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ABSTRACT

This paper reviews a decade of development of technology education at the secondary school level in Australia. It traces the influences, both national and international, which have pressed the nation's education systems to introduce technology studies into the school curriculum. The increasing globalization, the movement of capital and labor, the increasing use of English as an international language of commerce and tourism, and rapid electronic communications are some of the cultural influences that have affected curriculum developments. The societal context is examined, in which various sources of influence-from the political, industrial, and education sectors-have together resulted in technology studies becoming a major growth area in the senior years of Australian secondary education. Models of the technology curriculum which have influenced local curriculum design are described and characteristics which distinguish the new curricula from previous, traditional forms of technical education are identified. Recent attempts by federal government agencies to introduce a national curriculum in technology and seven other key learning areas are outlined. The paper ends by identifying some of the practical problems that have emerged as educational systems attempt to implement technology studies. Contains 46 references. (Author/JRH)

TECHNOLOGY EDUCATION IN AUSTRALIA: NATIONAL POLICY AND STATE IMPLEMENTATION

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ABSTRACT

Australia, a nation of 18 million people, has a federal system of government. There are six states and two territories, each with their own governments, and traditionally, education in schools has been under the control of the states and territories. Although there has been a long history of attempts at federal co-ordination of education, moves to develop and implement a single national curriculum are quite recent, and follow from a meeting of the Australian Education Council (the combined federal, state and territory ministers of education) in Hobart in 1989.

This paper reviews a decade of development of technology education at secondary school level in Australia. It traces the influences, both international and national, which have pressed the nation's education systems to introduce technology studies into the school curriculum. The development of technology studies has occurred during a period of intensive globalisation, not only in education, but in broader aspects of society. The views of multi-national business corporations and international governmental agencies, the increasing movement of capital and labour, the increasing use of English as an international language of commerce and tourism and rapid electronic communications are just some of the cultural influences which have affected curriculum developments. Conservative ("new right") political movements in Australia, as in other countries, have influenced education policies, resulting in an emphasis upon curricula with specified outcomes, testing of children at various age levels, and demands for accountability. This conservative shift cannot be identified with any one of the major political parties, since the federal government has been in the hands of the Australian Labor Party throughout the period, while state governments have been either ALP or Liberal.

The paper examines the societal context in which various sources of influence — from the political, industrial and education sectors — have together resulted in technology studies becoming a major growth area in the senior years of Australian secondary education. A major factor has been the increased retention rate of Australian secondary schools; virtually all students complete Year 11, and the vast majority, Year 12. Educators have recognised the need for broadening the curriculum and developing appropriate modes of assessment to provide opportunities for success and publicly recognised qualifications for a much wider range of students.

Models of the technology curriculum (often British in origin) which have influenced local curriculum design are described, and characteristics which distinguish the new curricula from previous, traditional forms of technical education are identified. These include an emphasis on identifying problems amenable to technological solutions, on designing and making artefacts, materials and systems, and on appraising these products. Appraisal is concerned not only with the quality of the product, but also with the broader issue of evaluating societal and environmental concerns.

Recent attempts by federal government agencies to introduce a national curriculum in Technology (and seven other key learning areas) are outlined. Some key learning areas

such as English and Mathematics represent traditional academic subjects; others, such as Technology, bring together various subject areas. A crucial ideological assumption underpinning this development, central to conservative educational ideology, is the belief that the curriculum should be constructed around statements of clearly-identified intended outcomes. However, the politics of implementation was complex, and the federal government was unable to impose a common curriculum on the states (partly because of lack of constitutional power, partly because of party-political conflict between the federal and state governments, and partly as a result of effective lobbying against the idea by segments of academia). Consequently, a decision was made to publish, for each key learning area, only two documents: a curriculum *statement* (i.e. a set of non-mandatory guidelines) and a curriculum *profile* (a set of assessment criteria).

The curriculum statement for Technology is organised into four interdependent *strands*: Designing, making and appraising; Information; Materials; and Systems. It is also organised into four *bands* and eight *levels*, spanning the years from the beginning of primary schooling to the end of Year 10. These levels were regarded as developmental stages of progression, and are not intended to be closely identified with Year levels. The accompanying curriculum profile contains statements of intended *outcomes* (broad statements of skills and knowledge that students are expected to attain) and *pointers* (illustrative examples of specific ways in which the outcomes might be demonstrated).

How these documents were subsequently to be used was left to the states to decide. The paper describes the development in one state (Victoria) of parallel documentation (the *Curriculum and Standards Framework*) in Technology. The CSF is organised into seven levels (instead of eight), and excludes consideration of the last two years of secondary schooling, already covered by the existing Victorian Certificate of Education. Although in some respects similar to the national documents, there are also important differences. In particular, in the national statement, the concept of a *level* refers to a learner's stage of development, while in the CSF documents, levels are tied closely to traditional ideas of age/grade levels.

The paper ends by identifying some of the practical problems that have emerged as educational systems attempt to implement technology studies. A major problem is in the area of teacher professional development, a problem exacerbated by the fact that this new curriculum development has been occurring during a time of national recession and, particularly in Victoria, during a period of reduced state government provisions for curriculum consultancy services. A related problem will emerge in the decade to come, as an ageing workforce of technology teachers retires. Ideally, the new curriculum developments call for teachers who possess a combination of psychomotor skills, design and problem-solving abilities, and an appreciation of the societal context of technology. The author has been involved in the implementation of pre-service programs and masters' courses in his own university in an attempt to meet this need, but the numbers of students enrolled are as yet too small to make a substantial contribution to future personnel needs. Unfortunately, there is little evidence at either national or state level of the long-term planning needed if Australia is to produce adequate numbers of well-qualified technology teachers.

INTRODUCTION

Technology education

This paper reviews the development of technology education in Australia during the past decade. *Technology education*, a term which means different things to different people, is used here to refer to curricula which introduce learners to knowledge and practical capabilities related to investigating, designing, producing and evaluating artefacts, materials and systems. It is therefore a broad term: it involves more than the teaching of practical skills; it is not limited to any particular sub-set of technologies (e.g. information technology). It is not conceptualised as an off-shoot of science education, nor as synonymous with Science-Technology-Society education which often emphasises the study of technology's external relationships, but de-emphasises students' direct involvement in learning technological skills. It is also distinct from *educational technology* (e.g. overhead projectors, encyclopedias on CD-ROM, Internet) which is concerned with the use of technology for teaching and learning in any curriculum field.

The Australian context

A federal system with state responsibility for education. Australia consists of six states and two territories covering an area similar to that of the continental United States; its 18 million people are mostly concentrated in large cities, spaced several hundred kilometres apart, situated in a narrow coastal band on its eastern, southern and south-western shores. Education systems began to develop in the mid 19th century, when the country consisted of a set of separate British colonies; vast distances and slow communications resulted in each colonial government establishing its own educational system. In 1901, the colonies became states under a federal system. A Constitution was adopted which defined the federal government's powers. Powers not so defined — the provision of education is an important example — were to be left in the hands of the states. Ever since federation, the building of schools, the appointment of teachers and the development of curricula have been a state responsibility.

Gradual federal involvement in education. Nevertheless, there has been a steady growth of involvement by successive federal governments in the education field. In 1936, the federal government and the various state governments established the Australian Education Council (AEC), consisting of the various Ministers responsible for education, in an attempt at some co-ordination of state educational policies. During the 1960s, the federal government became directly involved in the provision of resources, by funding universities and (later) other forms of tertiary education, in building school science laboratories, in partially funding non-government schools, in developing instructional materials and in ameliorating the condition of schools in socially disadvantaged areas.

In 1988, at a meeting in Hobart (the Tasmanian state capital), the AEC decided to take a more active role in the area of curriculum policy. In April 1989, in a document known as the Hobart Declaration, it published a statement representing "ten common and agreed national goals for schooling in Australia" (Curriculum Corporation, 1994a, p. iii).

Technology: an important area of learning. One of the ten goals announced in Hobart refers specifically to technology: students are expected to develop "an understanding of the role of science and technology in society, together with scientific and technological skills". The goals were to be implemented in eight *areas of learning*, a term which can refer to traditional school subjects (e.g. English, mathematics) or a cluster of related subjects (languages other than English, studies of society). Technology, which had already been emerging as a new area of the school curriculum in the various states and territories several years prior to the AEC's intervention, was identified as one of these areas. In distinguishing Technology from other areas such as Science and the Arts, the AEC was giving national prominence to a curriculum field in a way that had not been done before in Australia. Although Australia is not unique in this respect, in many other countries technology studies are subsumed under broader categories and included with science or with arts and crafts.

This development eventually led to the preparation of two documents for the Technology learning area: a curriculum *statement* (Curriculum Corporation, 1994a) and a corresponding *profile* (Curriculum Corporation, 1994b), concepts which will be discussed in more detail later. Statements and profiles were produced for each of the other seven learning areas as well. These documents encompass all the years of compulsory schooling, and attempt to lay out a progressive sequence of intended learning outcomes, together with suggestions for ways of assessing their attainment.

The meaning of 'technology' and the goals of technology education. In the Australian national curriculum statement, the term 'technology' is considered to encompass a broad range of meanings, as the following extract shows:

> Technology is often used as the generic term for all the technologies people develop and use. It involves the purposeful application of knowledge, experience and resources to create products and processes that meet human needs.
>
> The needs and wants of people and groups in particular communities determine what technologies are developed and how they are applied. Particular technological applications are judged by their impact on communities and environments and their effect on the personal wellbeing and ways of life of individuals.
>
> Decisions about the development and use of technology reflect a range of cultural issues and environmental factors. They are influenced, for example, by the values and experiences of different people and communities, by the political influence of different people... Making decisions about technology often involves a complex mixture of consensus, conflict and compromise (Curriculum Corporation, 1994b, p. 2).

Clearly, the developers of the national curriculum statement did not regard technology as simply the application of science, nor did they equate it with narrower terms such as 'information technology' or 'industrial technology'. Equally clearly, by referring to matters such as 'personal wellbeing' and 'impact on communities', the writers of the statement were expressing a view that technology was an enterprise with a human face. Their view of the goals of technology education were consistent with these conceptions:

> Technology programs encourage students to use technology productively and to become enterprising people. They involve students in generating ideas and in taking action as well as in using and developing techniques and products that satisfy human needs.
>
> Technology in the school curriculum combines theory and practice. It includes much that is scientific, mathematical, graphical, cultural, aesthetic and historical. It explores the synthesis of ideas and practices, and the effects of technology on societies and environments.
>
> Through a process of designing, making and appraising, students generate ideas and translate them into practice. They explore, apply and develop information, materials and systems (Curriculum Corporation, 1994b, p. 2).

The existence of such statements in a national curriculum document does not of course mean that all teachers throughout the nation have instantly adopted a common view about the meaning of 'technology' and the goals of technology education. However, such statements can provide a starting point for building a consensus about such matters.

THE EMERGENCE OF TECHNOLOGY EDUCATION

Technical education: the platform for technology studies. Where did all this come from? What influences were at work to give national recognition to Technology as an important component of the school curriculum? It did not of course come from nowhere: there is a long tradition, more than a century old, of technical education in Australia, not surprising in a country rich in natural resources but physically distant from its British cultural roots. The early settlers had to learn, sometimes by trial and error, to farm the land, the extract resources, to invent tools and implements and to produce valuable goods. (AATSE, 1988, offers an encyclopedic account of the history of technology in Australia.)

Early attempts at providing formal education focussed on primary schooling, and were provided by churches and later, in mid-19th century, by colonial governments. Technical skills were commonly passed on directly from artisans to novice apprentices; sometimes, they were taught in community institutions such as local Mechanics Institutes. In the present century, government secondary schools were established, and for most of this century, there were distinctive curricula to provide pre-vocational training in industrial arts such as woodwork, metalwork, automotive repair, etc. In some states (e.g. Victoria) distinct systems of high schools and technical schools were established early in the 20th century; these systems underwent massive expansion following World War II. (There is also, throughout Australia, an extensive Catholic education system, and a large number of independent schools, many of which are affiliated with various Protestant churches.)

Unlike England, where an examination at the end of primary schooling was used to direct students to different schools, the choice of high school or technical school was officially a matter of parental and student decision. However, there was a strong culturally accepted view that high school was for relatively brighter children who were "good with their brains"; less able pupils ("good with their hands") were often pressed to go a technical school, or follow vocationally-oriented subjects in the high school. Gender stereotyping was common and, for most of this century, unchallenged. Subjects such as woodwork, metalwork and mechanical drawing (invariably for boys) and home economics (for girls), often taught by people with industrial experience and minimal levels of general education and teacher education, tended to emphasise the transmission of a fairly narrow repertoire of skills, intended for use in fairly stable, predictable circumstances. These subjects assumed that students were heading for a stable vocational niche in which these skills could be put to practical use. There was much emphasis upon reproduction of standard procedures, little on invention and innovation (Gardner, Penna & Brass, 1989).

The differing educational pathways led to differing end-of-school qualifications. With few exceptions, university education was restricted to those who had completed "academic" subjects in high schools or non-government schools. Completion of technical school led to the workforce and apprenticeships, or to further education in certificate and diploma courses in technical institutes.

A change in clientele. During the 1970s, increasing proportions of secondary school students were remaining at school and completing Year 12. (In 1972, about a third of Australian children entering secondary school went on to complete Year 12; by 1990, this proportion had doubled.) As educators recognised that the senior years of secondary schooling were no longer the preserve of an academic elite, there were moves to broaden the curriculum and to change the accompanying assessment procedures. In Victoria, during the early 1980s, various alternative curricula and assessment procedures came into existence. The traditional, academic, Group 1 (largely externally assessed) Higher School Certificate continued to have the highest prestige and to control admission to university education. Group 2 Higher School Certificate and the Secondary-Tertiary Certificate, both utilising school-based assessment, permitted the inclusion of more "practical" subjects in the curriculum, but these pathways still tended to close off university education to students enrolled in them.

INTERNATIONAL AND NATIONAL PRESSURES FOR CHANGE

Concurrently with these developments, technology educators in the 1980s were recognising the need for change in their field: away from subjects that tended to make sharp distinctions between the "academic" and the "practical" towards subjects based on a marriage of thought and action, away from subjects which provided training in a narrow range of vocationally-oriented skills towards those supporting the goals of general education, and away from traditional "boys'" and "girls'" subjects towards curricula which were more gender-inclusive.

Various societal factors operated in Australia (as in many other countries) to bring about substantial change in the educational system in general, and in technology education in particular. These factors included:

* increasing trends towards globalisation of economic and educational systems;
* increasing demands for technological development in order to strengthen the national economy;
* changes in the role of technology in the work-place, coupled with beliefs that education in the post-compulsory years should help prepare students for the world of work.;
* increasing retention rates in the post-compulsory years;
* perceptions that technological awareness is important in modern society, that education ought to help raise that awareness amongst all students, irrespective of their career intentions.

Global influences. Developments in Australian curriculum policy during the past decade have taken place against a backdrop of increasing influence by international governmental agencies upon national policy agendas. Australia joined the Organisation for Economic Co-operation and Development (OECD) in 1971 and has drawn upon its policies in the area of education. The influence has not all been one-way. Australia has contributed actively to OECD policy making. During the late 1980s, the then federal Minister for Employment, Education and Training, Mr John Dawkins, was also the chair of the OECD Education Committee. At various times, 45 Australian educators have worked on OECD bodies.

In 1991, Mr Dawkins was the initiator of the federal government-sponsored Carmichael Report (1992) on vocational education, which set a target of 90% of young people complete Year 12 and argued for a nation-wide system of senior colleges to provide "mature learning environments...more vocational options in Years 11-12... improved careers education" (p. viii).

The influence of international agencies such as the OECD is merely one of many cultural processes which are operating to bring about a globalisation of education. Economic factors also exert a global influence on education systems, often in indirect ways. For example, multi-national corporations may at short notice relocate their production sites, resulting in international movements of capital and labour. Motor-car parts may be made in one country, assembled in another and are exported to a third country, where the cars have to be serviced. An obvious requirement for economic success in such settings is the availability of technically competent workers and business executives with sophisticated management expertise. Modern industrial techniques (e.g. just-in-time methods, total-quality-management control) generate increasing demands for workers who are multi-skilled. These demands affect education systems throughout the world.

Other cultural factors are also influencing education systems in many countries. More and more, English is becoming the international language of travellers, industrialists, scientists and technologists. The proportion of the world's population with access to information technology has dramatically increased during the past decade. Satellite and cable TV, fax machines and mobile phones, and personal computers equipped with CD-ROMs and linked to the information superhighway have all turned Marshall McLuhan's concept of a global village into a reality.

Macro-economic pressures. Australia is an extremely resource-rich country which for much of its history as a modern nation has had an economy based on the sale of raw or processed natural resources. For more than a decade, numerous political and industrial leaders have been warning that Australia must strengthen its technological and manufacturing base. Serious economic problems have been caused by selling raw materials cheaply and spending the proceeds on expensive, imported products, causing a serious balance-of-payments problem. (Australia is of course not alone in this.) During the 1980s, various government and industry reports have argued that Australia must improve its technological competitiveness, expand its exports and reduce its imports (Myers, 1980; Metals Industry Council, 1985). A state government report conveys the flavour of this argument:

> In an economic context, the Government is seeking actively to encourage export-oriented enterprise through the joint exploitation of the State's scientific, technological and industrial capacities to improve the international competitiveness of Victorian industry. Adoption of new technology offers a major opportunity to improve the competitiveness of industry — something which is urgently required if Victoria and Australia generally are to achieve sustained economic and employment growth. ...
>
> Improved competitiveness involves more than just advantage in the relative costs of production. Non-price factors such as entrepreneurial skills, innovation, excellence of design and, in particular, the ability to convert research and development activity into commercially attractive products and technology are key determinants of competitiveness (Victorian Government, 1986).

The Metals Industry Council (1985) expressed a similar view:

> One of the greatest challenges facing Australian industry is coping with the pace of technological change. If Australian manufacturing is to survive and prosper, it must keep abreast of international technological developments and make use of latest technologies in the manufacturing process. It must also be capable of making technological advances of its own.

It is perhaps worth noting that recognising a problem is not the same as solving it: a decade later, Australia still suffers from a massive balance-of-payments deficit. Economic concerns are still being expressed in more recent educational policy documents. For example, a national report on vocational certification and training (Carmichael, 1992) called for "broad structural reform" in methods of meeting Australia's training needs, and argued that "Change is needed to improve our international competitiveness, to complement changes in work organisation and industrial relations, and to improve the coverage, quality and equity of vocational certificate training in Australia" (p. vii). Recently, following a World Bank report identifying Australia as the wealthiest country in the world (measured in terms of total assets per capita), Dr Michael Dack of the Institution of Engineers wrote a letter to The Age (20 October 1995) pointing out that "only 21 per cent of our per capita wealth comes from human capital — that is, our workplace skills, standard of education, and so on. This is a low percentage on the world scene, which averages 64 per cent." Dr Dack went on to argue "the real indicator of cleverness is the ability to add value to our natural resources. Wealth can only be sustained by creating new wealth that compensates for the gradual depletion of our natural capital." He argued that, in this respect, the country is not adequately planning for its future: "our education, industry and research policies thrash around in isolation from one another. Vision is a concept unknown in government circles. Company boardrooms pay more attention to the current balance sheets than to long-term investment. The brightest of our young people gravitate to occupations that consume the nation's wealth rather than add to it." In a similar vein, a recent federal government advisory council report (ASTEC, 1995) attempts to look ahead to the year 2010 and draws attention to the need for "innovation and entrepreneurship ... to capture opportunities from globalisation ... to build a forward-looking science and technology system" (p. 2).

In this scenario, studies in science, mathematics and technology are regarded as necessary for educating future leaders and employees in technological fields. A federal government document makes clear the nexus between the economic challenges and their educational implications:

> Global economic forces are demanding changes in the structure of Australian industry, in our ability to compete in world markets, and in our readiness to adapt to new jobs, new career structures and new technologies. These changes will require new skills in communication, understanding and cultural awareness, in the workplace as much as in the international marketplace. They will also place added pressures on our education and training systems (DEET, 1991, p. 1).

An earlier state government report (Victorian Government, 1987) made some specific recommendations:

> In particular, there is a need to strengthen those mathematical, scientific and technologically based skills which are essential for the development of higher value added, more technologically advanced export and import replacement industries.

And the previously-mentioned ASTEC (1995) report recognises that technological development, innovation and entrepreneurship requires a "technologically literate society":

> The 21st Century will see an increase in the pace with which we introduce technology into our society. The appropriate response to more technology is not to ignore it, but to accommodate it, respond to it and shape it. We need society that can make informed choices (p. 2).

Pressures from the industrial sector. Pressure for change has also come from the work-place, reflecting the changing nature of manufacturing industry. Two trends are evident: the proportion of the Australian work-force engaged in manufacturing industry has been steadily falling while at the same time technological development (coupled with changing work practices in some industries) has led to a growing demand for employees with multiple skills. Increasingly, employers are regarding school leavers with only a narrow range of manual skills as unsuited to the needs of modern industry. Flexibility, a sound general education, a broad level of skill development, and the attitudes and skills to er in continued learning are better suited to modern requirements.

Employer demands (in manufacturing and other industries) for better-educated employees have contributed to a pressure to increase school retention rates. Other factors that have helped to increase retention include federal government initiatives, based on the belief that economic prosperity is related to the level of education of the workforce; improved employment opportunities for young people who continue their ucation beyond the compulsory years (and reduced opportunities for those leaving earlier); and increased numbers of places available in the universities and the TAFE (Technical and Further Education) sector, and a greater diversity of course offerings.

Societal and cultural pressures. Th remaining pressures reflect a recognition that technology now permeates every aspect of modern society: in the home and in leisure pursuits as well as in the work-place. Education for work is important, but work is not the only purpose in life. Technology education may help prepare students for the work-place, but need not serve solely economic goals. It can also help people gain understanding and control over their lives, by contributing to liberal aspects of education. (One might argue that modern technological developments are rendering the liberal/vocational dichotomy, and others such as technical/academic and education/training inappropriate.) A significant early exposition of this broad view of the potential contribution of technology education can be found in a report prepared jointly by the Hawthorn Institute of Education and the Education Department of Victoria as a result of a UNESCO initiative in 1982. The report (HIE, 1984) examines the goals of technology education, distinguishes it from technical education. It describes several case studies of technology projects carried out in various schools; in each, there is a clear commitment to involving students in design and action. In Chapter 2 of the report, the authors reject the view that technology education should focus exclusively on high technology such as

> computers, nuclear reactors and in vitro fertilization methods. Inventiveness and beliefs about what constitutes a better or easier life are at the centre of technology, and should have a central place in technology education. They may be exhibited as much in low or alternative technology as in high technology; as much in farming as in electrical engineering (Malcolm & Stephens, 1984, p. 23).

These authors argue for a liberal and comprehensive view of the role of technology education: technological expansion should not be accepted uncritically; social, environmental and economic aspects should be recognised. Students should be aware

> that technological decision making is multifaceted; that decision making is more the resolution than the solution of problems; that attacking one part of a problem often creates new problems somewhere else.... technology education should be a part of education for all students. It should assist students not only to cope with technological change and life in a technological environment, but also to contribute, by their work skills, and democratic participation, to technological development and social progress (p. 24).

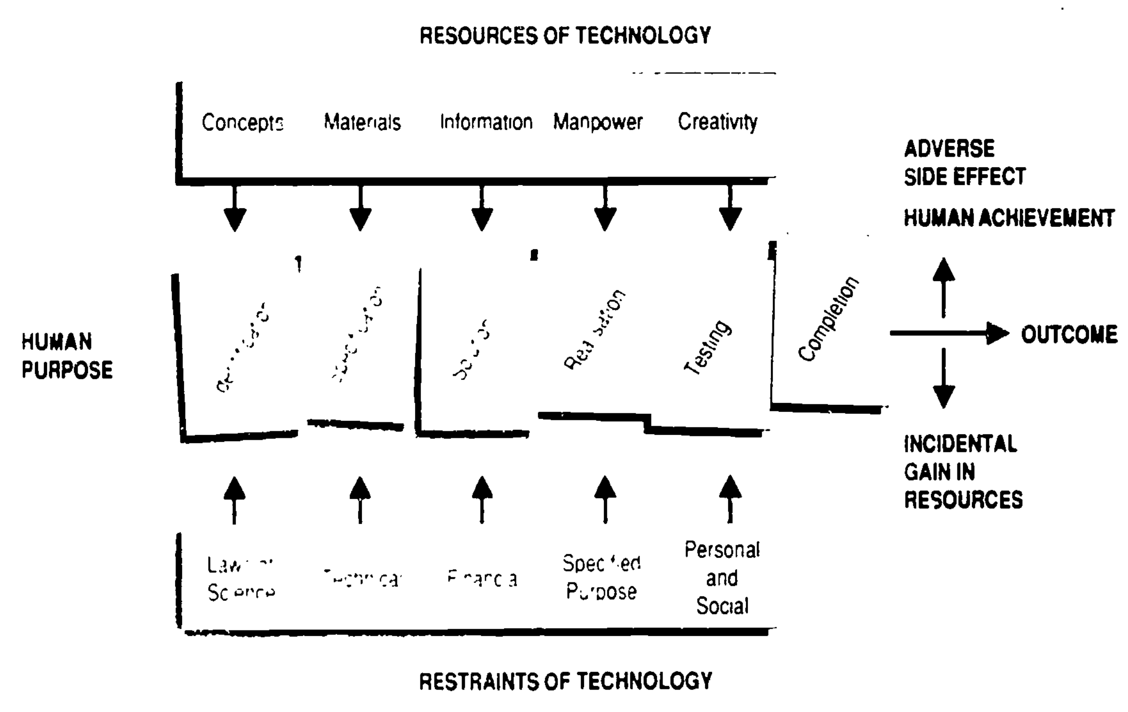
The Blackburn Report in Victoria. These various social pressures led to general agreement among political, industrial and educational leaders that narrowly-focussed vocational education at secondary school level was unsuitable for a society undergoing rapid technological change, and that separation of pupils early in their secondary schooling into distinctive streams or school systems was no longer justified. In Victoria, the influential Blackburn Report (1985) made 45 recommendations for educational reform, among them (Recommendation 32) the replacement of a bi-partite state system of technical and high schools with a single, comprehensive system of secondary colleges. Recommendation 12 called for the development of vocationally-oriented "applied studies" within the area of mathematics and science/technology. The next recommendation (13) called for the introduction of compulsory studies of "work in society ... in the contexts of technological change since the industrial revolution of the eighteenth century and in present day Australia ... [including] the study of work undertaken in domestic units..." (p. 64).

Most of the Report's recommendations were adopted by the then Labor government (Recommendation 13 was attempted but eventually abandoned). The policies were implemented by the early 1990s; in many cases, neighbouring schools were amalgamated to form multi-campus institutions; in other cases, surplus buildings were sold off to private developers. Paralleling this change in physical resources was a change in the structure of the curriculum: the various systems of curriculum and assessment in the final years of schooling were replaced by a unified system leading to a single certificate, the Victorian Certificate of Education. This development will be described in more detail later.

Curriculum developments in England. Although Australia is today virtually an independent nation, it is still part of the British Commonwealth and many aspects of its educational policies are grounded in English practice. (In contrast, Australian curriculum policy has very little in common with that in the United States, with its preponderance of one-year, unsequenced, text-book oriented subjects.) Many of the ideas about curriculum and assessment policy in Australia parallel earlier developments in the UK; in both countries, curriculum developments have been constructed on an outcomes-based model of education. As Marsh (1995a) has pointed out, although the actual terminology is different, there are many conceptual similarities between Australian and English ideas. Four central principles of assessment seem to be shared: that it should be criterion-referenced; that it should be used for formative purposes; that moderation procedures should be used to permit comparisons across classes and schools; and that assessment criteria should relate to a developmental progression.

The emergence of technology studies as a distinctive component of the national curriculum in Australia also followed similar developments in England. The broad view of the nature of technology and the emphasis on developing learners' practical capabilities parallel earlier statements by English technology educators. For example, Black and Harrison (1985) considered technology as the practical method which has enabled us to raise ourselves above the animals and to create not only our habitats, our food supply, our comfort and our means of health, travel and communication, but also our arts — painting, sculpture, music and literature. These are the results of human capability for action. They do not come about by mere academic study, wishful thinking or speculation. Technology has always been called upon when practical solutions to problems have been called for. Technology is thus an essential part of human culture because it is concerned with the achievement of a wide range of human purposes (p. 5).

Later official government curriculum reports (e.g. Parkes, 1989) reflect a similar position, emphasising breadth of scope and the value of practical action. Sometimes, the influence of English thinking upon Australian curriculum documents is explicitly visible. For example, a model of the technological process (Fig. 1) presented in an official Victorian state government curriculum guide (Maruff & Clarkson, 1988) is a simplified version of a model published in a UK Schools Council document a few years earlier (Page, Poole, Hucker & Harris, 1981).



<u>Fig. 1 A model of the technological process</u>
(Maruff & Clarkson, 1988, p. 8)

Although there are numerous similarities in curriculum ideology, organisation and content between Australia and England, there is also a noteworthy difference in implementation. In England, proposals to make the education system more accountable by introducing national curriculum guidelines and then assessing them were first touted by the (Labour) Callaghan Government in 1979. The idea was taken up with enthusiasm by the subsequent (Conservative) Thatcher Government which backed its curriculum and assessment policies with the force of law: schools were *required* to implement the government's curriculum policies. Whether the Australian Labor Party (ALP) government under the then prime minister, Mr Hawke, intended to pursue a similar line is unclear. It certainly had no constitutional power to do so, and in any case, as we will see later, political developments at state level in the early 1990s led to the abandonment of the idea of a national curriculum so that it had no more force than a set of suggested guidelines.

National co-operation. In June 1986, the AEC resolved to "support the concept of a national collaborative effort in curriculum development in Australia to make the best use of scarce curriculum resources and to minimise unnecessary differences in curricula between States (Curriculum Corporation, 1994a, p. 40). A year later, the AEC had identified five priority areas for collaboration. Technology was not amongst these: the decision to develop a national curriculum statement in this area of learning was not taken until December 1990.

As noted earlier, the 1989 Hobart Declaration, formally known as the *Common and Agreed National Goals for Schooling in Australia*, made explicit reference to technology. It also listed several goals to which technology studies might contribute (e.g. "skills of analysis and problem solving", "an understanding of and concern for balanced development of the global environment"). Over the next two years, the AEC eventually decided that eight areas of learning should be included in the national curriculum. It proposed, for each learning area, the development of a *statement* (guidelines describing the goals of the learning area, in a sequence of levels covering all the years of primary and secondary schooling) and corresponding *profiles*: descriptions of intended learning outcomes at increasing levels of complexity. Statements and profiles were being developed by separate groups of people, the former by a group managed by the various state Directors of Curriculum, the latter by a body known as the Australasian Cooperative Assessment Program. An administrative structure which separates the formulation of goals from the formulation of appropriate assessment procedures seems a curious way of going about curriculum innovation; by the AEC's own admission, this dual structure did not work satisfactorily and was replaced by an AEC Curriculum and Assessment Committee (CURASS) which took over all projects until completion. In June 1992, a secretariat was established to support CURASS, and produced draft and final versions of the national curriculum statements and profiles.

The National Curriculum Statement. The national curriculum statement for technology (Curriculum Corporation, 1994a), a 44-page booklet, consists of three parts. Part 1, *Technology as an area of learning*, describes the nature of technology and the goals of technology education. It indicates clearly that technology encompasses a wide range of artefacts, processes and systems:

People come into daily contact with a wide variety of both simple and complex technologies — in the home and workplace, through health services, transport and communication, and in leisure activities. Applications of technology include things as disparate as computer-assisted design and manufacturing, clothes hoists and automatic dryers, food production and processing, bicycles and jet aircraft, acupuncture and genetic engineering, as well as a range of management and organisational systems. (p. 3)

The document gives recognition to the social context of technology:

The needs and wants of people and groups in particular communities determine what technologies are developed and how they are applied. Particular technological applications are judged by their impact on communities and environments and their effect on the personal wellbeing and ways of life of individuals (p. 2)

It goes on to recognise the impact of cultural values and political beliefs on the development of technology, and the contribution that technology makes to cultural, social, environmental and economic changes.

Each learning area in the national curriculum is conceptualised as a set of interdependent *strands*, a term encompassing topics and skills which is meant to act as a guide for providing "unity of purpose and direction across all areas of study" (Curriculum Corporation, 1994a, p. 9). In the case of Technology, four strands were identified; these are described in Part 2 of the document:

* Designing, making and appraising
* Information
* Materials
* Systems

The first strand is primarily concerned with activities and processes, such as *investigating* (e.g. to identify needs and opportunities), *devising* (e.g. generate plans and proposals), *producing* (translate designs and plans into products and processes) and *evaluating* (develop and apply criteria to assess how well techniques and products meet specific needs). Evaluation is meant to include a consideration of "personal, local, regional and global implications,... environmental conditions... social and economic circumstances, ethical and cultural issues" (Curriculum Corporation, 1994a, p. 10), a broader conception than one which merely concentrates on how well an artefact or process "works".

The second strand (Information) gives recognition to the importance of information storage, retrieval and communication in various media, including "print, numerical, pictorial and graphical representations". Information technology is of course a vast modern field of knowledge in its own right, but in this area of learning, the emphasis is not so much on mastery of information technology for its own sake. Rather, it is seen as a set of tools used widely for "solving challenges across many areas of learning" (p. 10) and also as an object of study for investigating its effects: students should have opportunities to "explore the social, cultural and political effects of information technology" (p. 11)

The Materials strand focuses upon natural and synthetic resources: how various materials are selected, extracted, made, processed, used, combined, transformed, preserved and recycled, and how their properties are related to their suitability for various technological purposes.

The fourth strand — Systems — is concerned with "combinations of elements that work together to achieve specified outcomes" (p. 12). Systems may include artefacts made of many parts (e.g. a TV set), or organisational schemes (a work schedule), or complex arrangements involving the integration of many sub-systems (e.g. a sewage treatment plant, a communications network).

The AEC identified four *bands* (A, B, C and D) for use in all national curriculum statements. Bands are intended as representations of sequential development and as guides to possible learning experiences in corresponding years of schooling. These are outlined in Part 3 of the document. Bands A to C encompass early childhood through to year 10; Band D is related to the senior secondary years 11 and 12 and is designed to "meet the needs of students as they prepare for university studies, training programs and employment" (p. 32). The Statement explicitly recognises that bands should not be considered as inflexible groupings of grade levels: "Because students progress at different rates and learn in different ways, they will sometimes operate at levels above or below the band associated with their year levels. Students develop their technological capabilities and knowledge through activities based on a wide range of content. They may revisit the same content area several times from year one to year twelve, each visit refining and developing their skills and understandings." (p. 13)

Much of the document consists of a listing of exemplars of learning activities, classified by bands and further classified by strands. The language is deliberately general, and seldom refers to any specific knowledge content. For example, in Band A, Designing, making and appraising, the first three learning activities are:

> When students investigate issues and needs, they:
> * ask questions to identify needs and opportunities
> * look at how situations affect challenges
> * observe the major issues and factors in situations...

At the highest levels of secondary schooling, in Band D, the last three examples in the Systems strand are:

> When students design, make and appraise, they: [...]
> * apply quantitative tests to the components of systems (stress, strain, shear, torsion, efficiency, continuity, flexibility)
> * analyse the mechanisms used in machines and equipment (mechanical, electrical, infra-red, chemical, laser, circuits, programs)
> * select equipment to measure functions in systems (oscilloscopes, multimeters, tachometers, stress gauges).

The profile. The accompanying curriculum Profile booklet (Curriculum Corporation, 1994b) is a much larger document (152 pages), which repeats, classifies further and amplifies the material in the Statement. Its aim is to "assist in the improvement of teaching and learning and to provide a common language for reporting student achievement" (p. iii). Its scope is restricted to the first three Bands, corresponding to Years 1-10. (This was undoubtedly a realistic and sensible decision, since the various states would almost certainly not have agreed to dismantle their existing systems of end-of-school assessment in favour of an untried, centralised system.)

The strands are further classified into a small number of *strand organisers,* which are described as "organisers of content, process and/or conceptual understanding within a strand" (p. 7). The bands are divided into eight *levels* of achievement. The *level statements*, taken from the curriculum Statement, are amplified through the presentation of *outcomes, pointers* and *annotated work samples.* Outcomes are descriptions "in progressive order [of] the various skills and knowledge that students typically acquire". Pointers are "indicators or signals of the achievement of an outcome"; they are regarded as examples, not as requirements. Annotated work samples are illustrations of student work demonstrating achievement of the specified outcomes at a particular level.

Illustrative material from the Profile document is shown in Appendix 1. It shows a technological task considered appropriate to Level 3 (middle primary school years): the designing and constructing of a model moon buggy using pulleys and gears. This task provides opportunities for outcomes in the Design, making and appraising strand and in the Systems strand. The annotations next to one child's sketch of a Lunar Bugger [sic!] signal that the child has developed some ability to make a detailed drawing with explanations, to identify the parts and how they inter-relate, and has some conception of how a mechanical system can move and operate the buggy's antenna. Nearly all the document is taken up with this kind of material.

Many modern writings on educational evaluation stress the importance of *authentic assessment*, of ensuring that the methods used to evaluate student progress are consistent with and support the curriculum goals. Authentic assessment procedures "engage students in hands-on activities, often involving the creation of a product or the construction of a response" (Niyogi, 1995, p. 5). One of the strengths of the national curriculum statement is that it clearly reflects such a view. Judging a learner's achievement is not limited to traditional pencil-and-paper testing: rather, teachers are encouraged to obtain a wide variety of data in order to evaluate student progress. The Statement points out that

> Many sources of information can be used to assess student learning in technology. These include:
> * a diary or log of thoughts and plans
> * descriptions and analyses of techniques used
> * sketches and drawings of ideas and products
> * lists of information sources used, with justifications for their selection
> * recordings of interviews and on the job conversations
> * photographic and video records of activities and outcomes
> * summaries of tests carried out and processes used
> * working models and devices

* folios of designs and finished work
* documented and researched appraisal of outcomes
* design specifications and modifications
* oral presentations and reports (Curriculum Corporation, 1994a)

Rejection of the national curriculum policy: the 1993 AEC meeting. All of this might imply a highly organised and efficient curriculum development operation, soundly conceived and skilfully executed. In many ways it was, but while it was being developed, political events occurred which powerfully affected the status of the scheme. Intended as the basis for a uniform curriculum throughout the nation, it finished up as no more than a set of guidelines which individual states and territories could adopt (or not) as they wished. Concurrently, some academics and educational lobby groups were questioning the rationale of the whole operation.

In July 1993, the AEC met in Perth, Western Australia, to determine its policy on the national curriculum. In two states (Victoria and Western Australia), there had been a recent change of government, and the coalition (Liberal and National) now held a narrow majority (5-4) on the AEC. (The membership of nine consists of one federal, six state, two territory representatives.) Given the traditional ideological sympathy of conservative politicians for centralised curriculum control, one might have expected that this political shift would have made it even easier to implement a national curriculum, but that is not what happened. Instead, the coalition states voted 5-4 *not* to implement a national curriculum. Ellerton and Clements (1994) note that "intensive lobbying" took place immediately prior to the meeting among the coalition representatives; they cite evidence from a participant in the meeting that the decision turned on the issue of federal power versus states' rights. A national curriculum was now seen in terms of the federal government imposing its agenda and establishing a "subservient relationship between the states and itself" (p. 259). Thus Mrs Virginia Chadwick, the Minister of Education of in the (Liberal Government) state of New South Wales, despite the fact that she had initially been a staunch supporter of the national curriculum program, despite the fact that her Director of School Education, Dr Ken Boston, had played a leading role in developing the policy, became one of the five who voted against its implementation. Her motives may have been educational as much as political: Hughes (1993) notes that at about the same time, Mrs Chadwick had expressed serious concerns about the Mayer Committee recommendations (on competency-based education), and had questioned the benefits of educational reforms along these lines. Ellerton and Clements (1994) also note that media commentary at the time was cast, not in the language of political "states' rights", but in educational terms: a Sydney Morning Herald editorial on the morning of the meeting (2 July) argued that the national curriculum concept had no educational value "and should be buried at the AEC meeting starting today" (p. 260).

And so it turned out. Mr Don Hayward, the Victorian Minister (Liberal Party), moved the motion at the AEC meeting not to endorse the national curriculum Statements and Profiles. The meeting, however, carried another motion, asserting that "a collaborative approach between States and Territories is desirable in respect to education and training issues" (p. 261). The work of CURASS was terminated, and it was left to the Curriculum Corporation (a quasi-government federal body based in Melbourne) to co-ordinate the work of those states and territories that wished to continue to be involved in co-operative efforts. The Curriculum Corporation has published the national curriculum statements and profiles; it has been left to the states and territories to decide how they would make use of them. The national curriculum statement was (to borrow a phrase from the British author David Pryce-Jones who was talking about the current rule of law in Russia) indicative, not obligatory. There are wide variations around the country: Tasmania has adopted the national statements and profiles without amendment, South Australia has issued its own statements but adopted the national profiles, Victoria has issued its own versions of both, while in New South Wales, the Minister for Education and Training has put the whole process of implementation on hold, pending further investigation!

Monitoring attainment. One argument put forward by those who support the concept of an agreed national curriculum is that it can be used to guarantee students' rights, to underpin their entitlement to have opportunities to learn content and develop skills which have been identified as valuable. Such an argument does not, of course, demand a commitment to any particular *model* of the curriculum: an argument for a national curriculum does not entail an argument for, say, outcomes-based education. Nor does it entail a commitment to forced compliance: one polity may issue mandatory Orders and require observance, as in England and Wales, while another may issue guidelines and simply expect them to be followed, without legal compulsion, as in Scotland (Brown, 1995). Forced compliance implies the need for subsequent monitoring through systems of inspection or testing. Supporters defend such systems by appealing to equity arguments: monitoring ensures that students actually gain the intended opportunities to learn which have been guaranteed by the curriculum. In Victoria, in 1995, the state government introduced a statewide testing program at two grade levels of the primary school to monitor attainment in English and Mathematics. Sceptics of such procedures wonder whether their claimed benefits are genuine or illusory, and whether the monitoring procedures do more harm than good to the quality of education.

The Victorian Curriculum and Standards Framework. Early in 1995, the Victorian Board of Studies published a technology curriculum document which is modelled on (but not identical to) the national curriculum statement. The introduction of technology education in Victoria was not, of course, dependent on the appearance of the national curriculum statement: curriculum development in this field had been occurring for a decade. Many of the Blackburn Report recommendations were being implemented; the principle that technology education should form part of the general education of all students had been accepted. During 1985-87, the state Ministry of Education's Schools Division developed <u>The Technology Studies Framework: P-10</u> (Maruff & Clarkson, 1988) which faithfully reflected the shift in thinking away from traditional technical studies towards modern conceptions of technology education. This document, intended to cover all the compulsory years of schooling, outlined the nature of technology, made general suggestions about educational matters such as teaching and learning, curriculum organisation, assessment, reporting and evaluation, and offered a few illustrative examples of technology projects (designing a windmill, a musical instrument, an alarm system), but did not go into elaborate detail about intended learning outcomes.

Soon after the Framework publication appeared, Victoria reorganised the curriculum and assessment procedures in the senior secondary years (11 and 12) as a consequence of the

Blackburn Report. The Victorian Curriculum and Assessment Board (VCAB) established *Fields of Study Committees* which prepared *study designs* (clusters of related semester units of work). A new certificate, the Victorian Certificate of Education (VCE), was introduced which recognised work done during the final two years of secondary schooling. Three technology study designs were developed: *Materials and technology, Technological design and development,* and *Systems and technology* (VCAB, 1989abc). The inclusion of these study designs reflected a clear attempt to raise the academic status of this area of study; previous, deeply-entrenched distinctions between "more academic" and "less academic" curricula were being dissolved. The study designs also reflected a serious attempt to make technology education gender-inclusive. For example, the materials which could be studied in the first study design included food and textiles; the intention was that teachers and students of home economics, traditionally a female preserve, would be included in this curriculum area. Official curriculum documents consisted of guidelines which left schools some freedom as to how to implement them; assessment was based on a blend of external examinations and school-based, internally assessed project work (a development of a trend already in place in numerous previous subjects in the curriculum). Following the election of the state Liberal-National coalition government in 1992, these policies were kept in place, although there was a shift towards a reduction in the weighting of school-based assessment, and a more pronounced rhetoric about outcomes, testing and accountability.

The widespread adoption of VCE Technology study designs reflects a major success story. Although all VCE students are required to take some units in the science/ mathematics/technology field, there is no specific compulsion to take Technology. Nevertheless, in the Melbourne metropolitan area alone, 219 secondary schools (the vast majority of the city's schools) offer semester units in this field. In rare cases, the offerings may be limited to one or two semester units at Year 11 level; the most common pattern is to offer all four semester units, spanning Years 11 and 12, in each of two, or all three, study designs. In terms of enrolments, Technology has, since its inception, been a fast-growing area of the senior secondary curriculum.

After the 1992 state election, the government introduced tough budgetary measures which resulted in the retrenchment of thousands of teachers and the closing down of central and regional sources of curriculum support services. A paradoxical development occurred in which the government moved to decentralise decision-making and budgetary control to the school level (billed as the "Schools of the Future" program) while at the same time it moved to exert stronger centralised control over curriculum and assessment at all levels of schooling. VCAB, the agency responsible for curriculum and assessment in Years 11 and 12, was replaced in 1993 by a new agency, the Victorian Board of Studies (BOS), to oversee curriculum and assessment throughout all the primary and secondary years. After the defeat of the national curriculum proposal at the AEC's 1993 meeting, BOS drafted its own curriculum statements for all eight learning areas (BOS, 1994). Final versions of this document, separately for each learning area, appeared a few months later.

The <u>Technology: Curriculum & Standards Framework</u> document (BOS, 1995a) resembles the national curriculum statement in many ways, but there are also some differences in organisation. The four strands have been reduced to three (Materials, Information and Systems). The Designing, making and appraising strand now appears in the form of *phases* of the technology process (Investigating, Designing, Producing, Evaluating) which are to be considered in all three strands. The eight levels of Bands A, B and C have been reduced to seven, and although BOS recognises that "students do not learn at uniform rates", there is now a clear attempt to link levels to year levels in order "to provide clear guidelines to schools about timing and progression of curriculum and standards" (p. 4). Level 1 refers to the Prep (preparatory) year, levels 2 to 4 the six years of primary schooling, levels 5 and 6 the secondary years 7 to 10, and level 7 to "extension material" for able Year 10 students which "does not duplicate material covered in VCE" [Years 11 and 12]. The annotated work samples in the national curriculum profiles are missing in the CSF document.

The descriptions of learning outcomes reflect some subtle ideological shifts. In the national curriculum statement, "Analyses the design and management of systems in terms of their functional, aesthetic, social, environmental and commercial requirements, using scientific, mathematical and organisational modelling and systems analysis", appears in the CSF as "Analyse within environmental and commercial requirements, the design, cost benefit and management of systems particularly in relation to scientific principles of logic, sequence and control". Another learning outcome in the national curriculum statement, referring to political implications of the design, development and marketing of products and processes, is missing from the CSF, as are other outcome statements referring to societies and cultures. It is not known whether these shifts in emphasis have occurred as a result of explicit political direction, or deliberate choice by the Victorian writers, or result from unconscious decisions; however, the removal of 'social requirements' and the insertion of 'cost benefits' is not inconsistent with the political stance of the coalition government.

Current developments. In 1994, the federal government established the Ministerial Council for Education, Employment, Training and Youth Affairs, a merger of AEC, CURASS and another federal council, the Ministers for Vocational Education, Employment and Training. The new council asked the Curriculum Corporation to monitor the extent to which state and territory systems were adopting the national statements and profiles.

During 1995, schools in the various states and territories were engaged in efforts to interpret and implement the ideas in the national curriculum statements, or the local versions of them. According to McLean and Wilson (1995), who are engaged in the Curriculum Corporation monitoring process, "a great change is occurring across Australia in the way we see schooling and the language we use to describe its achievements" (p. 56). Marsh (1995b) notes that throughout the country many teachers are using profiles as a guide to "how they use syllabuses and other support materials" and that profiles are "providing a common language and purpose for monitoring and recording student achievement" (p. 53).

In Victoria, 1995 was identified as a planning year for the CSF; implementation is due to begin in 1996. Some material has already been published to give general advice to schools on how to implement the CSF (BOS, 1995b); advice on specific learning areas is in final draft form (BOS, 1995c). A Technology Network Leaders' Conference was organised by BOS in October 1995 as an initial step in disseminating ideas about the CSF to schools. The approach being used to support implementation has one noteworthy feature: rather than present the CSF as an entirely new curriculum, the line being taken is that teachers should consider what is already being offered in their schools, classify it according to strands and year levels, and then use the CSF as a basis for deciding what changes need to be made. During the conference, network leaders engaged in exercises to classify sample activities according to strands and levels. They devised learning activities around a specific technological task (e.g. "design and construct a lifting device") related to the investigating, designing, producing and evaluating phases of the technology process. They also engaged in mapping exercises which asked them to indicate the links between an existing learning activity and the various structuring ideas of the CSF (strands, levels, learning outcomes...) In addition to the work being done by BOS, the Victorian Department of School Education is planning to issue *Course Advice* documents for each level in all learning areas, and to run state-wide workshops on assessment and reporting.

A critique of the underlying model. McLean and Wilson (1995) report that there is "general acceptance of the outcomes approach to teaching and learning" throughout the country, that there was a willingness by the state systems to regard the next few years as a trial period for implementing the approach, and that most teachers' reactions to the new documents have been favourable. This generally positive evaluation is probably true, but it should be pointed out that the policy does not have universal acceptance.

The statements and profiles are founded upon an outcomes-based education (OBE) model — *competency-based model* is an equivalent term — in which curriculum inputs are defined, and corresponding, observable, learning outputs (competencies) are expected. Supporters claim that this approach to curriculum helps direct teachers' and students' attention to the attainment of a planned sequence of achievable goals, and that it provides a basis for demonstrating to the public that the intended goals have been met in practice. Although the rationale for such a model is often not made explicit, its defenders may employ the language of economic rationalism and talk about efficiency, consumer choice and public accountability.

In Australia, the language of OBE has been adopted, not only in national and state curriculum documents directed at schools, but also in recent policy documents on adult vocational education and training. A sequence of national reports (Finn, 1991; Mayer, 1992; Carmichael, 1992) define desired hierarchies of competencies for adults engaged in industrial training or enrolled in Technical and Further Education courses, operationalise these competencies for the purposes of certification, and propose national implementation strategies for ensuring that vocational education providers deliver consistent outcomes. The adoption of OBE is not a distinctively Australian phenomenon. It is driven by pressures to guarantee comparability of vocational qualifications, and to give proper recognition to prior learning when people transfer from one educational system to another. It is also indicative of a world-wide trend towards political demands for accountability.

OBE represents an updated version of the Tyler (1950) model of curriculum and assessment, which laid the groundwork for the behavioural-objectives movement reflected in the classic work of Bloom (1956). It is a modern version in two respects. First, the national curriculum proposes guidelines but does not specify the fine details of exactly what is to be learned. The pointers in the curriculum profiles are to be considered illustrative examples, not prescribed content. Second, the original behavioural-objectives movement led to an emphasis on pen-and-paper testing; in the modern version, there is scope for a wider range of student performance to provide evidence that learning has occurred.

The OBE model has some appealing features — it places value on clear purposes and evidence of learning — but it is not without its detractors. Some view it as an arm of economic rationalism and are critical of the use of economic metaphors in debates about curricula. Education, they argue, should not be treated as a "commodity" which can be "delivered". Other critics focus on the tendency of OBE models to limit the range of educational experiences through an over-emphasis on narrow, easily-measurable technical competencies. Elliott (1994), in an essay on the evaluation of educational innovations in the field of environmental studies, argues for the centrality of developing learners' practical competence. He argues that although this is "often reduced to mere technical competence in producing pre-specified states of affairs construed as 'objectives' or 'targets'", such a narrow view is mistaken. Practical competence also "embraces the manner as well as the objectives of performance... [It] subordinates the technical to the ethical. Its outcomes consist of wise judgements and decisions about how to realise human values in concrete and often complex social situations" (p. 38). Elliott's concern is that teachers may lose sight of these attributes of the broadly-educated person in a system which focuses too much on specific competencies.

Furthermore, the OBE model reflects a "social engineering" view of teaching and learning in which the *selection* of the outcomes tends to be treated as unproblematic. According to Angus (1994), competency-based education

> shifts our attention away from teachers and students struggling to make sense of complex issues and difficult material, and instead concentrates our attention simply on what students are able to <u>do</u> at the end of the day. ... It gives a false, or at least unduly simplistic, impression that education is a neutral process and that educational problems can be brought under control by managerial means. Competencies are likely to be atomistic, reductionist and to misrepresent the complex reality and variability of education. The narrow outcomes-based approach lacks a theory of learning and so is out of touch with developments in both social and cognitive psychology (and behaviourist psychology as well for that matter (p. 12).

Ellerton and Clements (1994) make a similar point. They mount a detailed attack on behavioural objectives, learning hierarchies and mastery-learning theory, and argue that outcomes-based education, which is derived from these earlier ideas, does not rest upon any strong research base. Boomer (1992), one of the senior educational bureaucrats associated with the introduction of the national curriculum statement, admits that there was no well-defined body of research which could guide the process of deciding how the National Profiles were to be organised for all eight areas of learning. Although less critical than Angus or Ellerton and Clements, Hughes (1993) records a lack of universal enthusiasm among Australian educators for this curriculum policy:

> For while TAFE [Technical and Further Education] has embraced the changes, undertaking major overhauls of its curriculum and certification procedures, the school sector remains diffident about launching a major overhaul of the secondary system along competency lines, and higher education appears to have rejected most of the proposals out of hand (p. 7)

Hughes comments that the policy has "failed to win consensus" and has "even provoked some pointed disavowals from [some] state ministers" (p. 8).

Other lines of attack focus on the procedures used to produce the national curriculum statements. Official publications assert that their development came about only after an extensive process of consultation. For example, the Curriculum Corporation (1994a) claims that "Throughout the writing process, nationwide consultations occurred with groups such as parents, teachers (from both government and non-government sectors), teacher educators, professional associations, subject and discipline specialists, curriculum developers, community groups, employers and unions" (p. iv). The focus of Ellerton and Clements' work was the national curriculum statement in Mathematics, but their critique makes general points about the entire rationale and procedure. They offer a detailed critique of the failure of the politicians and educational bureaucrats who were driving the national curriculum project to consult with academic and teacher organisations.

Similarly, official publications assert that the profiling procedure rests on a sound research base. The Curriculum Corporation (1994a) states that "The Australian Council for Educational Research (ACER) has validated the levels. The profiles have also been subjected to intensive trialling in Australian schools" (p. iii). Again, such assertions have not been accepted uncritically. Ellerton and Clements (1994) question whether the profiles could have been adequately validated in the short time available, commenting that the decision to develop and use profiles in all eight learning areas had been made by the AEC

> before research had demonstrated that the whole notion of profiling was educationally viable. It was indeed becoming increasingly apparent that faith and hope, and not the results of carefully conducted research, were fuelling the Profiles Juggernaut. At stake, was the curriculum of the nation's schools (p. 196).

One consequence of this for technology education (and for every other learning area) is that teachers should take a constructively critical attitude towards the sequencing of the intended outcomes. In theory, the notion of an ordered progression of capabilities has considerable appeal, but given the haste with which this phase of the work was done, perhaps several years of hands-on experience by teachers and research by curriculum evaluators will be needed in order to justify (and if necessary revise) the present scheme.

PRACTICAL PROBLEMS

In addition to these challenges to its theoretical underpinnings, implementation of the national curriculum statement has been fraught with a number of practical difficulties, for all learning areas. In the specific case of technology, some of the difficulties are distinctive.

Translation of the curriculum statement into educational practice. Some difficulties reflect problems in translating ideas in curriculum documents into school curriculum policy. Most schools now have senior teachers who are given special responsibility for curriculum development, but they usually come from traditional academic backgrounds and may have little understanding of the distinctive features of technology education. An anecdote will illustrate the point. On a recent national radio program (ABC, 1995), one high school principal in New South Wales explained that her school had been designated (without prior consultation!) as a technology high school. She stated explicitly that she considered 'technology' to be wider than 'computers', yet the examples of curriculum content she mentioned were related to computer technology: computerised stage lighting, digitised photography. She explained her understanding of the rationale of technology education: to help students to be "users of technology" rather than "makers of technology". Now, being able to use hi-tech equipment confidently is of course a valuable skill, but to de-emphasise the designing and making aspects of technology education is actually to subvert the intentions of the national curriculum statement. Anecdotes like this suggest that it is important to explain curriculum positions to school administrators (principals, curriculum directors); offering curriculum advice only to teachers may be inadequate for successful implementation.

The national curriculum statement indicates only in very general terms what is to be taught at any particular level. The complementary profiles provide some additional guidance, in that the annotated work samples illustrate ways in which the intended outcomes might be assessed, but neither document provides details of specified content or advice to schools and teachers about methods of curriculum implementation. Similarly, the material currently being drafted in Victoria to help schools to implement CSF Technology (BOS, 1995c) is intended to help teachers to familiarise themselves with the concepts underlying the CSF and indicate strategies for making use of it. It is not, however, a detailed course outline. (Perhaps the *Course Advice* documents to be issued in 1996 will offer more specific guidance.)

The absence of comprehensive details is intentional, and not grounds for criticism. In learning areas where schools and teachers already possess much relevant experience, it could be argued that detailed specifications are not only unnecessary but actually detrimental, since they would inhibit the freedom of teachers to exercise their professional judgement about what is appropriate for their students. In the case of technology education, that argument is more difficult to sustain, since many teachers are not highly qualified and lack experience in teaching some of the novel aspects of the new curriculum.

Teacher qualifications. A distinctive problem in the technology area relates to teacher qualifications and experience. At secondary school level, teachers of most other subjects have four years of tertiary education, typically a three-year degree plus Dip.Ed., or a four-year concurrent B.Ed, but this is usually not the case for Technology. A recent small-scale study in Victoria (de la Rue & Gardner, 1995) showed that of 20 technology teachers, only two held degrees, and these were not in technological fields; the others held various diplomas and certificates and had industrial experience in diverse fields such as woodwork, auto mechanics, coppersmith, electronics, fashion design and graphics. Half of the sample agreed that they had done no studies relating to the social and environmental aspects of technology. This makes the task of implementing a new curriculum in technology rather different from that of implementing a new curriculum in a well-established field.

At primary school level, teachers' qualifications are more uniform, as all teachers will have completed three or four years of teacher education in a college or university. However, the proportion that have taken any subjects that would equip them with technological capability is minuscule. Any attempt to introduce technology education into Australian primary schools in the coming decade must therefore concentrate on professional development, rather than initial teacher education.

The need for expanding professional development. There is widespread recognition among educators in Australia (as elsewhere) that professional development is a crucial element in the quest for raising the quality of education. Even the best and most comprehensive printed curriculum statements, profiles, guidelines, instructional materials etc. are of limited value unless teachers feel confident and competent about using them. The term 'professional development' encompasses a wide range of activities, from short sessions on specific topics to sustained programs lasting months or years. One area of professional development that needs more emphasis in technology education (and in other learning areas) is the provision of opportunities for teams of teachers to meet together over an extended period in order to develop their capacity to turn general ideas in the national curriculum statement into their own detailed and well-documented plans for classroom action in ways that suit their local school needs and their personal styles of teaching. Such plans (in the UK they are coming to be known as *schemes of work*) are not merely more elaborate listings of content: they include descriptions of intended time allocation, teaching approaches, classroom organisation, necessary resources and appropriate forms of assessment.

Some federal funding under the National Professional Development Program is being provided to universities and teacher associations to develop and implement professional development courses of various kinds, and to publish supporting material. It remains an open question as to what proportion of the teaching workforce is actually influenced by such developments. In Victoria, the post-1992 budgetary cutbacks in education, noted earlier, resulted in a sharp decline in centralised and regional curriculum support. Schools were given some funds to organise their own professional development, but teachers were not allowed to attend in-service courses run during normal working hours. As Northfield and Mitchell (1995) have pointed out, "system priorities are generally about an agenda of communicating policies and curriculum changes to teachers" (p. 5); they are not necessarily directed towards the more time-consuming processes of promoting teacher development and changes in classroom approaches to teaching and learning.

Several universities around the country offer a variety of programs designed to promote teacher professional development. One unusual project which has been running for five years is an on-going joint venture between the Faculty of Engineering and the Faculty of Education at Monash University. Fourth-year engineering students may enrol in an elective for credit and are placed part-time in a primary or secondary school for a few weeks, where they work with a teacher and a class to implement a technology project. Afterwards, the engineering student is required to write a report and make an oral presentation to a peer group at the university. This project is of triple benefit: the teacher benefits from the contact with an engineer, the school students benefit by working on an interesting project (and incidentally learning something about engineers), and the engineering student benefits from the experience of explaining engineering concepts to lay people. Monash University has also introduced three master's course-work semester units: *Technology in the Curriculum; Technology, Science and Society;* and *Design and Technology Education.*

At primary school level, Francis (1994) reported that many teachers in New South Wales who were attempting to implement a new science and technology syllabus lacked confidence in both content and teaching approaches; the proportion lacking confidence in teaching the technological aspects of the curriculum was even higher than that for the scientific aspects. In various Australian states, a small number of pioneers have been working to introduce technology education into the primary classroom, and to engage other teachers in professional development. For example, Jane and Jobling (1995) have reported on Grade 5 children's involvement in the technological task of designing, making and evaluating a device for catching live insects for the purposes of studying them in the classroom, and have prepared a video documentary to inform other teachers. Such initiatives are important for showing teachers that they do not have to be physics, chemistry or computer science graduate in order to introduce suitable technological tasks into the primary school classroom.

These are mere beginnings. Generally technology education in the primary school exists more on paper than in reality. A common (mis)conception amongst primary teachers is that technology is industrial arts (perceived as a male domain), or applied science, especially physics and chemistry. Most primary teachers are female, and these are subjects which have been avoided by teachers in their own senior secondary schooling and beyond; they therefore lack confidence in initiating curriculum innovations in this field. Various bodies — state and non-government education systems, teacher associations and universities — are introducing pre-service in-service programs to attempt to redress this situation. For example, at the University of Technology, Sydney, a unit on Science and Technology has been introduced into the three-year Diploma of Teaching program for intending primary teachers with the explicit aim of enhancing these teachers' feelings of competence and confidence; one major topic involved a co-operative group learning project which focussed on heat pumps in refrigerators and air-conditioners (Segal & Cosgrove, 1992). However, the proportion of primary teachers with such educational experiences is so far very small. It will take many years for this situation to change.

Future personnel needs. There is little evidence of effective planning at national or state level for future personnel needs. The post-1992 retrenchment of teachers in Victoria was mentioned earlier; since then, few new teachers have been appointed in the state system. The age-profile of the state's teachers is therefore steadily shifting upwards. In the particular area of technology education, the lack of overall planning will predictably lead to major problems of implementation in the coming decade. Most of the state's 2000 technology teachers are in their late forties or older, and hundreds will retire in the coming decade. These ought to be replaced with young graduates who possess technological capability in various modern fields and who have undergone a proper course of teacher education.

A new teacher education program. In 1994, the Faculty of Education at Monash University was the first in the state to introduce a one-year graduate-entry Methods and Practice of Teaching Technology option in its Diploma in Education program; the students in the course have degrees in Engineering or Applied Science. The methods program is constructed around four main components: a *curriculum model* based on the concept of project-centred learning; *change strategies* intended to assist new teachers faced with the task of introducing technology curricula into their school; *practical teaching*, carried out during three teaching placements in a variety of school settings; and a *technical skills program*, to provide the Dip.Ed. students with opportunities to gain adequate competence in working safely with a variety of materials, tools and equipment (e.g. basic electronics, pneumatics and robotics, computers).

The enrolment in the first two years of this program has been small, certainly not enough to meet future personnel needs. One of the causes of the problem is that entrants must compete for places, on the basis of academic merit, with applicants for all other Methods programs. But this is not the major problem, since in any case the demand for places is not very high: there is no clear tertiary pathway leading to this post-graduate teacher education program. Intending science teachers enrol for a B.Sc; future history teachers take a B.A. What should a technology teacher study? What is needed is a degree program, leading to a distinctive Bachelor of Technology degree, which incorporates theoretical and practical work in a variety of technologies, coupled with broader studies which encourage thoughtful consideration of societal and environmental issues.

Even if such a degree program were to be provided, other problems would still remain. Firstly, there seems to be little awareness among political leaders and educational administrators of the enormous gap between future personnel needs and what is actually likely to be available if current policies are maintained. Government documents rightly assert the importance of technology education, but some of the practical policies needed to ensure their implementation in the classroom seem to be missing. Secondly, if appropriate tertiary courses can be constructed and funded, there will be a need for a sustained public relations exercise to encourage capable school technology students to consider technology teaching as a career.

Physical facilities. Modern technology education requires students to have access to a wide range of facilities: material resources, tools of various kinds, services (water, electricity, pneumatic systems, kilns), computer hardware and software, and appropriate spaces in which to work. Some very positive developments are occurring. For example, Glen Waverley Secondary College, in Melbourne's eastern suburbs, has received $6 million in government and industry funds to build a new Science Technology Centre. The school's curriculum director and her staff recognise that the building is only one component, and that designing curricula appropriate for students' learning needs, securing staff commitment, providing opportunities for professional development, and purchasing suitable instructional resources are equally important.

A few schools outside the government system have also improved their physical facilities. Notre Dame College, a Catholic school in central Victoria, hired a teacher with an aeronautical engineering background to design a new Technology Centre costing $1.8 million, with various work areas for different types of materials and machines, a

Computer-Aided-Design area, Systems Laboratories for pneumatics/electronics, robotics with Computer Numerical Control and a multi-media laboratory. The Centre also serves students, from other schools in the region, who are bussed in. It also serves as a professional development centre for teachers in the diocese. On a smaller scale, St. Michael's Grammar School, an Anglican school situated in an inner Melbourne suburb, bought an old carpet-cleaning factory near its site and converted it into a Design and Technology Centre. The Centre's Director and Assistant Director, a husband-and-wife team brought from England, display a deep understanding of the goals of modern technology education and ways of translating them into curriculum policy and practice (Marsden & Marsden, 1994). These government and non-government "flagship" enterprises are of course commendable and provide fruitful models for other schools to emulate or adapt, but it needs to be remembered that these are rare developments and hundreds of other schools remain with obsolete buildings and equipment.

A concluding note. Any balanced evaluation of the state of technology education in Australia must give recognition to the achievements as well as the unsolved problems. The official recognition given to technology as a distinctive field, and the development of detailed national and state curriculum documents are major achievements. The rapid growth of enrolments in technology studies at senior secondary level is a welcome trend, and indicates that students are "voting with their feet" and seeing this area as an interesting option. The curriculum documents have been thoughtfully constructed, and there are serious attempts in various states to develop supporting documents for the purposes of informing teachers. However, more research needs to be done to validate the implicit theory of progression which underpins the curriculum ideology on which the structure is based.

In areas such as teacher qualifications, professional development and school facilities, the needs are open-ended; it is clear that the gap between current and ideal states is very large. In the late 1960s, the then Liberal federal government faced a similar situation in the field of science education, and made millions of dollars available for the development of instructional materials and for the building of school science laboratories. These are more troubled economic times and perhaps it is a forlorn hope, but one might at least express the hope for a parallel intervention aimed at enhancing the effective implementation of technology education. Perhaps the captains of industry who for a decade have been calling for an improvement in Australia's technological inventiveness need first to be convinced that the process begins with technology education in the schools. At present, there is a large gap between rhetoric and reality, and much remains to be done if that gap is to be closed.

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LEVEL 3 Systems

Level 2 outcomes:

2.9 Describes how some of the elements of simple systems (people and parts) work together.

2.10 Uses techniques and equipment to organise, assemble and trial simple linear systems.

Level 4 outcomes:

4.9 Identifies the relationships between elements in systems (people and components) and some of the sequences through which the elements work.

4.10 Selects and uses techniques to organise, assemble and disassemble systems, to manage, control and assess their performance.

Nature

At level 3, a student:

3.9 Identifies cause-and-effect relationships in systems, including some of their effects on people and the environment.

Evident when students, for example:

- Explain how motors and gears can be used to turn the clothesline in a working model
- Organise tasks to ensure efficient T-shirt screen-printing.
- Identify the relationships between parts of a belt-drive in a moon buggy.
- Determine the chain of events and parts that produce an irrigation system.
- Simulate a traffic system using models to explain the rules and relationships.
- Explain how wheels and axles work together to produce movement in toys
- Describe what happens when a switch is used to activate a buzzer or lightbulb
- Suggest improvements to a production system for meals at a camp
- Explain how a system operates to motorise a clothesline to improve drying power.
- Discuss how features of a room can affect the environment created.
- Use diagrams to describe a fish trap and how it works.

Techniques

At level 3, a student:

3.10 Selects and uses techniques to organise, assemble, disassemble and test systems.

Evident when students, for example:

- Propose a range of organisational features to improve the environment of the workers' staffroom (storage of cups, cafe bar).
- Explain, through diagrams and notes, how pulley systems can work to drive a moon buggy.
- Use mechanical systems to move and operate the antenna of a moon buggy.
- Produce a model of a semi-automatic clothesline that turns at different speeds for drying different materials.
- Organise a roster and procedure for caring for class pets and plants, making modifications where necessary.
- Use logo programming to make mazes and other interactive computer games
- Use a glue-gun and corrugated plastic to make a model house or cattle stockade with at least one movable part.
- Make changes to ingredients in recipes for different biscuits
- Explore how motor and gears can be used to turn the clothesline, resulting in a working model.

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Designing, Making and Appraising

Systems

Task

[illegible]

Background

As part of a unit of [illegible] the students [illegible] requirements for a [illegible] buggy. They researched conditions on the [illegible], experimented with materials and drew up plans. They made models and tested them, discussed their work with their peers and wrote explanations and evaluative comments.
Most students chose to work independently, although they did seek help from each other when necessary. They used an understanding of gears and belt drives developed in a previous task.
Resources used included commercial construction material, wood, plastic wheels and a variety of tools. The students also produced advertisements for the buggy, an activity linked to work in English and the arts.

Relevant outcomes

Designing, making and appraising

3.2 Generates designs that

- take into account some social and environmental implications
- use a range of graphical representations, models and technical terms

3.[illegible] Assesses how well [illegible] [illegible] [illegible] [illegible] functional and aesthetic [illegible]

Systems

3.9 Identifies cause and effect relationships in systems including some of their effects on people and the environment

3.10 Selects and uses techniques to organise, assemble, disassemble and test systems

Summary comment

The students' designs reflect their investigations of the moon environment, although their understanding and the materials available couldn't realise some features. The recognition of the importance of safety features also shows an understanding of the environment for which the products are being designed. A developing sophistication is evident in drawings and attached explanations.
The students identified aspects of their moon buggies that needed improvement but did not establish a standard field test for all models. Their evaluation emphasises the functional aspects of the task and lacks consideration of aesthetics.

3.2 Uses understandings of pulleys and gears to direct and transfer power when developing buggy design (A)

3.2 Develops detailed drawing with explanations of how buggy will operate (B)

3.9 Identifies relationships between parts of a belt drive in buggy (C)

3.10 Explains through diagrams and notes how pulley systems can work to drive buggy (D)