unknown to the researcher at the time of the interview. While this lack of knowledge did not affect either the collection or the analysis of the data, the researcher found it useful to contact the named bodies to be better informed about points mentioned during the interviews. Thus, the researcher received relevant documents from the South Australia Technology School of the Future about their vision in technology and from the

Education Department of Western Australia about the trialing of the Student Outcome Statements.

Also, the research itself contains certain inherent limitations. The research was an interactive one. And the interaction had an influence on the types of questions and answers shared and also on the depth with which certain topics were treated with some participants. Certain questions could not be treated in depth with some participants because of their limited interests on particular issues. For example, it was inappropriate to question teachers from the private schools on the implementation of the Student Outcome Statements; it was also difficult to have in-depth discussions about holistic marking for example, as in practice, most teachers were still marking the students' work in a way incompatible with the philosophy of outcome-based education as specified in the literature review.

CHAPTER FOUR: RESULTS AND DISCUSSION

The Design Process

Research question one relates to the definition of the design process and how Design and Technology teachers view its different elements.

Definition of a Design Process

A design process is defined in its simplest terms as a type of practical, creative problem-solving activity. Respondents to the interviews described the process in the following way:

> I don't think it's 'the' design process type of thing. I would say there are many design processes ... The design process, as I see [it] being used in schools, is a cyclic iterative process that you use with children to help them solve problems. [Robin]
>
> For me it's the Design-Make-Appraise process. [Ashley]
>
> The design process is utilising the ideas that the students have within themselves. [It's] utilising a method where we can use research and sketches and development to actually come up with a final solution for a problem. So the design process is a means to an end in solving a problem. [Chris]
>
> The design process is about making things that work and then making them work better. [Nicky]
>
> The design process is part of technology and it is concerned with the improvement of artefacts. I see the design processes as part of how humans develop technology ... The design process, if applied to a product or an artefact or a system, is an improvement ... It's a continuous process. The design process is certainly continuous ... I think that the design process in itself is a type of problem-solving process, but in the context of technology. [Kerry]

The interviewed teachers shared different views on the definition of a design process. For example, Ashley relates the design process to the DMA approach proposed in the Student Outcome Statements (Education Department, 1994a), while Kerry puts

emphasis on the belief that the design process should only be viewed as part of technology. However, the teachers feel that the design process is a continuous one.

Characteristics of a Design Process

In Technology Education, this continuous process is a structured one. This structured process may be used flexibly or rigidly depending on the teachers' managerial approach or their perception about the nature of the process. For example:

> You can have a rigid process that you put in place and then a series of rigid design problems that you use in a particular classroom that would help you from a management point of view, but whether there would be any ongoing, transferable life skills, I doubt very much. [Nicky]

> I don't think children necessarily go in [a] sequential step ... The design process is not linear. It bounces all over the place. [Kerry]

In fact, Kerry perceives a design process as a non-directional one. In the literature review, Kelly, et al. (1987) stressed that this view may be consistent with the real design and technological activity going on in a classroom.

A design process offers a wide range of opportunities to the students. For instance, students may have the possibility to think for themselves and to make something desirable:

> [It's] getting them to think a bit more rather than just going slap bang into it and making something for the sake of making it. [Kim]

> So I can see that Design-Make-Appraise is teaching students to think about what they're doing and that's important. And that's a thing, I think, that people are lacking down here in Design and Technology. [Ashley]

Teachers are aware that too much emphasis has been put on manipulative skills. They now expect that their students would also use the mind in solving technological problems. In the literature review, Marsden & Marsden (1994) cited Professor Richard Kimbell who believes that the modelling of ideas with both the hands and the mind

remains an important capability in Design and Technology. It is interesting to note that participants in this research are feeling a need for more thinking to occur on the part of their students.

In Design and Technology, the design process allows students to plan their work from the beginning to the end. Moreover, the students are introduced to a wide range of skills including literacy and communication:

> They got to get [their] idea out of their head onto paper or verbally to the teacher. So, [there is] a huge amount of literacy skills there. So, oral communication, graphical communication, communication between peers - if they are working in group they need to be able to talk to each other. So verbal presentation skills are very important. [Robin]

This set of skills may produce cross-curriculum outcomes and these outcomes are in accordance with some of the aims of Technology Education presented in the review of literature (Australian Education Council, 1991 & 1992). Moreover, the literacy component has contributed to move the subject away from its position as a purely manual subject to one where students are also encouraged to use their thinking. The inclusion of the design process in the school curriculum is specifically viewed by the respondents as an element which brings educational credibility:

> It was a grasp to try to get academic credibility. I suppose if we go back to the ancient Greeks, we use to have the people who used to think, and draw on the sand [laughing] and stuff, they were the thinkers ... I don't think that's changed really, in society today. [Kerry]

> It's the only thing that gives us any educational credibility. [Robin]

It appears from the responses, that the design process has simply changed the appearance of the subjects found in the Technology and Enterprise learning area. This point will be raised in a later section on technology curriculum on page 79.

Elements of the Design Process

The models used by teachers vary, but they can all be reduced to a simple one which includes a designing component, a making component, and an evaluating (or appraising) component.

The degree of importance which the teachers placed on each of the above mentioned components could be associated with many factors, and varies according to the perception of the teacher about the nature of Manual Arts or that of Technology Education.

The designing component

The designing appears as a perceptible change in an area which has been traditionally oriented towards practical work:

> If you look at what's happening today in Manual Arts or call it Design and Technology, whatever you call it, the only significant change is that the children are designing the teapot stands and ... the garden trowels. Not the teacher ... [Kerry]

The reasons why the projects are said to be the same, whether or not a designing approach is used, have not been investigated. It is suspected that teachers do not want to move too far from skills and designs which are already familiar subjects to them.

The participants use different concepts to describe how children design. For the purpose of understanding the comments made in this research, the designing component has been subdivided into four different phases. Usually, in the first phase, a need is singled out. This phase is sometimes referred to as the Statement of Intent. The second phase is named Research and Investigation. The third phase consists of the Exploration of Ideas. And the fourth one is the Synthesis phase.

Of these four phases, the research phase is considered as fundamental to the design process. Proper research is viewed as a *sine qua non* condition for successful design. The ability to do research is a competency which teachers want their students to master. This subject matter is raised again in another section on the relevance of the DMA approach on page 57. It is also felt that time and energy are managed efficiently through appropriate research. This point of view is shared by Kim:

> The research I think is very important. And, without actually going and researching what you're making, you can go ahead and make mistakes, and therefore you have to start at the beginning again. If you don't do proper research then you are wasting your time, in the wrong way. So I would place a strong emphasis on the research part of it.

Another participant explained that investigation and research produce a ripple effect on the students. In using a design process, students who are initially motivated exert a positive influence on the less motivated ones. In this context, Kerry gives the following testimony:

> In year 8 you've got kids from the low academic stream right up to the extremely high academic stream. And when you push them to research, when they are doing it themselves, these bright kids love it. And it's a huge success because of that, and the lower ability children tend to lift themselves when they see the standard of the stuff and enjoyment the other kids get out of it. [Kerry]

This enjoyment acts as an impetus and it keeps students motivated in their research. The motivation enables them to investigate the different parameters of design, including shapes, forms, sizes, materials, and time:

> So we might say with a year 10 year or year 9 woodwork class we are going to design a spice rack, so you take in different types, sizes [of] glass jars and so the students within these parameters of sizes, of materials, design [their] own spice rack. [Ashley]

In carrying out their research work, the possibility is offered to the students to link their design to the real life situation. The students explore factors such as safety, aesthetics, and ergonomics:

> You'd research the type of material that's best suited to [the artefact,] you would look at the cost factor that you had to work with, the aesthetics, whether or not you wanted it to fit in with a particular decor or not. [Chris]

The research phase can occur in different ways depending on the need of the group of students and on the preferences of the teacher in terms of teaching methodology:

> Research may simply be talk-to-me and talk-to-the-other-kids, any form of research where you are asking other people's opinions. [Lesley]

So, from this point of view, research is both investigation and communication. The contribution of teachers in doing research work is valuable. Teachers often participate actively in the compilation of information and ideas. This research activity may extend outside their school time. Teachers may compile newspapers and magazines which are used as a research bank:

> Whenever I see something in the newspaper I tear it out, and put it in [a file at home] if I think it is a good idea ... That's my job as the Design and Technology teacher. I'm doing things like that all the time ... That's like an on going thing, even, coming down to the point of a Saturday morning, I flick through the paper, I see things, and I would tear it down ... It might be a dining room table or a hanging basket or an idea that I think I could use at school. I cut them out and just put them in [my] file. I mean it's very random sort of thing and I don't just sit down and research these things ... I know that there's going to be time that I would need [these ideas, or else] a student [may be] needing ideas and I would say: I've got something at home ... or there may be a time when I may need to make something myself so I've got that bank of ideas. [Chris]

The bank of ideas is useful for exploring ideas. This exploration may be done in small groups in an interactive way. The teaching of strategies like co-operative learning and brainstorming, which have been mentioned in the review of literature as appropriate for teaching problem-solving techniques (Christensen & Martin, 1992) are used by some teachers:

> Usually [the students] work in groups of two or three and they would all sit down and work out the plan of a model they want to make. They have combined different ideas, come out with a plan or model of what they want to do. [Ashley]

> Basically we explore ideas in whatever is the most manageable way for the problem that we've got to solve Then we make decisions about which ideas we're going to develop, depending on which [idea] the student thinks is the most satisfactory. [Nicky]

Based on what is explained above, it could be imagined that the learning experiences of the students about exploration depend to a large extent upon what methodology is used by the teacher. In practice it could be expected that during a research task everyone is kept active and interested. While Manual Arts teachers are familiar with such situations, not all of them are, however, willing to get involved in research work with the students.

In the last stage, that is, the synthesis phase, the students choose the most appropriate solution for the original problem:

> I have got to be able to see how [the student] went through this jellying down of 20 ideas into 10, into 5, into 2 into this is what I want to make. [Lesley]
>
> That's the beauty about technology, we find 'an' answer. Not 'the' answer. And that's one of the keys to it. There's no correct thing. There is [a] better solution but no 'correct' one. [Kerry]

Although one teacher listed serendipity as one of the ways of arriving at a solution to a perceived need or problem, it is not clear why the others made no mention of this way of solving problem. Still, in looking for a better solution to a problem, both the teacher and the students participate actively in discussion. This gives the students the opportunity to make use of their verbal and communicative skills:

> [With] year 8 students ... what I would do, I suppose, would be just a question and answer session. Getting them to respond to, and coming out with questions like say: what sorts of things do you think we should look for if we were designing a screwdriver? Do you think we should design a right angle screwdriver? Would there be any benefit in [this] design? ... Do you think the screwdriver should be of any particular shape? Should it be this shape? Should the handle be this shape to make it easy to hold and so on like that. And in that way, unconsciously, they are thinking about the design process. [Kim]

However, the approach used by teachers to introduce design is often inappropriate. One respondent felt that:

> The major mistake that our own teachers are making is [that] they will take kids into the classroom, and say: okay, you got to design a piece of furniture ... off you go and design it. And then they wonder why the kids can't do it. And many

> of the Manual Arts teachers would say kids can't design. Of course kids can design. They need strategies to help them to design. Adults don't design very well without strategies. And so the teachers role in this is to facilitate with the use of strategies, to develop those in kids. [Robin]

Indeed, the notion of the teacher as a facilitator of learning, as previously discussed in the literature review (Christensen & Martin, 1992), is compatible with the use of a design process and an approach based on student centredness.

The making component

The making is perceived as the *raison d'être* of Design and Technology (or Manual Arts) and as the core of the DMA approach. The making component is seen as a popular one:

> The kids they like to make; and they get a lot of satisfaction, a lot of self-esteem; [when] they have finished this model [they would say] look I made that. That sense of achievement that they can say: this is what I have done, they don't get [that] from paperwork ... Even though they might design something fantastic on a piece of paper, they think they still don't get the same sense of achievement or self-esteem out of actually producing the model. [Ashley]

The making or the production of an artefact is also felt to be an educationally valuable activity:

> [This component] to me that's very important. To do something with your hand, gets it into your brain quicker. Because not only are you doing it, you are thinking about it and you are watching yourself doing it. So to me you are doing three things at once. [Lesley]

Indeed, the literature review has noted the point of view of Piaget who believed that hands-on activities foster cognitive development (Woolfolk, 1993). On their side, the teachers note that the students are proud of the things that they design and make, for these things develop in them a sense of ownership and pride in creativeness:

> I think that's important that kids have some ownership in what they're doing, that they have had some decisions, that they have made some decision about what form their product is going to be ... [Nicky]

> I would say about 60% [of the students] really enjoy it. Having the freedom, just to add their own personality [to] the model. I suppose, their own touch in the model. [Ashley]

Teachers always refer to the ownership of ideas as an important concept in Design and Technology. In one sense, this concept of ownership of ideas has contributed to move the subject away from the traditional view which tended to notice the manual aspect of the subject only.

The creative factor seems to stimulate the interest of the students and they consequently make artefacts with design parts which appeal to them. In fact, the teachers themselves value this creativity:

> Because they've worked out what [the project] was going to be used for, the shape of it, it gave them ownership of the model, I suppose. It was their design, and it had their idiosyncrasies that they have done. Just the way they made the shapes, it's something unusual. [Ashley]

> They know they own that design, that is their project. It's not something that I've given them, [and] if someone is very good at design, then they will get recognition from the other students. [Chris]

However, it is of general concern to these teachers that the students often do not complete the work that they have conceived:

> One of the things that happens is that the students come up with all these weird and wonderful ideas, and I think that's a learning process. I let them go ahead and come up with all these cages and doors that open and shut, and bits and pieces that move; and then, when they come to make it, some of them start getting frustrated because they can't make it. And I sort of try and explain to them ... [that] part of the design process, when you are young, is that you'd learnt that you can't always manufacture what you've designed. [Chris]

> Under Design, Make, and Appraise approach ... some of [the students] do not get any product at all. [Nicky]

> [I know a case where a student] has spent half the year designing, making cardboard mock-ups, making drawings on the computer - and all of that is very valuable, but when it finally came down to making, his design was so bad, the whole thing fell apart and split apart. [Lesley]

The fact that students may not end up with even a single product at the end of one or two school semesters may be a hard reality for the teachers, even if proponents of the

design process may argue that the journey is more important than the destination. This concern will be raised again in the section on the resistance to change on page 52.

The appraising component

The third component of the DMA approach is the appraising component where the students and the teachers evaluate both the processes and the products made. Teachers use different criteria for evaluation:

> The evaluation is based on two things: are they happy with what they did? Did they do it to the best of their ability? [Lesley]

It was felt that the exact position of the appraising component within a design process is not fixed. Appraising (or evaluating) may be either at the end or at the beginning, or as an integral part of the other components (i.e. the designing and the making components). Kerry thought that

> Evaluation is throughout; right from the very beginning through the end you are making actual evaluation about things.

Ashley approached it more sequentially,

> With the year eight we mainly look at the appraise side of things and then [with] the year nine we bring in a bit of redesigning ... We have a worksheet that they [go] through when [they] finish [their artefact], to appraise the model, [they look] at things like functions, the ergonomics and the aesthetics of that model and make personal judgements I suppose, of their model they've just made.

The teachers highly value the educational importance of appraisal. Indeed, apart from learning new concepts, students also learn how to critically analyse their own work. Ashley summed up this feeling this way:

> They can give reasons why their models do not meet the requirements or the function they have actually set out to do. They can hold [the handle of the artefact they have made]. Oh, that's uncomfortable to hold, and it's uncomfortable because my hand is shaped and I bent [the handle] the wrong way here. So they can critically analyse what they have made; so they are learning how to critically analyse.

The appraising component is not limited to school projects. When students are appraising, they are learning a skill which is believed to be transferable to life in the future:

> If people can become conversant with assessing technology, then people will be able to make better decisions about its [appropriateness] in society and [we will] have decisions based on a sound judgement rather than fear and ignorance. [Kerry]

Summary

A design process is defined as a type of creative problem solving process which when used in Design and Technology helps the students to solve a problem constructively. The process is a cyclic and structured one similar to the simple loop model described in the literature review on pages 18 and 19. The process is also referred to as the Design-Make-Appraise approach.

Teachers view the design component of the design process essentially as the cognitive input in an area which has remained for too long associated with practical work. The making is viewed as a valuable and essential component. There is also a preconceived attitude that both designing and making may share a conflicting position inside the process, depending upon the teacher's personal preferences in terms of teaching methodologies. Finally, some teachers hold diverse views on when and how to perform an appraisal.

The Effects of a Design Process

Question two relates to the effects of the inclusion of a design process on the teaching methodologies and learning strategies.

First Encounter with a Design Process

This research has shown that a design process has been present in Western Australia for many years. According to one participant, it was once recommended under the name Project Planning, and it was used in Applied Technology. In short, the teachers agreed that the design process is not a totally new concept in Western Australia:

> Design, Make and Appraise although it's part of the Student Outcome [Statements] we have experimented with it before ... [The] Manual Arts curriculum review recommended [to incorporate more designing]. [Ashley]

> The sort of [design] process that I am using ... I don't think it's anything new ... This is what Manual Arts teachers have been doing since at least 1968, because this was our direction [as per the policy statement from the Manual Arts Teachers Association] back then. [Lesley]

> [At a certain time] I was English-oriented with the design process, dabbling in it because I taught upper school. Because we've been doing it since about the 60's, 70's. [Kerry]

Yet, the impact of the application of the design process in the school curriculum is not felt by teachers. Therefore, it is not possible to ascertain how effective the initial encounter has been. It is possible that it may never have been implemented in schools:

> Theoretically we have had the design process in our upper school subjects for years ... Theoretically it should have been happening in schools for the last ten or fifteen years. [Robin]

> The actual philosophy of teaching from technology perspective have been around for a long time. In 20 years. But nothing much has happened. The majority of teaching is still, now, in our area, exactly as it was 20 years ago, only probably not as rigorous. [Nicky]

The Resistance to Change

The attempts to utilise the design process in school are being met with resistance in Western Australia. A perception prevails among Design and Technology teachers that the future of their subject is at risk. Lesley is convinced that there are political moves to phase out the subject:

> This push to lessen the skills-base of our course and going more and more into the design, I see that purely as governmental cut backs. We are an expensive subject to run and they want to kill us. They want to turn us into more of a theory subject, so that we don't cost as much, [and this] is going to alienate 70% to 80% of the population of the school. [Lesley]

The DMA approach is also a threat to those who use a trade approach in teaching. Nicky feels that this is so because a lot of Design and Technology teachers have successfully been teaching, using a trade approach for years:

> Let's be realistic about this [situation]. While you have got 32 periods a week, and 22 kids in a workshop situation, and you know they are not all model well behaved students, in fact hardly any of them are, your main thing is about survival and while you are surviving, while you are struggling to survive, teaching the way you always taught to the best of your ability, you are not going to embrace a whole stack of change ... It will [be] like, being a first year out teacher again, because you are asking people to get out in front of their class and teach something that they have not been taught how to teach. They don't have the basic skills; they don't have the understanding; and, in many cases they don't even believe in it.

The teachers base their reluctance to change on errors apparently committed by some countries in introducing a design process in schools. For example, the English encounter with the design process is cited to back arguments against the use of this process. Critics of the design process have already been mentioned in the literature review (Massey, 1992; West, 1989; Wright R.T., 1993; Wright, 1994).

> If you look at England, they went to an extreme where they threw out all the practical side, and basically went to design and cut out with cardboard and that sort of thing and it did kill the subject. The students hated them. And yet, we haven't learnt from that experience. [Ashley]

> England did that 15 years ago. It's failed. They are now moving closer to our [Australian] system. And what are we doing while they're doing that? We are going to make sure that we fail too. Just to prove that we are better than [the English]. [Lesley]

This fear for the future of this subject is a constant preoccupation for many of the interviewed Design and Technology teachers:

> Just on Friday I was talking with some people down in Nearbyarea and our biggest concern was that, if we went in the direction [of] Design-Make-Appraise

or the DMA Enterprise and Technology as a whole rather than Design, Design Technology, Home Economics, Information Technologies [being] completely different subject areas ... then jobs will be lost. There won't be the need for as many teachers and our subject area, as it is, will be lost. And so, it is a big concern with the teachers that that would happen. [Ashley]

Certainly, the DMA approach remains an ambiguous one for the teachers. On the one hand, the literature pertaining to this subject presents it as a process strand used to facilitate the achievement of the technology outcomes proposed by the Students Outcome Statements. On the other hand, it is perceived to be suspended like the sword of Damocles on the head of the teachers.

The Teaching of Thinking

Traditionally, students in technical subjects have not been encouraged to think. The thinking part of the design process was usually done by the teacher, and Kerry thinks this prevented any real learning taking place:

> Teachers in themselves have been doing what the kids are doing today for hundred of years. We would have seen a product and thought: that's a good idea I could use in my classroom. So we went away ourselves and went through the design process in our mind. And we used to do sketches as well, and then by the time it got to the children it was developed. So the real thinking and the real high level cognitive skills were done before by the teachers. The kids just followed a recipe, that the teachers had developed. And so what we were testing then, of the children, was their ability to follow a recipe. Not their ability to solve problems and understand. And that's where I believe the real learning is. Now the emphasis has shifted from that teacher-centred approach to student-centred approach, where that job previously done by the teacher, which was done really well, has now been pushed back to the children.

The shift from a teacher-centred approach to a student-centred approach is not, however, taking place smoothly. According to teachers, the students who have a short attention span in the lower school do not want to spend too much time on design. So, Kim sees that one of the main objectives is for the teacher to initiate them to think:

> I think even if you get them to think a little bit, you have done something on the way of the design process. If they are thinking before they go and make something, if they are just thinking a little bit then, you know, at least they have done some sort of work on the design process in their head.

The use of the mind appears to be an indispensable condition in learning problem-solving. It has been noticed that teachers introduce students to unconventional ways of thinking:

> [For one spoon project] I try to start to get them to think laterally. Like I'll bring in Woman's Weekly magazines from the library, and they'll be looking through initially for pictures of spoons and I'll say: No! No! No! We don't have to look for pictures of spoons. We can look for something that we can use, an element of [a] design like ... a flower that you may be using in your handle or it could be a part of the Sydney Opera House ... maybe a treble clef symbol off a music score in the magazine. [Chris]

Despite the belief that lateral thinking fosters the development of cognitive abilities, Lesley thinks that the teaching of lateral thinking is not an easy task:

> [The students] either have the ability to think laterally or they don't. You can give them opportunities to try ... it's like the old saying: you can lead the horse to water but you can't make it drink. We should give the kid the opportunity to try but it should not take over their schooling.

When they are given opportunities to use lateral thinking, the students come up with strange ideas. This situation may be viewed as unusual, and Robin advises teachers to be open to this unusual situation:

> Even if their ideas might be a bit bizarre, some very bizarre ideas have ended up being some very good design solutions.

In fact, creativity may be developed as a side effect of problem solving activities:

> One of the spin-offs of the design process is that the kids' creativity is developed in some more than others. [Kerry]

Still, this research showed that most teachers believe that the students do not like to think:

> 40% [of the students], perhaps the low ability students don't like [to think], because they like to be told: this is what you are making; this is the plan for what you are making; and, this is how you make it. They don't like the freedom to change the plan ... They like to be told what to do. [Kim]

The teachers' perception about what students really like or dislike is based on their own opinion. Indeed, students may have a negative reaction about designing because they are not used to it and they have never used a different approach to Design and Technology. In fact, students have been used to make what the teacher had already designed. Moreover, in a sense, the design process appears as a revolutionary concept which cannot function in an old setting. For it to be fully implemented, existing teaching methodologies will have to be radically changed to fit a student-centred type of education.

Coupled with the students' perceived unwillingness to think, students are said to be reluctant to make decisions even when they are offered the possibility of choosing their own project:

> Most of the kids would sit there [and say:] but what am I going to make. And you say: well anything you like. And they also beg: please give me a plan, please give me something to make. [Ashley]

Ashley's observation seems to confirm the point that the students have been so exposed to a particular way of doing things that they may not feel confident enough to operate differently. Viewing the problem from another perspective, it could be said that the ones who should change are the teachers themselves. If for example, the students are given the knowledge of how to produce a plan by themselves, there may be no need for them to rely solely on the teacher. However, the research has noted that only a few studies have been done on the development of critical thinking in technology education. This makes it difficult to back the point that problem-solving skills may be easily transferable.

Relevance of the DMA Approach

In Manual Arts, traditionally, every student makes the same product, using the same materials and the same dimensions. Chris compares teaching in Manual Arts with teaching which is done in kindergarten:

> The way that we have taught Manual Arts in the past [is similar to the way teachers] taught Art at kindergarten ... They'd draw a picture on the board and they'd say: copy this, this is how you draw sun, now copy this down. This is how you draw a hill, draw this out, so every kid would take home a drawing exactly the same.

By contrast, when a design process is used, the end product is much more diversified, and from this emerges the individual talents of each student:

> I think [the design process] teaches [the students] to realise that there isn't always only one way of solving a problem. I think it teaches them that the teacher isn't always the person who has the answers. That we can give them some resources and we can give them some skills and guidance, but [that] within themselves, [they] have got a lot of ability to come up with their own unique idea. It gives them self confidence to think that they may come up with an idea and make it and see it through to the final product being completed. [Chris]

The teachers tend to invest much time and energy to teach students the concepts of the design process, because they feel that students lack an early contact (at primary level) with the design process:

> There are not very many students, capable of going out and designing a project, unless they have had the design process, started right from primary school ... And I think once [we start with the K to 12 curriculum] then they may be better when they come to high school, and they may have more ideas about the design process. But at the moment, we are still, to a large extent, helping the kids in their design part of it. [Kim]

Certainly, the design process is not seen as an easy concept to teach:

> I really think that the design process is an extremely complex issue and a very high order cognitive level. [Kerry]

The literature review has already pinpointed a study done on Western Australia which stressed that students need strategies to be able to solve design problems

effectively (McGirr, 1985); but, not much is known about what goes on in the mind of the student who attempts to solve design problems in technology education.

From a practical point of view, Ashley sees the use of the design process as being a time consuming activity:

> Because doing student outcome and also the Design-Make-Appraise, you do lose a little bit of time because it takes that time to do the design process.

However, the general consensus is that the DMA approach is perceived as being purposeful:

> I can see Design, Make and Appraise is important in that that's teaching the students to think rather than: here's the model, make it! [Ashley]

Robin concludes that, through the design process, students learn to master a new set of skills much more relevant than those offered by the traditional Manual Arts course:

> [The things that I include in] my courses are those things: that kids know how to access information, they know how to do something, to analyse that information, and synthesise it, and utilise it in some effective way. Now, if I have taught kids how to do that, then I have won.

The set of skills or competencies mentioned by Robin fits well within the aim of technology education as proposed by the Australian Education Council (1992) which is to make the people in Australia technologically literate, innovative and resourceful, skilful and responsible.

The Training of Teachers

Responsibility of universities

This research showed that a design process was not taught in all Western Australian schools, in part because of the teachers' initial training and that current pre-service teacher training was still inadequate. It was felt that most, if not all, of the lecturers did not have a background either in technology or in the design process:

[Most of the lecturers] don't understand what technology is about. It's not overlaying the design process on what we do now. It's changing the entire thinking and I don't know how we do that, unless we have a complete outlook. [Robin]

None of us have been trained to teach from Design, Make, and Appraise perspective. Even students coming out of tertiary institution now have not. I had them here as long term prac-students, they are not prepared at all. [Nicky]

So rather than rock the boat and have an unpleasant working life, it's easier in the Australian way: I will slide in with, do the same as the rest, and I would dabble a bit in this new technology. And that's what happening at the moment. The younger ones are dabbling. [Kerry]

Thus this situation reflects what is being done at lower secondary school level. Moreover, as the Student Outcome Statements are still in draft form, the teachers are not sure about the proper method in which technology should be taught in schools. And although both schools and universities are trying to combine some new ideas on outcome-based education with traditional teaching, they still have to teach the traditional approach due to lack of direction from the Education Department.

The fact that some of the Manual Arts teachers come from trade backgrounds and were employed at a time when the Education Department was short of teachers, was posited as another reason why certain people may find it hard to teach the process:

Some of our Manual Art teachers are barely literate. [Robin]

When I went to teacher's college I realised that grammatically I was ignorant, most kids in primary school were better at grammar that I was, and I had to take grammar courses at teacher's college, to learn English grammar. For god's sake I was born in the country. I have never known any language other than English. Yet, I didn't have a good comprehension of English grammar. [Lesley]

Role model

Finally, because it is a common view that the design process and Technology are not being properly taught, there are no role models or curriculum change leaders who are prepared to risk that change:

> I don't think that we have got the role models there ... There [are] few true real role models out there. [Kerry]

> Unfortunately there are not too many [curriculum change leaders] around. The ones probably that are ... they get sent to the country: they can't get back to the city. [Nicky]

> I would say [out] of the 600 Manual Arts teachers, there would probably be at the top of that 20% who may be [even] if they haven't had any pre-service training in technology, but [they] have an inherent understanding of it, because they've got that sort of mind. [Robin]

Still, Kerry and Robin felt that Manual Arts (or Design and Technology) teachers have the knowledge and skills to solve problems and to do the design process:

> Manual Arts teachers have an enormous wealth of knowledge to draw on. They can solve problems. [Kerry]

> How are we going to do the design process when the only people who have any idea about it, and they deny it, are the Manual Arts teachers? [smiles]. [Robin]

Summary

The research found that the design process has not apparently affected the lower secondary school curriculum albeit recommendations were made in Western Australia more than twenty-five years ago. The inclusion of the design process in schools is still being met with resistance. In fact, some of the users of the design process are not totally convinced about its suitability and they view the move to using design with suspicion and fear. Moreover, teachers have an apprehension that if the process is fully implemented, the teaching and learning of manipulative skills will disappear.

A salient feature of the design process which emerged from this research is its effect on the teaching of thinking to students who traditionally have never been exposed to thinking strategies. Teachers feel that there is a scarcity of curriculum change leaders in schools. Resentment is felt by the teachers who blame both the teaching institutions and the Education Department for their inefficiencies in devising a proper teachers' training scheme for the teaching of Technology. This creates a situation where teachers feel alienation *vis-à-vis* this new technological approach. This research also found that there exists a hidden feeling of anxiety concerning a perceived lack of leadership and direction on the part of the teachers.

Assessment of Students' Achievement

Question three relates to how teachers assess students' achievements in Design and Technology.

Assessment

Quantitative assessment

Quantitative assessment is one type of assessment done in Design and Technology. In quantitative assessment the teachers look for specific skills. These skills are linked with certain criteria which are chosen by the teacher. The teachers usually break the different skills into manageable portions to which a certain amount of marks are allocated. Nicky gives some detail about the example of a break down of marks for a specific project:

> Before we started the actual project, I would have told the kids that I'm going to assess [the given] project on these criteria: you might be going to get ten marks for your thinking skills and I'm going to look at how original your designs are; I might give you ten marks for your actual sketching ability; I might give you ten marks for your technical drawing ability, if we're going to actually do a technical

> drawing of it; I might give you ten marks for sawing; ten marks for your chiselling and so on.

This research found that it is this breaking down of the marks (which appears in the teacher's marks book) which can show exactly what the teachers look for when they assess the students' achievement in Design and Technology. The parcelling of the school project is also done to monitor attainment of certain specific objectives:

> For the actual production of the model I will say the objectives way [as proposed in the Unit Curriculum] will be easier [than with Student Outcome Statements] to mark. Because you can look at the model and say: that's been joined well or that's been finished or filed well. So you can look at specific things rather than general. [Ashley]

> They get a mark for the marking out; a mark for the fit of the joint; a mark for as well they've planned it; a mark for the foil on the back; and then, a mark on the wheels. [Lesley]

While some teachers consider it important to detail their markings, Robin considers that the breaking down of the marks is not useful to everyone:

> Teachers are assessment locked. It's not the fault of the Education Department or [of] the system to mark as much as they mark, or assess as much as they assess. Teachers do it because of their own lack of self-confidence I think. There is nothing in the Unit Curriculum that says people have to assess every piece of work that kids put through. They create the rod for their own back. [Robin]

Still, some teachers feel that the breaking down of marks may serve certain purposes such as being fair to students:

> Why I go through all [these] hours of marking and adding all of these numbers up at the end of the term when I could just go through [the works] and grade them. Because you know what students are likely [to achieve, even though] you always find there will be one or two surprises either up or down. And I think, that's being fair to everybody. [Chris]

Apart from the element of fairness, the marks also serve as a basis to justify how assessment was done:

> I find that just looking at something and saying: yeah, that's just an A, is perhaps, especially if you are young teacher, first out of college, if someone comes back and say to you: why did you give that an A, why did you give that A, B or C? It

also gives you somewhere to go back to and say: look this is the breaking of the mark. [Chris]

Chris also considers that the breaking down of the marks may serve to identify and to locate where students went wrong in a project. Thus learning is enhanced:

> You can say to the students: this is where you were able to pick up a mark, this is where you perhaps need to improve next time ... I think that perhaps the most important person in the marks processes is the student ... We are not just marking to put a mark on a report sheet, at the end of the semester. The marking should be a tool whereby the student can learn from that. Say, [s]he's made a mistake or if [s]he hasn't done as well as [s]he could, [s]he needs to know where [s]he can pick it up, where [s]he can pick up on [the] marks. And if there is a student with you when you're marking [you may say:] so I'll give you 4 out of 5 for finish; hum, your accuracy at marking out, 3 out of 5, because this was not quite square. It helps to convey to the students. And I think they are the most important people really, aren't they?

It has not been possible to understand the rationale used in marking a project in detail. However it is felt that this system of marking does have practical utilities, for example communicating with the student on specific points.

Qualitative assessment

A qualitative type of judgement may also be suitable when the teacher uses the design process. Qualitative assessment may be in the form of observation, discussion or questioning techniques:

> I do [the assessment] all verbally with the kids. The kids talk to me about what they are going to do and I simply wander round the room and observe them. Most of [the assessment] is anecdotal, most of it is just me wandering around, looking at who's doing the thinking. [Lesley]

Robin uses questioning techniques to work out what students are thinking:

> When they work through the design folio with me, I understand where they are coming from in terms of the conceptual development of their ideas. I know how much knowledge they've got when I start to work through from the conceptual stage to construction. [I] know, what sort of knowledge they have got there, how much I have to input, how capable are they if they say: how do I put this together. I say: how about we go in [the library] ... go and get some books and let's have a look at all the different joints that are available, and when you come back to me with some suggestions of joints, then we'll talk through those. I mean

> it's that's sort of assessment [that I am doing] so it's very qualitative in some sense. [Robin]

Holistic assessment

In using qualitative assessment, teachers make use of professional judgement. In a sense, professional judgement is a sort of holistic assessment. This research shows that the teachers believe it is possible to form comprehensive judgements about the performance of students:

> Teachers are able to form good judgements about where the students are after having worked with them over a semester period of time. [Robin]

> When you have a class of students for up to say a term, you could perhaps almost go through and say by the end of the year: I think these [students] are going to be my As, these are going to be my Bs, these are going to my C students, your Ds. You can almost pick them ... I just find as a teacher 90% of the time, you will know where the student is going to end up. [Chris]

The comments made by Robin and Chris corroborate with recent literature on the issue, namely that holistic marking is more reliable than marking each separate component of the design process. In addition, holistic marking is consistent with the move towards outcome-based education.

Using the Student Outcome Statements

The Student Outcome Statements are still being put to the test in a number of schools in Western Australia. So, the impact of the use of the DMA approach and the type of assessment most appropriate for Design and Technology have not been published yet. But a number of the teachers have made comments about the use of the outcomes:

> [Student Outcome Statements] is a monitoring tool. It's not an assessment tool [but] the politicians will force us to use it as an assessment tool, and reporting tool. It's a diagnostic tool. And that's what it is ... It tells you what kids can't do and tells what kids can do. [Robin]

Basically, the Student Outcomes Statements favour criterion-based assessment:

> The Student Outcome Statements just amount to: did the child have that ability to do it or not? Yes or No. Rather than Yes/No/Maybe. [Kerry]

While the Student Outcome Statements appear to be clear-cut, there is a perceived difficulty for the teachers in understanding how each different level relates to school grades:

> For me as a teacher, I will have to teach the student from level one to level eight and make sure I have told them everything that they would need to know, to enable them to achieve at a level eight and, it's just too much work. [Ashley]

> If you look at [the eight levels] chronologically. It's about one [level each] eighteen months if kids progress evenly. It will take about eighteen months to go from one level to the next. That means that the majority of the kids in your class for the whole year [is] not going to move a level, let alone, when you only got' em for six months for a special unit. Might be only one or two kids move up a level, so what you are going to say for the rest? [Nicky]

Nicky has pinpointed that the work expected from teachers is indeed viewed as a difficult and a time consuming activity:

> The level of the assessment and the whole reporting quandary [of the Student Outcome Statements] is so unmanageable. You could not possibly spend that amount of time assessing kids and still teach that a 32 periods a week. I mean, really what they are asking you to do, if you look at the letter of the law, is to spend as much time, if not more time, assessing as what you do teaching. There's not that many hours of a day.

Quality of work in Design and Technology

In assessing the work of the students, teachers have to take into account the quality of the product. The quality of work in Design and Technology is said to be of lower standard than work done in traditional Manual Arts:

> Kids produce a quite reasonable quality product [in old Manual Arts] and you don't get that same quality product under Design, Make, and Appraise approach. [Nicky]

Teachers will refer again to the quality of work in Design and Technology, in another section, when they will talk about students' need for a basic knowledge in manipulative skills.

Repercussions of Assessment

Learning by trial and error

The research has shown that the ability of students to cope with unsatisfactory achievements in their work is a concern for the teachers. Design and Technology is viewed as a subject where students may experiment with materials and may risk making mistakes without being ridiculed or feeling anger and frustration. Moreover, it is said that in Design and Technology, there is room to patch things and fix mistakes by certain techniques which are not available in subjects like Maths or English. Thus, mistakes may be transformed into success:

> I sit down and I explain [to the students] where they've gone wrong and it is not judgmental. It's not where you failed, let's just move, let's do this. It's: let's try and fix it up so that [what you made] look better. [Lesley]

Bringing artefacts home

Artefacts produced at school are often taken home:

> If they're making something that they are going to like, that they can see, this is going to able to be used at home, that's a motivation [to work]. [Chris]

The artefacts that the students produce at school are often used as a report to show to their parents. For the students who are constantly being punished at school for misbehaviour or poor academic performance, the bringing home of the product made in the workshop is a concrete example of what they can achieve positively in their school life. There is a perceived pride in taking things home, to impress the parents. A teacher feels that the bringing home of the artefact has lots of implications. These are mainly linked with their child's competencies and future job prospects:

> [If] the teacher saw it's good enough to actually let them take it off the school premises, it's pride for [the parents] as well. They realise: perhaps my kid, (s)he might not be good at maths or science, but perhaps (s)he is going to, one day, get a job, (s)he can do something. [Lesley]

For the teacher, the bringing home reflects not only the performance of their students but it forms an accountability link with the parents or the community:

> If you have got [the spoon made at school] sitting on the table, I mean, it can become a conversation piece. People [would] say: gee, where do you get this. No one ever saw a teaspoon like this one before. And, people will say: where do you get this and that ... [Chris]

For the teacher, the community outside the school should be informed about what is done at school. The teacher views the artefact as a way of describing to the parents what their students can do, in a language which is visible to them. This research shows that the bringing home is similar to an unwritten contract between the teacher and the community. Thus, the artefact produced in class has to obtain public acknowledgement:

> Nothing hurts me more, and it's happened a couple of time since I've been here, nothing hurts me personally more than to find a kid's job in the bin after (s)he's taken it out of the room [pause] because that means that (s)he's not proud enough of what (s)he did to take it home. [Lesley]

Recognition of student's performance

Acknowledgement of student's work is also a matter of concern at school. This recognition of a students' work may come from various sources. It may be peer recognition or recognition in the form of encouragement from the teacher:

> If someone is very good at design, then they will get recognition from the other students that they've come up with this really fantastic idea ... When they're working on their project, student will be coming around and say: gee, that's really good, I think I might change mine and make mine a bit more like yours. I'll will be giving them recognition saying: gee ... that's really a great idea. [Chris]

Participants were not explicit about the sort of ideas which found recognition from either the students or the teachers themselves. Chris accepts that ideas from upper year students may be adapted to design projects for lower year students. However the skills which are associated with these ideas are not mentioned.

> I even found that some ideas from [upper year] students [can be incorporated] in programs in prior year, in year 8 programs. Some of the ideas are very very good. [Chris]

Summary

Design and Technology teachers are primarily concerned about achieving specific objectives. Their tendencies to mark work in detail is based on a desire to be fair towards all the students and to have a concrete basis for monitoring students throughout the accomplishment of their project. There is concern about helping the students to achieve self-esteem and self-confidence. This research also found that Design and Technology teachers place a particular importance on public recognition of project works done by their students.

Teaching the Design Process

Question four relates to how the design process can be taught in lower secondary schools.

Clientele for Design and Technology

Students' characteristics

According to teachers, most of the students who choose to do Design and Technology are said to be students of low-academic ability who have a short attention span.

> The clientele for Design and Technology area, ... in lower school year 8s, 9s and 10, tends to be a reasonable mix I feel. Probably, tending a little bit towards the lower end of ability, whereas, say, perhaps in Tech Drawing there will be, the ... shift to the other direction, might be to the brighter end of the students. [Ashley]

> Oh quite frankly, we tend to get the non-academic kids mostly ... I would say that 70% or better of the kids in the class are the non academic kids who are going to end up in non academic jobs, the kids who may never like to go on to tertiary studies and probably [they] won't. [Lesley]

Because most of these students do not view themselves as potential applicants for university courses, they may adopt learning strategies which are different from those students who compete for university entrance. These students do not view secondary education as a spring-board to enter university. They tend to choose the subject, according to the teachers, because Design and Technology is viewed as a subject where they can have good fun. Furthermore students are not required to input much mental activity in the subject either in the classroom or at home. They have been conditioned to expect such an approach. This conditioning is explained by Robin:

> The kids are spoon fed. They live in a world of electronic visual imagery. They do very little analytical, or critical thinking ... very little independent working, thinking, planning and it's hard work. And they have never done homework in Woodwork. And now we want to come down and make things with the hands and now you are telling us we have to do some writing and some research and some drawing before we even get into make things. And they didn't like it. It's

> sheer laziness ... [The main reason for this laziness is that] we've pampered the kids for so long, particularly in Design and Technology, because we fight for numbers. We haven't got a captive audience so we virtually do things that the kids want to do rather than what is good educationally.

In Design and Technology, the students are also viewed as behaviour problems. Some of them have trouble in all the other learning areas. They get involved in rows. They have to carry behaviour monitoring sheets with them, and they often get suspended from school as Lesley recounts,

> I have got kids here who were holding knives to kids straight out in the playground ... There [are] kids that I have coming in here who have been in trouble and suspended in every single room, in every single area in the school except this one.

The influence of the personality of the teacher on the student may be a factor which contributes to the fact that there is a perceived improvement in the behaviour of the students. On the other hand, it could be that Design and Technology itself gives an opportunity to the students to show their potentials in a constructive and creative way.

Selection procedure

Teachers know that the clientele which comes to Design and Technology is not the result of chance, but rather is the direct consequence of a selection procedure at school. This research has shown that the whole selection procedure may not offer much choice to the students. Initially, there are certain academic (or scientific) subjects which are outside the reach of the low-achieving students and the sole alternative is to select a subject from the optional list offered by the school:

> You might end up with twenty-two kids in that class. But only eight of them originally want to do it. The others have sort of been shifted from other areas, subjects which didn't run. So they just filled the vacuum. So I mean, theoretically, you would have a class of kids all here because they choose to do it, because they want to do it. But, in the reality of the school situation, that does not occur at all. A few of them wanted to do it and that's why it's still stay in the curriculum, and the rest got stuck in there. [Nicky]

Students' reasons for selecting the subject

Students are said to have a pre-conceived idea about what is done in Design and Technology. They think that it is a subject where the only objective is to make concrete things. This view is shared by most respondents:

> The kids [who are] coming in here come in for different reasons. Some come in here quite frankly because they don't like any of the other options that are available on, at that time. Others just like that making ... They want to make something. [Lesley]

> They don't like the paper work. They go to Maths and they sit down on a desk and they write all day. They go to English, they sit down on a desk, and they write all day. They go to Social Studies, they sit down on a desk, they write all day. They like the change. They like standing and making things. And if you take that away, students don't like the subject. If you make students sit down and write more, or if the students see the course as more written than practical, they don't like it because they have had enough of that. For the rest of the day they enjoy the change of making things and the practical side of it. [Ashley]

Some students choose certain subjects for their relevance to future job prospects. For example, Technical Drawing is chosen because it may be useful in an engineering career:

> [Students choose to do Technical Drawing because it] is linked with engineering ... so you get a lot of those engineering type students, the brighter type students doing Technical Drawing whereas they don't see the relevance of doing Woodwork and Metalwork. [Ashley]

But not all technical subjects lead to engineering careers. For example, other students may choose Industrial Workshop because they want to be manual workers:

> One boy decided that he wanted to make some sort of toolbox [because] he's going to be a tradesman. He knows he's going to be a tradesman. His dad was a tradesman before him, and it goes back multiple generations. He is quite happy with his decision in life. [Lesley]

The results also show that the selection of subjects may be linked to gender issues:

> Genderwise we may have in a class of [eighteen students doing Woodwork or Metalwork] you might if you are lucky to have one girl in the class. Except for jewellery of course. The jewellery is the other way round. You might have a class of seventeen girls and one boy. [Ashley]

Furthermore, the curriculum which is proposed to the students is questioned as being one which attracts only a special clientele for Design and Technology:

> And yet [teachers] don't actually look at the curriculum itself, and say: oh perhaps this is the curriculum that attracts them ... [Kerry]

Traditionally, the school curriculum contains an inherent bias in that it favours academic and scientific subjects which rank at the top of the list. In practice, the technical subjects are chosen by the less able students. These technical subjects put emphasis on the development of motor-skills. Thus the syllabi for these subjects have been designed to cater for the needs of the less performing students. Design and Technology has retained much of the vocational aspect of old Manual Arts. This situation accounts for the fact that basically, the course contents have not been significantly altered.

Learning Experiences

Teachers experimenting with different approaches

The curriculum proposed for Design and Technology is one which is not clear. Teachers are trying to manage changes such as the inclusion of technology in the curriculum or the move towards outcome-based assessment. So, in the teaching of the design process, teachers are faced with many concerns. One of these concerns is to get the students interested in what they are doing at school:

> I only really want to equip the kids, at any one time, with the minimum amount of information they need to know to get on with the job so that they stay interested and excited and they've got some ownership in it and I haven't sort of bored them to death. [Nicky]

Another concern is which type of approach should be used to expose children to techniques of design and to have a good knowledge of materials. Teachers are trying different approaches. One of these approaches is the trial of a tri-cycle arrangement

where either a woodwork or a metalwork or a design teacher will have a group of students for a number of hours every week on a rotating basis. The main problem generated by this arrangement is that it is difficult to relate each bit of knowledge in a natural and harmonious way because each group of students would have been exposed in a different order to each of these bits of knowledge:

> [We have three different groups] ... So [group] A1 comes to Design Drawing. [Group] A2 goes to Wood. [Group] A3 goes to Metal. And then that group moves around. So, in say group A3, I don't see [the students] until the third week into; so they have already done some materials and have not done any Design Drawing. So you can't do a design folio related to the materials because of this cycle ... [Robin]

A third concern is the teaching of design as an alteration of one part or more of an existing artefact. In these situations, the teacher designs a piece of work, and the students are allowed to modify it either partly or wholly.

> The design that I started with my lower school kids is simply alterations ... I give them an exercise which is a basic exercise. They all have to do it. But there are parts of it where I say: what do you want to do here? [Lesley]

A fourth concern is to introduce the students to different concept and technique options in designing and making. The teachers have found that teaching the design process is a dilemma. They are unsure whether or not to teach design first or to teach psycho-motor skills first. In a school situation this may create confusion as far as the most appropriate learning experiences should be. Ashley's solution to this problem was to teach the students three different processes and to allow them to use any of these options in their design under specific criteria:

> We have just finished making a garden tool and I have given them two different types of metal ... I have shown them three different ways to join those two pieces of metal together and then [said:] based on your knowledge on how to join these pieces of metal together, I want you now to design a garden tool ... and join the two pieces of metal together in one of the three ways I have shown. So they have the options then, and the flexibility as well, to make their own model that suits them and use the appropriate jointing. [Ashley]

Basis in skills

Material knowledge is viewed by teachers as a prerequisite for the teaching of a design process:

> I don't believe that we can expect kids to design well, or even to design poorly, without knowing anything about wood or plastic or metal, without having any materials knowledge. So my personal belief is that we should be giving the kids the basis in skills. [Lesley]

Each teacher invents an approach most suitable to the students' needs and to the school environment and resources:

> I don't think you can just teach design-design-design, because the students need at some time to learn the skills, and sometimes the best way of teaching the skills is through a selected project which you know is going to cover all those skills. [Chris]

> We do a skill-jointing exercise which I say to them is my way of knowing their hand skill at the beginning of the course. [Lesley]

> In Woodwork ... I actually get them to practice some basic skills on a piece of wood first, to get an idea of the materials and processes and their own level of skill ability. And then we look at their talent and try [to] get them to design something they can sort of make, having got an understanding of the materials and processes. [Nicky]

> With my year eights, early this year, they only do one semester one period a week. Most of their projects are sort of a lock step project, skills orientated, but towards the end we get them onto design, where they make a train, and then they actually have to make a carriage to go with the train they've made. So they've made the train and they've learnt the skills, and then they've got to design a carriage. [Chris]

> The importance of the skills is that as they go through from year 8, year 9 and year 10, they are building a repertoire of skills that they will then be able to use for upper school year 11 and 12 to make much more complex models or tasks. If you haven't got a skills-based, and you come into year 11, to make a model it is extremely difficult to produce a quality product [to satisfy the] high level standard required by the SEA. [Ashley]

In general, the teachers feel that students need a repertoire of skills to be able to start design properly. However, none of the models of a design process described in the literature review put stress on the necessity for a background knowledge in manipulative skills.

Based on what the teachers have shared, it is understood that a non-directional model of a design process is appropriate to that level of students. This may give them flexibility to start the process at the manufacturing stage for example. And then, they may either go to the ideas generation or the appraisal stage, or to any other stage, depending upon how the class respond to this type of learning experience. It is also understood that the teacher may be faced with new managerial challenges.

Modelling

Modelling is used to help students make up their lack of competence in drawing:

> [I provide them with] modelling materials such as cardboard, foam, sticky tape, glue so they can actually work much like they did in primary school ... We might make a series of models ... we have to keep all those models, we might then draw the model in some form so we've got a record of the models, and then break the material down and re-use it. [Nicky]

Modelling is not restricted to the use of modelling material only. Drawing is also viewed as one form of modelling. Teachers are concerned about the the type of material to be used for modelling. However, the real issue is that, in the literature review, the modelling of ideas in the mind and the modelling of ideas in reality are viewed by proponents of technology education as the cornerstone of capability in Design and Technology (Marsden & Marsden, 1994).

Physical resources

Modelling is also done on computers although computers are not primarily or solely used for this purpose in Design and Technology. In fact, students use computers for drawing. Still, teachers fear that basic (manipulative) skills will be lost:

> [Most of the kids] are going onto CAD drawing, Computer Aided Design drawing. I think that their sketching techniques are going to suffer. We've got to watch that we don't loose that ... I think we have got to be very careful, because, if the kids can't even sketch what their ideas are on paper, then we're lost ... Your initial sketches have got to be put down from the brain to the paper. And then it goes from there to expand on the computer, which is okay ... I think there's a fine line, that if we go too far on the design process, we are going to

I lose that on the skills, some of the traditional skills, not only on the sketching side but also on the hand skills from Woodwork and Metalwork for ever. [Kim]

> I haven't been taken down to use the computers, but [for] quite a few students that hand their design brief in, there is work that has been done on the computers. Some have even [used] drawing packages to do their sketches. I've been quite impressed that they're using the computers. Now both for the presentation and also for their drawing. I find though that you've got to be careful not to be swayed too much by the fact that some kids presented his all on a computer ... It's really the ideas that you're looking for. [Chris]

The integration of CAD and folio preparation is becoming a reality in schools which are sufficiently equipped with computer resources. The computer is taking over certain repetitive tasks; and in the design area, it also guarantees a reasonably high standard in the quality of the drawings or the presentation of students' work. However, this issue was raised by teachers from the private schools only.

In their search for ideas, both the Design and Technology teachers and the students are using the library more often. Indeed, students are encouraged to do some research before actually making a project:

> I take the children a lot to the library. I set them problems and I take them away from the workshop environment into a place that is intrinsically a learning environment, seen as a learning environment, where there [are] lots of resources ... Previously, Manual Arts teachers have never ever been into the library because it's traditional. [Kerry]

It was traditional also for teachers and students to compartmentalise places for practical work into wood workshop and metal workshop. This research found that composite rooms are not yet a reality in many Western Australian schools. However, because of the nature of the DMA approach, teachers are considering the necessity of setting up composite rooms. Still, this research did not find that it is an issue, as most teachers are still teaching Design and Technology from a one-subject approach:

> If you are looking in particular at a Design-Make-Appraise approach, a composite room would be a good room for [composite projects]. But I think

> [that] in the early start in year 8 and year 9 in your skills teaching, you would need to make sure that you taught the kids that [the different materials] actually go together ... Otherwise [the] kids themselves tend to separate [these materials] in their mind. [Lesley]

This view of Lesley may not be generalised. Still, it shows that, from the teachers' perspective, students appear to have pre-conceived ideas about what is expected from them in Design and Technology. Certainly, the students in Design and Technology may have been exposed to ideas which are no more relevant to the direction taken by technology education.

Needs

Support documents

Teachers believe that an urgent matter which should be resolved for teaching to be effective is the provision of curriculum material for teaching:

> There is no [technology support document in] Western Australia ... And to me I don't know whether it's arrogance or ignorance, but no one up there in that central office seems to [be concerned about this matter] ... because it's going to cost them money. I don't know how we are going to get to Technology if we don't know what we are teaching to get there. [Robin]

There is a perceived need for curriculum writers who have a solid background in the subject. At present, teachers view most curriculum writers as being people who are cut off from the day-to-day reality of the school environment. Both the credibility of their actions and the validity of their work are questioned:

> The people who have put together [Student] Outcome Statements in the main, are not teachers. They are sort of politicians and professional career curriculum people. You know, if they have written the course and then went into a school for three years and taught it successfully, then a few more people [would] want to listen to them. [Nicky]

There is a perceived view among the teachers that the curriculum should be provided to them. However, there are examples of people who are working on syllabuses and support documents which are best suited to their school and community. In this sense, it

may be expected that more and more teachers will be involved as curriculum developers inside a team at school or in the community.

Teaching graphical communication

Another urgent issue which it is felt should be addressed concerns graphicacy or the ability to communicate graphically. It may be that the student is not able to communicate her or his ideas and therefore the teacher is unable to assess the student work properly as the student cannot detail her or his problem solving procedures in a clear manner:

> The kid ... may be solving the problem in the mind, but he may have a problem, he may have trouble with his fine motor-skills and his sketching and so on, getting his ideas on the paper. He may have these brilliant ideas, but actually getting them down onto paper [may be difficult]. And we can't assess what's going on in his mind. We can only assess what we have seen coming out of the paper. [Chris]

In general, the teachers are fully aware of the students' inability to express themselves graphically:

> We have to be very careful about limiting the creative process to a kid's ability to draw, because most of them can't draw very well. So you have to look at other ways of them communicating what they want to make besides the drawing. Otherwise you block off 75% of the kids because they can't draw. It's very hard to get kids to draw something they haven't yet invented. [Nicky]

> Quite often, I do the drawing for them, a bit like the old police identikit thing, you tell me what you want and I will draw it for you. So they feel that success. They can see their ideas going on to paper. And then the next time they're usually more confident to give me a drawing. [Lesley]

> It's very hard for anyone whether it's a child or an adult designer to actually take the idea that's in their head and communicate it to someone else who does not have the same sort of knowledge. [Robin]

> One of the skills, the earlier skills we should teach, if we are going to teach this design process successfully is to be able to have the kids express their ideas quickly. [Kerry]

The views shared by the participants clearly indicate that there is an urgent need for students to learn how to model their ideas. When this issue is solved, it is expected that students will have acquired an essential tool towards technological capability.

Technology Curriculum

The Technology and Enterprise learning area

The success of the design process in school depends mainly on an educationally relevant technology curriculum. There is a perceived suspicion amongst teachers that the design process has been included in the Technology and Enterprise Learning area as an attempt to link some mismatched subjects together:

> [We] have ... the big 4: English, Maths, Science and Social Studies ... then there was a floating group, out to the right and then they threw an umbrella over them or a rug and said: well we'll call them Technology. So we've got all these groups mounted together. So we sort of start the thinking: well, we've got to put them in an area. What links them together? What is common? And I suspect that one of [the reasons] was this Design-Make-Appraise, which really loosely equated to a problem-solving process. So if you call them the problem-solving process then the Business people can squeeze into it, the Home Economics people can squeeze into it. The Media people can squeeze into it. Under a very sort of loose thing. But it's a process. It's not technology as the, whole thing ... what we are trying to do is we've built a curriculum around what was there previously. We had previously Home Economics, Manual Arts, Media type things. So we built the curriculum around them ... We tried to, put a square peg in a round hole by bashing it and moulding it into to suit it. [Kerry]

There is concern that there is no rationale for the inclusion of the design process in some subjects which have no relation to Technology. Hence, Technology appears as an isolated subject which has no deep historical roots. Therefore, the reduction of the design process (which is in fact the methodology used in technology) to a problem-solving process which may be applied to Physical Education, for example, is perceived as ridiculous. There seems to be a need for the Education Department to make clear its position concerning Technology Education:

> The Education Department does not understand Technology. They are looking at eight learning areas. Technology is just a nuisance one that they keep sticking down the end. What they're concerned about is English, Maths, Science and Studies of Society, [Physical Education] and maybe LOTE. We don't have a champion, we don't have anyone out there who is saying to the Education Department: you better get into gear about Technology. We have not got politicians doing it. We have not got industry ... [Robin]

It is of concern to teachers that the design process does not equate with Technology and that the focus of Technology Education should be on Technology itself and not on the design process. Students' exposure to the design process at an early age is questioned. The concern is that the curriculum may be based on a random selection of design process or design briefs without any reliable course structure to support the teaching:

> [Given a brief] to design a wooden toy ... as a Technology teacher what I would do, would be that I would look at how humans develop [movement] ... like [in] cams, gears, levers. So I would have some activities that expose the children to those types of things ... Then I would use that knowledge in a synthesis to design a wooden toy that incorporates that movement. Now in a lot of the design books they just do that. The end. And then somehow, the poor student has got to have the maturation to actually realise that one of the ways that humans develop movement in little wooden toys is cams. Then they've got to go and find out about cams ... they're doomed to fail because they put the cart before the horse. [Kerry]

The main argument in Kerry's statement is that the design process should not be used to teach Technology, that the design process will not transform any subject automatically into a technological one, for the design process is only part of technology. The point made by Kerry may be construed as a suggestion that Technology - and not the design process should be at the foreground of the teaching of technological capability in school.

Summary

This research found that effective teaching of the design process may be achieved only if certain conditions are present. It is of concern that the clientele for Design and

Technology comes from a group of students who have not voluntarily selected the subject. This research showed that teachers are experimenting with different approaches through trial and error. The perceived priorities are:

1. the provision of a selected repertoire of basic skills to students;
2. the development of the graphical abilities of students;
3. the designing of curriculum material; and
4. the shift of emphasis to technology instead of the design process.

CHAPTER FIVE: CONCLUSION AND RECOMMENDATIONS

Concluding Observations

It is of concern to the Design and Technology teachers in this study that the future of technology is uncertain. Changes occurring within the school curriculum are coupled with changes occurring within the education system in Western Australia. Both changes are having a direct impact on Design and Technology. The inclusion of the Design, Make and Appraise approach in the Technology and Enterprise learning area is considered as an uncertainty factor which prevents this learning area from having clear-cut boundaries and expectations of predictable results.

There is concern that moves by the educational authorities to introduce the design process as a central element to Technology Education is generating more problems than solving existing ones. One of the underlying causes is that the teachers themselves are experiencing difficulties in grasping the concept of the design process. Changes occurring in the school curriculum, as far as Design and Technology is concerned, are creating apprehension. Some teachers seem to be afraid of losing their jobs, as their trade background expertise may become increasingly irrelevant within the new learning area of Technology and Enterprise. As a result students also are likely to be disadvantaged.

This research found that a design process is being used in an environment which is structurally inappropriate to the teaching methodologies suggested by Christensen & Martin (1992) or Williams (1987 & 1991). For example, in using a design process, students should be given the opportunity to use, in a safe way, any material they want to

include in their design. But this is not the case in practice as the teachers are still using, in most cases, an approach based on limited materials.

Also, this research noted that the method used to assess students' work was sometimes in contradiction with the philosophy of Technology Education itself. For example, the literature on the issue proposes holistic marking as an alternative to the current method, but, for different reasons, the teachers find it better to rely more on the breaking down of marks than on their professional judgement to assess students.

The literature review suggests that the current trends in Technology Education are oriented towards a student-centred learning approach with the role of the teacher one of a facilitator of learning (Christensen & Martin, 1992; Williams, 1993). However, this research shows that the transition from a teacher-centred approach to a student-centred approach is being made with much difficulty. There is a perceived fear on the side of the teachers that their expertise will be lost and that the students will lack manipulative skills if emphasis is placed on process instead of on the product.

This research also concludes that students have preconceived ideas about the nature of Design and Technology. The simplistic view that Design and Technology is only about the development of the psycho-motor domain is still ingrained in the mind of students and their parents. Further studies are needed to understand what could be done to market Technology not only to teachers but also to the students and to the community at large.

All in all, this research has shown that greater focus should be given to the underlying methodology of the design process. Lack of curriculum materials, role models and uncertainty as to the future of the Technology and Enterprise Student Outcome Statements are all factors relevant to the teachers in this study, and significant to their concerns when implementing the design process with their technology students.

Finally, as this research limited itself to only seven lower secondary school teachers it may not be possible to generalise the findings to all the Western Australian teachers who may be using a design process in Design and Technology. However, the views shared by the participants are valuable ones, as these views may reflect not only the individual perceptions but also, in some instances, a common feeling about some current issues in education in Western Australia. Therefore, this study may be useful as a pilot study for relevant future research in Western Australia.

Recommendations

Based on the interviews and their results, it is appropriate to consider a series of recommendations pertinent to the subject of this research.

1. Considering that Technology has gathered momentum, its teaching should be made compulsory at both the primary and the secondary levels. A committee, consisting of the three levels of educational establishments should be set up to ensure continuity in the teaching of Technology subjects. The committee would have the responsibility to ensure that there is no duplication in subject/course contents across levels or ambiguity of roles in the three levels.

2. Teachers are called upon to play a pro-active role in shaping and directing the changes in the teaching of Technology in educational institutions by designing appropriate support materials for the teaching of Design and Technology. These support materials should be designed with the active participation of members of the Design And Technology Teachers Association (DATTA), university lecturers and curriculum builders from the relevant government body.

3. The importance of technological projects carried out by students should be emphasised by disseminating information in school newsletters or bulletins; displaying the projects at school social events such as fairs; and, exhibitions sponsored by both government and private sectors.

4. Special attention should be given to the content of pre-service training courses for Design and Technology teachers. It is also submitted that the Teaching Practice (TP) and Assisted Teaching Practice (ATP) should include exposure to the new technological methods and to new technologies.

5. It is recommended that universities should offer relevant units to teach Technology to already trained Design and Technology teachers to enable them to upgrade their knowledge and skills in this learning area.

6. It is also recommended that students be given special courses on how to develop their communication skills. In the context of Technology Education, special attention should be given to how students should communicate their ideas graphically. Special packages should be designed by technologists and psychologists to help students confidently communicate their ideas.

7. Design and Technology teachers should be given clear guidelines on what is expected from them in terms of the assessment of students' work. It is submitted that suitable assessment procedures be established, that some sort of assessment framework or standardisation of documents be designed for reporting. Teachers should be kept well informed about how any monitoring of standards will be performed by the Education Department.

8. Schools should undertake either individually or in groups studies on the habits, beliefs, attitudes and expectations of lower schools students who are in the process of selecting subjects for their upper school life. These studies should focus on the needs of low ability students. It is important to understand why students like or do not like to make things with their hands. It is also important to understand why students do not like to write or to draw in Design and Technology.

APPENDICES

Appendix A Name Used by Fifty-Six Schools to Denote the Design and Technology Department

Type of School	Name Used			
	Design & Technology	Manual/Practical/ Industrial Arts	Both	Nil
Government	4	19	8	6
Catholic	1	3	2	4
Anglican	2	1	0	1
Other	1	3	0	1
TOTAL	8	26	10	12

Source: 1995 - Secondary School Index Questionnaire file, Department of Teaching and Curriculum Studies, Edith Cowan University, Mount Lawley, Perth.

Appendix B Table of Technology Subjects Offered by Fifty-Six Schools

	Department		TECHNOLOGY SUBJECTS OFFERED				
	D&T	MArts	CAD	IT	Tech	TStd	ET
1	X	X					
2		X					
3		X					
4		X					
5	X	X					
6	X	X		✓			
7		X					
8		X					
9	X						
10		X					
11		X					
12		X					
13	X	X					
14		X					
15		X					
16		X					
17							
18	X						
19		X					
20							
21	X				✓		
22	X	X					
23		X					
24	X	X					
25		X					
26		X					
27		X					
28	X	X					
29		X					
30							
31	X						
32	X	X			✓		
33		X					
34							
35		X					
36							
37							
38							
39	X	X					
40		X					
41		X					
42		X	✓			✓	
43	X				✓		
44							
45		X					
46	X	X					
47			✓				
48							
49							
50	X						
51	X						
52		X					
53	X						
54							
55		X					
56		X	✓				✓

Source: 1995 - Secondary School Index Questionnaire file, Department of Teaching and Curriculum Studies, Edith Cowan University, Mount Lawley, Perth.

KEY

CAD	Computer Aided Design
D&T	Design & Technology
ET	Energy Technology
IT	Information Technology
MArts	Manual Arts
Tech	Technology
TStd	Technology Studies

Appendix C Letter to the Technology and Enterprise Superintendent EDWA.

Desire Mallet
15/10 Braeside Road
MOUNT LAWLEY 6050

19 May 1995

Ms Margaret Banks
Education Department of WA
151 Royal Street
EAST PERTH WA 6004

Dear Ms Banks,

I am sending this letter to you to ask you if you could help me to get access to some information which I need for my studies.

I am actually completing my BEd (Hons) in Design and Technology (D&T) at Edith Cowan University - Mount Lawley Campus. For my research, I am looking at the perceptions of metropolitan D&T teachers towards the 'design process'. I shall also assess the educational significance of this approach and shall look at the issues linked with it.

At this stage of the preparation of my research, I need to identify:

- all the government schools which have an 'affinity' for the 'design process';
- which 'subjects' those schools are offering to year 8 - 10 students; and,
- which high schools are trialing the Student Outcome Statements in D&T.

Your help will be useful for the selection of a valid sample for the study which I am planning to do. Would you need any further clarification about my request, please feel free to either contact me on the [redacted] (between 9.00 am and noon), or to contact Mr. John McQueen, my supervisor, on the 370 6271.

Thanking you in anticipation.

Yours sincerely

Desire Mallet

Your Ref.

Appendix D Letter from EDWA

Our Ref. 506393VO1

Enquiries

Branch

DEPARTMENT OF WESTERN AUSTRALIA

151 ROYAL STREET
EAST PERTH WA 6004
TELEPHONE (09) 264 4111
FACSIMILE (09) 264 5005

Mr D Mallet
[redacted]

Dear Mr Mallet

Thank you for your letter of 19 May regarding information on Design and Technology in Education Department schools.

I trust the information provided to you over the telephone has been useful for your research. A Design and Technology resource centre is located at Perth Modern school. Officers at this centre have some contact with other Design and Technology teachers and may be able to assist you with further information.

You can contact the Resource Centre by telephoning Louis Marcus on 388 1355.

My best wishes to you in your research project.

Yours sincerely

[redacted]

MARGARET BANKS
LEARNING AREA SUPERINTENDENT
TECHNOLOGY AND ENTERPRISE

22 June 1995

Appendix E - List of the Fifty-Nine Schools Considered for this Research

No	Name of Western Australian School	School Contacted by Researcher	Response of Design & Technology Teacher/s		
1	APPLECROSS SENIOR HIGH SCHOOL				
2	AQUINAS COLLEGE	YES	?		
3	ARMADALE SENIOR HIGH SCHOOL				
4	BALCATTA SENIOR HIGH SCHOOL				
5	BALGA SENIOR HIGH SCHOOL				
6	BALLAJURA COMMUNITY COLLEGE	YES	?		
7	BELMONT SENIOR HIGH SCHOOL				
8	BELRIDGE SENIOR HIGH SCHOOL	YES		-VE	
9	CARINE SENIOR HIGH SCHOOL	YES		-VE	
10	CECIL ANDREWS SENIOR HIGH SCHOOL	YES			+VE
11	CHISHOLM CATHOLIC COLLEGE				
12	CHRISTIAN BROTHERS COLLEGE				
13	CHURCHLANDS SENIOR HIGH SCHOOL				
14	CITY BEACH SENIOR HIGH SCHOOL				
15	COMO SENIOR HIGH SCHOOL				
16	CORPUS CHRISTI COLLEGE	YES			+VE
17	CRAIGIE SENIOR HIGH SCHOOL				
18	CYRIL JACKSON SENIOR CAMPUS	YES			+VE
19	DUNCRAIG SENIOR HIGH SCHOOL				
20	GIRRAWHEEN SENIOR HIGH SCHOOL	YES		-VE	
21	GOSNELLS SENIOR HIGH SCHOOL	YES	?		
22	GUILFORD GRAMMAR	YES			+VE
23	HALE SCHOOL	YES	?		
24	HAMILTON HILL SENIOR HIGH SCHOOL				
25	HAMPTON SENIOR HIGH SCHOOL				
26	JOHN CURTIN SENIOR HIGH SCHOOL	YES		-VE	
27	JOHN FOREST SENIOR HIGH SCHOOL	YES			+VE
28	KENT ST SENIOR HIGH SCHOOL				
29	KEWDALE SENIOR HIGH SCHOOL				
30	KINGSWAY CHRISTIAN COLLEGE	YES	?		
31	LA SALLE COLLEGE	YES			+VE
32	LAKE JOONDALUP BAPTIST COLLEGE	YES			+VE
33	LAKELAND SENIOR HIGH SCHOOL	YES		-VE	
34	LEEMING SENIOR HIGH SCHOOL	YES			+VE
35	LESMURDIE SENIOR HIGH SCHOOL	YES			+VE
36	LOCKRIDGE SENIOR HIGH SCHOOL	YES			+VE
37	LUMEN CHRISTI COLLEGE				
38	LYNWOOD SENIOR HIGH SCHOOL				
39	MADDINGTON SENIOR HIGH SCHOOL				
40	MERCY COLLEGE	YES		-VE	
41	MIRRABOOKA SENIOR HIGH SCHOOL	YES		-VE	
42	OCEAN REEF SENIOR HIGH SCHOOL		?		
43	PADBURY SENIOR HIGH SCHOOL	YES			+VE
44	PRENDIVILLE CATHOLIC COLLEGE				
45	PRESBYTERIAN LADIES COLLEGE	YES	?		
46	ROLEYSTONE SENIOR HIGH SCHOOL	YES			+VE
47	SCARBOROUGH SENIOR HIGH SCHOOL				
48	SACRED HEART COLLEGE	YES			+VE
49	SCOTCH COLLEGE	YES		-VE	
50	ST HILDA'S ANGLICAN SCHOOL GIRLS				
51	ST MARK'S ANGLICAN COMMUNITY SCHOOL	YES			+VE
52	ST NORBERT COLLEGE	YES	?		
53	ST STEPHEN'S SCHOOL	YES	?		
54	SWANBOURNE SENIOR HIGH SCHOOL	YES			+VE
55	SWANVIEW SENIOR HIGH SCHOOL	YES	?		
56	THORNLIE SENIOR HIGH SCHOOL				
57	WANNEROO SENIOR HIGH SCHOOL				
58	WARWICK SENIOR HIGH SCHOOL				
59	WILLETON SENIOR HIGH SCHOOL				

Key:
- ? No contact could be made with any D&T teacher
- -VE D&T teacher/s could not participate
- +VE One or more D&T teachers accepted to participate

Appendix F Sample Letter Sent to Fifteen Design and Technology Teachers

Desire Mallet
[redacted]

9 August 1995

Technology Teacher
Lower Secondary School
8/10 Teeheehee Pathway
METROPOLITAN AREA 6XXX

Dear *Tech*

RE: RESEARCH ON THE USE OF THE DESIGN PROCESS

I am referring to the telephonic conversation which we had in July 1995.

I am doing some research focussing on the use of the design process. You have been identified as a potential participant for this research. Still, more information is required to confirm whether or not you may meet the criteria established in the research proposal. To help determine the final sample could you please fill in the enclosed "**Participant's Profile Form**" and post it to me in the envelope provided as soon as possible.

For more information, please feel free to contact me on the [redacted] or my supervisor, Dr John Williams, at Edith Cowan University, on **370 6847**.

Thanking you in anticipation.

Yours sincerely

Desire Mallet

Appendix G

PARTICIPANT'S PROFILE FORM

SECTION A

In these last eighteen months I have been teaching the following subjects *to the following classes* **For coding purposes**

please tick [✓]

		yr8	yr9	yr10	yr11	yr12	REF	
[ ]	Applied Industrial Arts	[..]	[..]	[..]	[..]	[..]	AIA	{ }
[ ]	Applied Technology	[..]	[..]	[..]	[..]	[..]	AT	{ }
[ ]	Computer Aided Design	[..]	[..]	[..]	[..]	[..]	CAD	{ }
[ ]	Computer Aided Manufacturing	[..]	[..]	[..]	[..]	[..]	CAM	{ }
[ ]	Design and Technology	[..]	[..]	[..]	[..]	[..]	DT	{ }
[ ]	Design Drawing	[..]	[..]	[..]	[..]	[..]	DD	{ }
[ ]	Design Studies	[..]	[..]	[..]	[..]	[..]	DS	{ }
[ ]	Drawing	[..]	[..]	[..]	[..]	[..]	D	{ }
[ ]	Electricity	[..]	[..]	[..]	[..]	[..]	tri	{ }
[ ]	Electricity and Electronics	[..]	[..]	[..]	[..]	[..]	EE	{ }
[ ]	Electronics	[..]	[..]	[..]	[..]	[..]	tro	{ }
[ ]	Farm Construction	[..]	[..]	[..]	[..]	[..]	FC	{ }
[ ]	Farm Vehicles and Machinery	[..]	[..]	[..]	[..]	[..]	V&M	{ }
[ ]	Furniture Woodwork	[..]	[..]	[..]	[..]	[..]	FW	{ }
[ ]	Graphic Arts	[..]	[..]	[..]	[..]	[..]	GArt	{ }
[ ]	Graphics	[..]	[..]	[..]	[..]	[..]	Grph	{ }
[ ]	Graphics Design	[..]	[..]	[..]	[..]	[..]	GDes	{ }
[ ]	Graphics Technology	[..]	[..]	[..]	[..]	[..]	GT	{ }
[ ]	Home Workshop	[..]	[..]	[..]	[..]	[..]	HW	{ }
[ ]	Industrial Workshop	[..]	[..]	[..]	[..]	[..]	IW	{ }
[ ]	Jewellery	[..]	[..]	[..]	[..]	[..]	Jew	{ }
[ ]	Mechanical Workshop	[..]	[..]	[..]	[..]	[..]	Mec	{ }
[ ]	Metal Constructions	[..]	[..]	[..]	[..]	[..]	MC	{ }
[ ]	Metalwork	[..]	[..]	[..]	[..]	[..]	MW	{ }
[ ]	Modelmaking	[..]	[..]	[..]	[..]	[..]	Modl	{ }
[ ]	Motors and Machines	[..]	[..]	[..]	[..]	[..]	M&M	{ }
[ ]	Photography	[..]	[..]	[..]	[..]	[..]	PHO	{ }
[ ]	Plastics	[..]	[..]	[..]	[..]	[..]	Plas	{ }
[ ]	Robotics	[..]	[..]	[..]	[..]	[..]	Rob	{ }
[ ]	Technical Drawing	[..]	[..]	[..]	[..]	[..]	TD	{ }
[ ]	Technology	[..]	[..]	[..]	[..]	[..]	Tech	{ }
[ ]	Technology Studies	[..]	[..]	[..]	[..]	[..]	TS	{ }
[ ]	Welding and Metal Fabrication	[..]	[..]	[..]	[..]	[..]	W/M	{ }
[ ]	Woodwork	[..]	[..]	[..]	[..]	[..]	WW	{ }

Please underline ALL the subjects which you are teaching this year

SECTION B

For coding purposes

- *I have integrated the design process (or the designing, making and appraising approach) in my teaching during*

[ ] these past four years
[ ] these last three years
[ ] these last two years
[ ] this year

4yrs	{ }
3yrs	{ }
2yrs	{ }
95	{ }

- *I am actually using the design process in*

[ ] Year 8
[ ] Year 9
[ ] Year 10

yr8	{ }
yr9	{ }
yr10	{ }

- *I am presently being employed as*

[ ] a full-time teacher
[ ] a relief teacher

F-T	{ }
P-T	{ }

- *I am willing to share about this teaching experience*

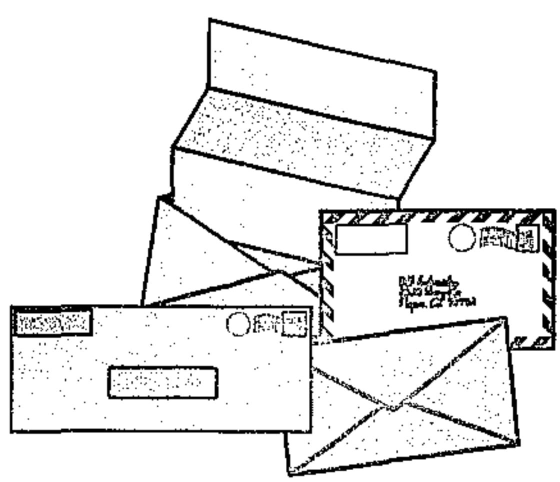
[ ] YES [ ] NO

Will	{ }

FIRST NAME:

CONTACT PHONE NUMBER:

THANKS FOR COMPLETING THIS PRE-INTERVIEW QUESTIONNAIRE.



PLEASE MAIL IT <u>NOW</u> IN THE ENVELOPE PROVIDED

Appendix H Table Showing List of Subjects Taught by Participants

Table 4
Subjects Taught by Participants During the Last Eighteen Months Prior to the Interviews

SUBJECTS TAUGHT [Period February 94 - July 95]	PARTICIPANT 1	2	3	4	5	6	7
Applied Industrial Arts	*	*	*		*		
Computer Aided Design					*		*
Computer Aided Manufacturing							*
Design and Technology					*		*
Design Drawing				*			*
Design Studies				*			*
Drawing						*	*
Electricity						*	
Electronics							*
Furniture Woodwork	*			*		*	
Graphics							*
Industrial Workshop						*	
Jewellery	*	*	*	*			
Mechanical Workshop		*				*	
Metal Constructions							*
Metalwork	*	*	*				
Modelmaking				*			
Plastics							*
Robotics							*
Technical Drawing		*				*	*
Technology			*		*		
Technology Studies				*	*		*
Woodwork	*	*	*	*		*	

INTERVIEW SCHEDULE

PARTICIPANT	Design and Technology teacher who uses the design process in lower secondary school - metropolitan area, Perth, WA.
DURATION	**60 MINUTES**
VENUE	At place agreed by both participant and researcher.

****

INTRODUCTION TO INTERVIEW

I am very glad you have accepted to participate in this research. I am doing my research on the use of the design process in schools.

For practical reasons it is easier for me to record the conversation. I would need your permission in that matter. I will take all the precautions to guarantee confidentiality.

Do you wish to ask me any question about the study or do you feel that it's okay for us to start?

[If response is positive: TEST EQUIPMENT while participant is signing the "Statement of Disclosure and Informed Consent Form"]
???

START INTERVIEW

First of all, I would like to have an idea about your own definition of the design process

⇒ What does the design process **mean** to you ?
⇒ How would you **describe** it to a lay-person ?
⇒ Why have you **chosen to use** the design process ?
⇒ What do you consider to be the **main elements** of the process ?
⇒ **Why** are these **elements** in the design process **important** ?
⇒ Which elements are the **most important** ones ?
⇒ How do you view the **DMA approach** ?
⇒ What are the **advantages** of using the process ?
⇒ What are the advantages for the teachers?
⇒ What are the advantages for the students?
⇒ What are the **disadvantages** of using the process ?
⇒ What are the disadvantages for the teachers?
⇒ What are the disadvantages for the students?
⇒ **How do students feel** about using the design process ?
⇒ What makes them feel this way ?
⇒ **When do you use** the design process ? In which grade ?

⇒ For **which group of students** is it appropriate ?
⇒ **Why** do you feel that it is appropriate for them ?
⇒ **How do you teach** the different elements of the process ?
⇒ What would you suggest to **improve the teaching** of the design process ?
⇒ Could there be a link between the design process and the **Student Outcomes Statements** ? [If 'yes': what sort of link ?]
⇒ Are students **keen** to use the design process ? Why are they keen to use it
⇒ As a teacher, **what are you main concerns about the design process** ?
⇒ Why do you think that the design process has been included in the **syllabus**?
⇒ What hurdles do the **new university graduates** have to cross in order to be able to use the design process effectively ?
⇒ Do you believe that there are **pressures** to force people to use the design process ? [If 'yes': Who put the pressures ? Why do they put the pressures ?]
⇒ **How do you assess your students** (artefact & process) ?
⇒ According to you what are the **main issues** linked with the assessment of student's outcomes ?
⇒ If you have to suggest a **weightage** for the assessment of the artefact and the process what would you suggest ? {When would you use that weightage ? Would you always use the same weightage each time? Why ?}
⇒ What type of **challenges** have you experienced in assessing students who used the design process ?
⇒ How do you assess the students' **folio**?
⇒ How can the Design Folio be used to **reflect** appropriate students **achievements** in Design and Technology?
⇒ What are your students' views on **homework** ? What are your views on this matter ?
⇒ How can it affect the teaching methods ?
⇒ How can the design process help to **enhance learning** ?
⇒ How can **problem-solving** be taught through the process ?

I thank you for your time !

STOP INTERVIEW

* WRITE PROTECT TAPE
* LABEL TAPE
* PLACE TAPE IN SECURE PLACE

Appendix K Sample Pre-Interview Letter Sent to Participants

Desire Mallet
[redacted]

22 August 1995

Happy Interviewee
Peaceful Place
SAMPLE, 6XXX

Dear *Happy*

RE: Research on The Design Process

I wish to thank you for responding positively to my request.

I am looking forward to our meeting. The interview is expected to last for about 45-60 minutes. At this stage you may wish to note that my interview will focus on the following points:

- your definition of the design process;
- the benefits of the process;
- the challenges encountered;
- the types of design process suitable for students; and,
- the assessment in outcome-based education.

I wish to stress that your opinion is not expected to reflect that of your educational institution or that of your colleagues. The interview will be audio-taped, but confidentiality will be safeguarded.

The data collection will be done in the period 28 August to 8 September. The place, date and time for the interview will be arranged on the phone.

I wish to thank you for your co-operation.

Yours sincerely

Desire Mallet

STATEMENT OF DISCLOSURE
AND INFORMED CONSENT

The aim of the project is to investigate teachers' perceptions of how the design process should be used to demonstrate student outcomes in Design and Technology. Schools where potential participants are recruited have been identified according to the design/technology subjects they offer and to their reported 'affinity' for the design process. The participants for this project have been partly identified on the basis of their willingness to be involved in the study.

Each participant will be interviewed individually by the researcher for approximately fifty minutes. The interview will be audio-recorded. There is no discomfort or risk involved. Subjects will be given the opportunity to voice their personal ideas, views, feelings and thoughts on design and technology. This type of research may assist to better understand what is involved in the design process; and this understanding could contribute to the improvement of Design and Technology teaching, and thus be of benefit to students.

Any questions concerning the project entitled

Perceptions Of Design And Technology Teachers About The Utilisation Of The Design Process

can be directed to Dr John Williams (Supervisor)

of Edith Cowan University, Mount Lawley campus,
2 Bradford Street, Mount Lawley 6050

on 370 6847 (Telephone)

I have read the information above and any questions I have asked have been answered to my satisfaction. I agree to participate in this activity, realising I may withdraw at any time.

I agree that the research data gathered for this study may be published provided I am not identifiable.

Participant Date

Investigator Date

Appendix M Sample Post-Interview Letter Sent to Participants

Desire Mallet
[redacted]

10 October 1995

Chosen Participant
Selected Secondary School
Last Turn
VALIDATION, 6XXX

Dear *Chosen*

I am sending to you the following items:

[ ] a computer disc;
[ ] a typed document; and
[ ] an audio-tape.

I would much appreciate if you could advise me on corrections you would like me to make. You may wish to

either contact me on the phone,
or insert **missing/corrected** words in bold on the disc provided and send it back in the envelope provided,
or write to me about your concerns.

Please note that I have been requested by the Committee for the Conduct of Ethical Research, Edith Cowan University, to preserve the records of my study for a minimum of five (5) years. In this context, I would much appreciate if you could return the audio-tape to me at your earliest convenience.

I wish to thank you again for participating in the study.

Yours sincerely,

Desire Mallet

Appendix N Example of Hierarchical Titles Used for this Study

(11)	/ability
(11 2)	/ability/kids
(11 2 3)	/ability/kids/communicate
(11 2 3 2)	/ability/kids/communicate/graphically
(11 2 3 1)	/ability/kids/communicate/orally
(11 2 1)	/ability/kids/design
(11 2 2)	/ability/kids/draw
(11 2 4)	/ability/kids/sketch
(11 2 4 1)	/ability/kids/sketch/computer
(11 1)	/ability/teacher
(11 1 3)	/ability/teacher/change
(11 1 2)	/ability/teacher/solve problems
(11 1 1)	/ability/teacher/teach
(6)	/assessment
(6 15)	/assessment/accountability
(6 3)	/assessment/artefact
(6 13)	/assessment/criteria
(6 4)	/assessment/folio
(6 11)	/assessment/judgement
(6 2)	/assessment/kids
(6 2 3)	/assessment/kids/mood
(6 2 3 2)	/assessment/kids/mood/fail
(6 2 1)	/assessment/kids/self
(6 6)	/assessment/presentation
(6 14)	/assessment/purpose
(6 14 1)	/assessment/purpose/accountability
(6 8)	/assessment/rationale
(6 8 1)	/assessment/rationale/marking
(6 5)	/assessment/research
(6 7)	/assessment/school
(6 7 1)	/assessment/school/lower
(6 7 2)	/assessment/school/upper
(6 1)	/assessment/teacher
(6 1 1)	/assessment/teacher/marking
(6 1 1 4)	/assessment/teacher/marking/artefact
(6 1 1 2)	/assessment/teacher/marking/fairness
(6 1 1 3)	/assessment/teacher/marking/folio
(6 1 1 1)	/assessment/teacher/marking/time
(6 10)	/assessment/time
(7)	/change
(7 1)	/change/causes
(7 2)	/change/effects
(7 2 5)	/change/effects/assessment
(7 2 3)	/change/effects/curriculum
(7 2 2)	/change/effects/kids
(7 2 4)	/change/effects/layout
(7 2 1)	/change/effects/tchers
(21)	/competing
(21 1)	/competing/kids
(33)	/computer
(33 1)	/computer/use
(33 1 4)	/computer/use/industry
(33 1 3)	/computer/use/schools
(33 1 3 2)	/computer/use/schools/kids
(33 1 3 1)	/computer/use/schools/teacher
(12)	/creativity
(12 1)	/creativity/assessment
(23)	/curriculum
(1)	/design process
(1 6)	/design process/assessment
(1 6 3)	/design process/assessment/appraising
(1 11)	/design process/benefits
(1 11 1)	/design process/benefits/kids
(1 4)	/design process/characteristics
(1 4 1)	/design process/characteristics/tchers
(1 19)	/design process/critics
(1 19 1)	/design process/critics/mockups
(1 3)	/design process/definition
(1 3 2)	/design process/definition/layperson
(1 3 1)	/design process/definition/tchers
(1 3 1 1)	/design process/definition/tchers/govt
(1 3 1 1 1)	/design process/definition/tchers/govt/sos

(1 3 1 1 1) /design process/definition/tchers/govt/sos

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