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DATE DUE: 30 Jan 2001

by

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Submitted in complete fulfilment of the requirements for the degree of

Master of Arts

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January 1993
Deakin University
Candidate's Certificate

I certify that the thesis entitled: A Curriculum History of Business Computing in Victorian Tertiary Institutions from 1960 - 1985,

and submitted for the degree of Master of Arts,

is the result of my own research, except where otherwise acknowledged, and that this thesis (or any part of the same) has not been submitted for a higher degree to any other university or institution.

Signed: ..................................................

Date: 30th January 1993
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Summary

Fifty years ago there were no stored-program electronic computers in the world. Even thirty years ago a computer was something that few organisations could afford, and few people could use. Suddenly, in the 1960s and 70s, everything changed and computers began to become accessible. Today, the need for education in Business Computing is generally acknowledged, with each of Victoria's seven universities offering courses of this type. What happened to promote the extremely rapid adoption of such courses is the subject of this thesis.

I will argue that although Computer Science began in Australia's universities of the 1950s, courses in Business Computing commenced in the 1960s due to the requirement of the Commonwealth Government for computing professionals to fulfil its growing administrative needs. The Commonwealth developed *Programmer-in-Training* courses were later devolved to the new Colleges of Advanced Education. The movement of several key figures from the Commonwealth Public Service to take up positions in Victorian CAEs was significant, and the courses they subsequently developed became the model for many future courses in Business Computing. The reluctance of the universities to become involved in what they saw as little more than vocational training, opened the way for the CAEs to develop this curriculum area.
Chapter 1: The Problem and its Significance.

The Need for Courses in Business Computing.

The Current Situation

Today, the need for tertiary courses in business computing is generally acknowledged, with each of Victoria's seven universities offering courses of this type. Moreover, it is not just a matter of one course at each university as these institutions now offer many different business computing courses on many of their campuses. This dissertation is primarily concerned with one type of computing course: business computing, however the boundaries between this and other aspects of computing are far from distinct. There are currently around one thousand four hundred students (IIETF 1992)\(^1\) enrolled in computing courses at Victorian universities, which contain at least sufficient study in computing to qualify those students who complete them for Level 3 membership of the Australian Computer Society\(^2\). This number shows just how significant the curriculum area of computing has become in Victorian universities.

Data on the number of persons employed as computing professionals in Australia, given in Appendix A (IIETF 1992), shows that there has been a significant increase: from 46 600 to 89 500, over the past five years. In keeping with this increase, the number of students enrolled in tertiary computing courses has also grown in recent years, particularly in Victoria. Other interesting data includes the fact that 73% of computing professionals in Australia are now under 40 years of age. Of greater significance to this thesis though, the report shows that enrolments in tertiary computing courses in Victoria are significantly higher than in any other state: in 1990, 34% of Australia’s future computing professionals were enrolled in tertiary courses in Victoria and, despite the recession, future growth is still anticipated. Later I will describe how Victoria took an early lead in

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\(^1\) Information Industries Education and Training Foundation. See Appendix A.

\(^2\) This means that, as well as including tertiary courses specifically in computing, courses such as a Bachelor of Business in Accounting, for example, provided that they contain at least eight (out of twenty-four) units considered to involve a 'professional study in computing', are also included in this number.
the development of courses in business computing. The IIETF figures are consistent with the view that Victoria still maintains this lead.

Depending on how you define Business Computing (or Information Systems as it is now often called) which I will, for now, simply describe as curricula designed primarily to educate people in the efficient and effective application of computer hardware, software, and systems to the solution of business and organisational problems, at least 80% of these students fit into this category.

As it is currently taught in tertiary institutions the computing discipline is composed of a number of major curriculum areas, principally Computer Systems Engineering, Computer Science, and Information Systems. Furthermore, in most universities the teaching of computing thus tends to be spread over the faculties of Engineering, Science and Business.

Very recently, a study was conducted into the computing discipline in Australia, and the Report of the Discipline Review of Computing Studies and Information Sciences Education was released by the Commonwealth Government in March 1992. The following figure, extracted from the Australian Computer Society's submission to this review shows an attempt at delineating the complete scope of the computing discipline. It is immediately clear that there is good deal of overlap between the various curriculum areas, and also the interests of the three professional societies potentially involved in computing: the Australian Computer Society [ACS], the Institution of Engineers (Australia) [IE(Aust)], and the Australian Society of Certified Practicing Accountants [ASCPA].
Scope of the Computing Studies and Information Science Disciplines.

NB: The topic areas are indicative only and are not exhaustive. The orientation dimension, comprising basic research, applied research, product development and application areas (such as commerce, industry, government, libraries, land information and health) is orthogonal to this disciplinary dimension.

The Growth in Demand for Computing Courses

But this differentiation and demand for courses in many aspects of computing is a very recent one. Fifty years ago there were no stored-program electronic computers in the world. Even thirty years ago a computer was something that very few organisations could afford and very few people could use. The first real electronic computers were built in the 1940s by engineers and scientists for military and research purposes. In designing machines like ENIAC\(^3\) in the USA

\(^3\) I will resist the temptation to get into a discussion of whether ENIAC was really a computer, or just a large calculator. The distinction is not relevant here.
and Colossus in Britain, little heed was paid to possible commercial applications: it was during World War II and the need was military and pressing. A major purpose behind the design of ENIAC was the need to solve the differential equations required for calculation of ballistic trajectories. At the same time in England, Alan Turing, a pioneer in the theoretical foundations of computing, worked on Colossus, a special purpose computer adapted towards Boolean logic and designed for the task of breaking enemy codes. As is becoming apparent now that the secrecy surrounding this period is passing, the work of Alan Turing, using Colossus in cracking the Enigma codes, had significant military consequences. (Winston 1986: 140).

This beginning was only fifty years ago, and events have moved very rapidly to the point where many of the things we take for granted today would not be possible without the existence of electronic computers. Bailey (1992) notes that it is curious that people often overlook the question of how it took so little time for these "supposedly unprecedented marvels" to be filled up with useful work. "Immediately as the first electronic computers were put together, trusted algorithms were waiting to be put into them. It was almost as if computers had existed and been used all along." (Bailey 1992, 67). Bailey suggests that in fact they had existed all along, but that prior to the 1940s all the computers had been human. The rapidity of the adoption of electronic computers in the 1950s and 60s was thus due to the ability of these machines to meet an existing need. Bailey believes that because these electronic computers 'thought' in a serial fashion as we do, we readily accepted the results they produced.

Computing as a human activity had, of course, existed long before the 1940s. There has been a need to carry out commercial calculations ever since humans began trading with each other. The amount of commercial computation required had steadily increased over the years, and as this need increased, human inventiveness created machines to assist in the performance of these tasks. Firstly using primitive calculators like the abacus, then with mechanical and electric calculating machines, and later with punched-card accounting machines, business was not slow to adopt this new machinery as soon as it became reliably available. This technology thus did not develop in a vacuum, after which a use was found for it. As evidenced by the development of the first electronic computers discussed above, it can be argued that particular prevailing cultures throw up particular technologies. As Franklin (1990) puts it:
"Looking at technology as practice, indeed as formalised practice, has some quite interesting consequences. One is that it links technology directly to culture, because culture, after all, is a set of socially accepted practices and values. Well laid down and agreed upon practices also define the practitioners as a group of people who have something in common because of the way they are doing things." (Franklin 1990: 15).

Once computer technology had developed, in Australia the practice of computing was first put into serious use by the Commonwealth Government in the 1960s, but it was not much later that business also began to make use of computers. Quite quickly, from a situation where courses in business computing did not exist in the early 1960s, such courses were devised and put into place in almost every tertiary institution in the country.

What happened to cause this rapid growth in the curriculum area of computing, and to move things to where they are now, is the subject of this dissertation. I will argue that the requirement of the Commonwealth Public Service Board for large numbers of computer professionals to staff its administrative computing projects in the Department of Defence and in the Postmaster General's Department (PMG) in the 1960s, was the major factor in getting business computing underway in Australia. The training needs of these projects were the main spur to the introduction of courses in business computing in tertiary institutions in this country, and in Victoria in particular. In a 1965 paper on the recruitment, education and utilisation of ADP (Automatic Data Processing) staff, Commonwealth Public Service Board Commissioner K. E. Grainger acknowledged these training needs and declared that:

"The remarkable development of computer technology and its continuing penetration into so many areas of human endeavour throughout the world has been so rapid that it has outstripped the capacity of education systems to provide, and of user organisations to mould, sufficient people skilled enough to exploit the computer potential now available to commerce, industry and government. It is certain that this problem of shortage in staff skills will remain with us for many years unless well-organised action is taken on a co-operative basis between users, equipment suppliers, and tertiary education bodies to correct the existing deficiencies." (Grainger 1965).
Although a number of Australia's universities had access to computers during the 1950s and some had even begun to take the teaching of computer science seriously, during the early to mid-1960s they were both unready and unwilling, for reasons that I will later discuss, to take up the challenge of turning out what they regarded as people with 'vocational training' in computing. It was the Technical Colleges, which were soon to become the Colleges of Advanced Education (CAEs) and Institutes of Technology, which began to develop these courses. From that point on, a discipline of computing which was wider than computer science, and was soon to encompass what we now call business computing, began to develop.

Computing as a Discipline

The question whether computer science is a branch of science, or a branch of engineering, or whether it is something else entirely unique, had been under discussion now for twenty years and some sort of consensus has at last begun to emerge (Gries, Walker & Young 1989). Business computing, which some have suggested is just a watered down version of computer science located in an organisational context, is today just beginning to come to grips with questions of its disciplinary status. Uncertainty often characterises the boundaries of new, fast growing curriculum areas, and the boundaries of business computing are still to be satisfactorily resolved.

In 1975, in the forward to their new text Introduction to Computer Based Information Systems, Couger & McFadden (1975) noted that in the United States, curricula in the field of computing were changing. They remarked that tertiary institutions, and particularly Schools of Business, were revising courses that had previously offered only computer programming and hardware concepts, to include topics such as an introduction to systems analysis and design.

They also stated that their book was intended for both users and practitioners, acknowledging that students studying functional areas of business such as accounting, or management also required a knowledge of computing. "They need the same foundation course as students who plan to become practitioners in the systems design field. With this common background, the user and practitioner will
be able to communicate better in order to produce effective systems." (Couger & McFadder 1975: viii).

In 1987, in the *Communications of the ACM*, Hopcroft (1987) wrote that Computer Science was just beginning to establish itself as a discipline when he began his career in 1964. He describes how, in the 1960s, changes in electronics technology allowed computer science to broaden its scope from considerations of circuit theory into computation, and that in 1987 there were signs that computer science was interesting itself much more in application areas. Two years later Gries, Walker & Young (1989) were able to say that there appeared to be general agreement that the discipline of computing had matured, and come into balance. In another ACM article on the discipline of computing, Denning et al provide the following short definition:

"The discipline of computing is the systematic study of algorithmic processes that describe and transform information: their theory, analysis, design, efficiency, implementation and application." (Denning et al 1989: 12)

They went on to remark that the fundamental question underlying all of computing thus was: "what things can efficiently be automated?" In a rather more philosophical discussion of the discipline of computing, Banville & Laudry begin with the assertion that "anyone attempting to assess the state of a particular scientific discipline must necessarily proceed with the implicit or explicit help of a model as to what a scientific discipline is and how it should develop." (Banville & Laudry 1989: 48). But the question of whether computing is a science needs to be tackled. A 1989 UNESCO paper attempts to describe the general relationship between scientists, engineers and technicians by suggesting that:

- Scientists seek (through research) after new knowledge, and so make new discoveries.
- Knowledge of these discoveries flows to engineers who incorporate it into objects that are developed to be useful and cost-effective.
- Technicians are given, by the engineers, details of how the objects work and how to install and maintain them; the technicians propagate the knowledge along with practical, skilful use of the objects (UNESCO 1989).
Whether it is really this simple is, however open to question. Lyotard (1979) considers knowledge to be science. Poster, expanding on Lyotard's views, suggests that science is not simply a set of disciplines, but "a force that provides fundamental knowledge of the economy, the military, and the state." (Poster 1990: 141). But computer science differs from the other sciences in focusing its attention on a particular machine: the computer. Poster makes the point that computer scientists are especially sensitive to the question of the "epistemological purity of their discipline", since computers are seen as useful objects to governments and commerce.

Even if computer science is to be considered in a manner similar to that of a physical science, current debate does not suggest that business computing is also of this nature. Most writers would now suggest that business computing is related more closely to organisational theory and to management than to 'pure' science. In the United States, during the 1980s in particular, the Data Processing Management Association (DPMA), the Association for Computing Machinery (ACM), and the Computer Society of the Institution of Electrical and Electronic Engineers (IEEE-CS) all published papers and documents discussing these issues, and giving curriculum guidelines for courses of various types in Computer Science and in Information Systems.

In a summary of a 1991 joint ACM/IEEE-CS curriculum report, Turner (1991) suggests that in the US during the 1970s and 80s, many tertiary computing programs had sprung up in response to local demand, but that the local implementors of these programs often did not have a "good feel for the discipline" and that consequently, the programs developed were too narrow. Clearly there is still much more to be done in defining all types of tertiary computing curricula, but the fact that there is any form of international consensus at all on business computing courses, most of which developed locally, recently, and without outside models, is somewhat remarkable after such a short time.

Parallel Developments

A consideration of available historical data suggests that there was little conscious attempt in Victoria to follow interstate or overseas models in the development of courses in Business Computing, yet today all these courses display a remarkable degree of similarity. Business computing courses are not the only aspect of human
endeavour to exhibit this phenomenon. In her discussion of chaos theory, Katherine Hayles (1990) describes a number of situations in which the apparently unrelated development of similar ideas by different people, often in different countries or cultures, cannot be explained by direct influence. She suggests that this is because those involved, no matter how specialised or diverse their work, all shared a variety of everyday experiences. In many of these situations, any connection would otherwise be very difficult to find.

"Interdisciplinary parallels commonly operate according to a different dynamic. Here influence spreads out through a diffuse network of everyday experiences that range from reading 'The New York Times' or using bank cards or automatic teller machines to watching MTV. When enough of the implications of these activities point in the same direction, they create a cultural field within which certain questions or concepts become highly charged." (Hayles 1990: 4).

A number of the early business computing courses in tertiary institutions within Victoria developed at about the same time, and the similarity of these courses was notable. Furthermore, in the early 1960s: a critical time in the formation of early course concepts, three key personnel from the Commonwealth Public Service Board took up appointments at Caulfield Technical College, Bendigo Technical College and RMIT. Hayles idea of a cultural field is useful in thinking about how such similar developments occurred.

Soon after this almost all the former Colleges of Advanced Education had courses in business computing, and these all tended to follow the same pattern. Several institutions even had a number of different courses at the undergraduate and graduate diploma levels. In some institutions, computing courses aimed at the needs of business were soon being offered in both the faculties of Applied Science and Business. In other cases, computing courses in Applied Science were much more mathematically related. The range of tertiary computing courses has thus been large. The offerings in computing in the 'traditional' universities, in particular Melbourne, had always been more often oriented towards computer science.

In the United States, a curriculum for Computer Science was first formally outlined in 1965, marking the beginnings of the recognition of this discipline in that country. Information Systems (business computing) curriculum development did not begin in the US until the early 1970s, with the publication in 1972 of the
American Computing Machinery's (ACM) *Graduate Professional Program in Information Systems*. Nailing down the fundamentals of this area has proved more difficult than computer science as, being more concerned with the applications of computing, the development of information systems curricula has reflected many dynamic changes caused by the rapid development of information technology.

"Revisions of the Information Systems curriculum have been driven by technology. In the past, new technology resulted in additional courses rather than a synthesis of new material into the basic tenets of the discipline." (Data Processing Management Association 1990: 1)

It appears that computing as a discipline has emerged in more than one form: at one end of the spectrum, the more theoretical and 'academic' *Computer Science* - related to mathematical methods and the study of algorithms. This always tended to be offered in the traditional universities. At the other end is the rather more practical and application related *Business Computing* (Information Systems), initially offered in the former Colleges of Advanced Education. Clearly, the situation is rather more complex than a simple dichotomy of Computer Science versus Business Computing would suggest, as courses in computing form a continuum between these extremes.

**Significance of a Study in this Area.**

Education in the business applications and principles of computing is unique in the speed with which it has grown from nothing to a major curriculum area in both tertiary and (much later) secondary education. Few other curriculum areas have developed so rapidly, but curiously, little interest has been shown in documenting these developments in formal curriculum studies. Almost nothing has been written on the evolution of tertiary courses in business computing in Australia, or so far as I can establish, overseas. A study of the curriculum history of business computing thus has the potential to illuminate the processes that led to the creation of a curriculum area, which although it owes something to other curriculum areas such as mathematics, accounting, commerce and management, is essentially new.

It is, I believe, thus quite clear that a study of the evolution of tertiary courses in Business Computing in Victoria is an important one. In justifying the use of a
curriculum history approach to this subject, I can do no better than to quote Watson (1909), to whom I refer more fully in the next chapter.

"If a history of any educational subject encourages and deepens with us the habit of looking with a keener interest for educational provision to the full social, economic, political and religious needs of a community in a past period, from the point of view of the contemporary aims and scope of knowledge of that period, then the study justifies itself." (Watson 1909: vii-viii)

And also from Goodson and Walker,

"A combination of life stories and curriculum histories should then offer an antidote to the depersonalised, ahistorical accounts of schooling to which we are only too accustomed." (Goodson & Walker 1991: 134)

Much of the work on the development of new curricula by writers such as Goodson, relates to discussions of the slow evolution of subjects at the secondary school level in Britain. In particular, Goodson (1984) describes the curriculum history of the school subjects: geography, biology, rural studies and environmental studies. He describes how forces at the school, university and professional levels have interacted to effect the development of these subjects, and suggests:

"That in the process of establishing a school subject (and associated university discipline), base groups tend to move from promoting pedagogic and utilitarian traditions towards the academic tradition." (Goodson & Ball 1984: 29)

It should be noted that the formal study of computing in Victoria did not reach the secondary school level until 1981 (some 20 years after the start of business computing at Caulfield) with the introduction of HSC\(^4\) Computer Science after the pressure of several prominent tertiary academics including Peter Juliff (then at Victoria College), Gerry Maynard (Chisholm Institute) and Tony Montgomery (Monash University). As I will elaborate later, there was certainly no early influence caused by prior, or concurrent introduction of the subject area into the

\(^4\) Year 12.
secondary curriculum, on the development of tertiary courses in computing, in the way that there was for Geography last century in the UK (Goodson 1987).

Little formal writing exists on the recent development of tertiary curricula in which there was no previous or concurrent development at the secondary school level. One of the aims of this study is thus to shed some light onto the relevance of using curriculum history methodologies developed from primary and secondary curricula in the study of tertiary curricula.

Curricula in business computing are unique in the degree to which they have been affected by rapid changes in technology which have introduced a cyclic factor into course evolution. Existing models of curriculum change typically describe the slow evolution of new subjects over a considerable period, and building a model to account for this rapid and cyclic growth has been a major aim of this thesis.

Although beyond the limits of this dissertation, it is interesting to speculate upon the nature of computing courses in Australia's new universities, produced by the recent government policy of abolishing the binary system and amalgamating the traditional universities with the former CAEs.

As I will show in Chapter 4, in the late 1960s and early 1970s the CAEs in Victoria (and other states) developed courses in computing quite different to those offered by the universities. The expected competition between these new institutions in the establishment of high status courses in business computing is likely to push these courses towards the academic end of the spectrum, as might be expected if influences of the type described in Layton's (1972) model of curriculum development eventually prevail and the pursuit of academic respectability for these courses becomes a major goal.

Structure of this Dissertation.

This Curriculum History of Business Computing concentrates on the period 1960 to 1985 in Victoria. The very first electronic computers only became generally available during the 1950s, and the only significant educational developments in computing to occur before 1960, have relevance to this thesis only by way of°pre-
history. While important curriculum developments in business computing still continue today, most of the direction for these courses was determined by the mid-1980s when almost every tertiary education institution offered at least one such course, and the almost universal adoption of the microcomputer in business and in education had been accepted.

In this study I will illuminate the growth of tertiary courses in business computing by drawing on Goodson's Curriculum History methods. (Goodson 1984-1992).

As will become clear in this dissertation, the study of business computing did not evolve from university courses in computer science, but had an altogether different beginning in the practical needs of government and industry for computing professionals. Many different terms are used to describe tertiary courses involving computing. Courses with names such as: Information Science, Information Processing, Numerical Methods, Computer Science, Data Processing, Automatic Data Processing, Electronic Data Processing, Business Data Processing, Commercial Data Processing, Business Computing, Information Systems, and Computing, all either currently exist, or have existed during the past. In relation to these courses, a number of questions are considered in the dissertation:

- What do these courses have in common? What are the differences?
- What development has there been from one course type to another?
- What factors have influenced the development of courses?
- Is there any emerging trend towards one (or more) course type?
- Have developments in Victoria followed, paralleled or lead those of other states and overseas?
- What underlying social, political and economic factors affected the development and adoption of these courses?

In attempting to answer these questions, I will begin, in Chapter 3, by looking at the role of the non-human actors: the machines and methods, and examine how the development of courses in computing has been closely tied to technological developments. Chapter 4 will look, in some detail, at how the courses actually developed; the influence of the Commonwealth, and why the Colleges of Advanced Education in Victoria played a leading role. Finally, in Chapter 5, I will propose a model relating technology, invention of educational need, growth of courses and infrastructure, and the later stability of courses, in an attempt to
further illuminate what has happened. I will suggest that this relationship is in the form of a cycle that operates in a societal context, and that the cycle is repeatedly executed each time significant new computing technology or a new educational need emerges, the history of former cycles being largely forgotten each time.
Chapter 2:  
Research Methodology.

Qualitative Research.

Much research, in various fields, involves the collection of large quantities of numeric data on the subject in question, and the subsequent analysis of this data. For this purpose, a variety of quantitative methods have been developed. Not all data, however, can conveniently be expressed in numbers and analysed using such methods. Renata Tesch (1990: 3) describes any data that are not quantitative, and so cannot be expressed in numbers, as qualitative data.

It seems quite clear that, by its very nature, a study of the curriculum history of business computing will not be one involving much analysis of numbers. There is no large quantity of numeric data to be collected or analysed and there is little to be gained by conducting surveys and analysing the results. The methods that are most appropriate are those of the analysis of documents, and the collecting of oral narratives from people who participated in the development of curriculum. In short, there is little data to collect for which the application of quantitative methods would be of value. In this study, the small amount of numerical data used is in the form of tables that are then used in descriptive analysis, similar to that used in historical research, merely to illustrate trends and to make simple comparisons.

In the curriculum history literature, little use is made of numeric data thus, with the possible exception of examples such as the monitoring of the popularity of subjects with students, between courses, and over time, there seems to be only a selective role for quantitative analysis in curriculum history. Goodson makes little mention of the use of numeric data in his work.

Unlike other approaches to research in which there may be clearly layed down procedures to be followed, there is no single agreed set of established procedures for conducting qualitative research. Tesch puts it this way:

"Qualitative researchers are quite adamant in their rejection of standardisation. Whenever they describe their methods, they are usually
eager to point out that this is just one way of doing it, which others should feel free to adopt as much of as they see fit, and modify and embellish it according to their own needs and ideas. ... The only agreement we would find among qualitative researchers is that analysis is the process of making sense of narrative data." (Tesch 1990: 4).

Writing on the research process, William Gephart described six research methodologies existing in education in 1969 as: historical, case study, descriptive, quasi-experimental, unobtrusive-measure experiment, and experimental (which came to be know as naturalistic inquiry), and added two hypothetical ones (Gephart 1969). Tesch (1990: 51) goes on to describe ten variants on research methodology: action, or collaborative research, emancipatory action research, educational connoisseurship and criticism, ethnography of communication, ethnography, naturalistic inquiry, phenomenography, phenomenological research, qualitative or illuminative evaluation, and transcendental realism.

In describing qualitative research in education, Smith (1987) argues that such research is empirical, and that the researcher collects data about the phenomena under study and then proceeds to work on them: organising, categorising and hypothesising. She suggests that qualitative research demands no standard form in the presentation of results, but should attempt to preserve concrete details of the matter in question, in a coherent account. Tesch shows that the replicability of outcomes is not the issue. The validity of the research does not depend on this, but on a process of data reduction and analysis that results in something that can be generally recognised as representing (or perhaps re-presenting) the data.

"The result of the analysis is, in fact, a representation in the same sense that an artist can, with a few strokes of the pen, create an image of a face that we could recognise if we saw the original in a crowd. The details are lacking, but a good 'reduction' not only selects and emphasises the essential features, it retains the vividness of the personality in the rendition of the face. In the same way a successful qualitative data reduction, while removing us from the freshness of the original, presents us instead with an image that we can grasp as the 'essence', where we otherwise would have been flooded with detail and left with hardly a perception of the phenomenon at all." (Tesch 1990: 304).
Presenting a useful hierarchy of qualitative research methods ranging from the most structured to the least structured and most holistic, Tesch (1990: 59) lists the following:

- the characteristics of language,
- the discovery of regularities,
- the comprehension of the meaning of text/action, and
- reflection.

In further describing the category 'comprehension of the meaning of text/action' as what she calls research that seeks to discern meaning, Tesch breaks this category down into:

- the discerning of themes of commonality and uniqueness, and
- interpretation.

Two methods she offers for consideration under the heading of 'interpretation' are case study and life history methods.

Tesch describes the characteristic mode of analysis of case studies and life history as "dialoguing with the data" (Tesch 1990: 94) as they typically call for interpretation of one piece of data and what it means, rather than with regularities and patterns across many pieces of data of a similar kind. She goes on to point out that these methods are related to those historians employ, particularly in explication which Barzun and Graff describe as "worming secrets out of manuscripts" (Barzun and Graff 1977: 94). In this type of study, however, a researcher would need to go beyond explication and into interpretation as the concern is not with historical documentation but with an understanding of the dynamics of the human aspects of the curriculum developments (Tesch 1990: 69).

The essential part of any case study, or life history approach to qualitative analysis is for the researcher to seek connections and explanations, not just to describe. According to Tesch, researchers in this field "... try to find out more than just what is, they also try to find out why it is." (Tesch 1990: 85). She suggests that what is important is the seeking of explanations, and that the analysis procedures used must be designed to facilitate such theorising.

Ardra Cole (1991) notes that methods that have traditionally been associated mainly with studies in the field of anthropology: oral history, biography, narrative, life story, life history, and a variety of other similar forms of constructionist and interactionist inquiry are gaining in popularity and use in educational research.
Such approaches are particularly appropriate to curriculum history, which is based in a social constructionist perspective.

**Curriculum History.**

**Curriculum History and Social Constructionism**

Smith (1987) notes that qualitative research is divided by the differing views of researchers on the nature of reality. They argue whether there is "a world of social objects and forces separate from the observer's perception of them." (Smith 1987: 173) Curriculum history, and in particular Goodson's interpretation of it, is framed in the particular social theory of knowledge espoused in M.F.D. Young's *Knowledge and Control* and Bernstein's *Sociology of Knowledge*: that the production and transmission of knowledge is a social process, and that knowledge is constructed and not 'a given'. Young has said that "one crucial way of reformulating and transcending the limits within which we work, is to see ... how such limits are not given or fixed, but produced through the conflicting actions and interests of man in history." (Young 1971: 248-9). Goodson & Mangan (1991) state their belief that reality is socially constructed and quote from Berger and Luckman: "All aspects of both the physical and social world known to us are apprehended through human sensibility, and are given shape and meaning through the social processes of language and thought." (Berger & Luckman 1967). They suggest, borrowing from Harvey (1990), that "This perspective concentrates not on a system of structures and institutions which are presumed to exist independent of the people who inhabit them, but on the symbolic processes by which human beings create, sustain, and reproduce their life-worlds." (Goodson & Mangan 1991: 9).

Fliessner notes that in the 1950s and 60s, most of the research in education was "largely a positivist enterprise, dominated by quantitative research methods, focusing on prescriptive theorizing" (Fliessner 1991: 209). He points out that the methodologies used by researchers were clearly defined, unambiguous and clearly understood by those who used them, but the results were often less than clear to practitioners. In arguing for a social constructionist perspective on curriculum, Goodson notes that "One of the perennial problems of studying curriculum is that it is a multi-faceted concept constructed, negotiated and renegotiated at a variety of levels and in a variety of arenas." (Goodson 1991a: 49, 73). He argues that we
need to move away from a single focus on "curriculum as prescription" and fully embrace the notion of curriculum as social construction. He suggests that individuals, groups or collectives, and also the various interactions between individuals and groups, are curriculum foci amenable to study from a social constructionist perspective.

Goodson and Dowbiggin (1991) describes their notion of curriculum in the words of the Canadian curriculum historian George S. Tomkins (1986: 1), as: "the ostensible or official course of study, typically made up in our era of a series of documents covering various subject areas and grade levels together with statements of aims and objectives and sets of syllabi, the whole constituting, as it were, the rules, regulations, and principles to guide what should be taught." (Goodson & Dowbiggin 1991: 231). Other writers give a somewhat wider definition. Kearner and Cook (1969: 1127-44), for instance, describe curriculum as "all the experiences a learner has under the guidance of the school". In 1973, Lawton noted that older views of curriculum, restricting themselves only to the content of what was taught, were being replaced by a broader notion of curriculum encompassing all aspects of the education process. An acceptance of this notion facilitates the use, in this study, of a combination of both life history accounts, and documents relating to curriculum. Referring mainly to the school context, Lawton suggested that any study of curriculum should include a consideration of:

- teachers and how their roles are defined;
- the content of what should be taught, and how this is influenced by philosophical ideas on the organisation of knowledge, the sociology of knowledge and psychological factors including theories of instruction and child development; and
- the social background and abilities of the pupil (Lawton 1973: 12).

A social constructionist perspective does, of course, have an effect on research methodology. Goodson & Mangan suggest that there are two closely related sets of methodological implications. Firstly, they suggest that in order to adequately analyse an observed social process, the meanings ascribed to that process by the participants must be taken into account. They also note that there are ethical imperatives, as the human subjects of the research must be recognised as "fully engaged participants in the process", and that their dignity and autonomy as individuals should be respected.
"If reality is socially constructed then its meanings are socially negotiated, and researchers must recognise the fundamental role of participants as the primary agents in this process of meaning construction. However they must also acknowledge their own role in negotiating new meanings which may differ from those of the participants." (Goodson & Mangan 1991: 14).

The Scope of Curriculum History

Interest in curriculum history is not new. In the view of Ivor Goodson (1988a: 49), perhaps the most systematic early treatment of the history of curriculum came from Professor Foster Watson. In 1909, Watson, who was Professor of Education at the University College of Wales, Aberystwyth, produced a 'history of the teaching of modern subjects' in which he argued:

"If a history of any educational subject encourages and deepens with us the habit of looking with a keener interest for educational provision to the full social, economic, political and religious needs of a community in a past period, from the point of view of the contemporary aims and scope of knowledge of that period, then the study justifies itself. If, further, such a study stimulates that exercise of thought on the multitudinous problems which have arisen in every period, and leads us to identify ourselves in real interest with the aims and methods of the solutions attempted to solve those problems, then our judgement is strengthened for forming decisions as to the educational difficulties of the present age." (Watson 1909: vii-viii)

Watson, who was speaking of the need for facts regarding the beginning of the teaching of modern subjects in England, went on to stress the need for a detailed curriculum history and for both its importance and its uniqueness in connection with the history of the social forces that brought these subjects into the curriculum.

But curriculum history is in its nature, its methods, and its treatment of the subject matter, quite different from both history in general, and educational history in particular. Most importantly, curriculum history is seen, by its proponents, primarily as a study in curriculum rather than a study in history. Goodson strongly
asserts that in a study of curriculum history, one should be less interested in history for its own sake, and "much more with history for the sake of curriculum" (Goodson 1988a: 53) as an aid to the understanding of fundamental curriculum issues. He quotes from Franklin:

"I see curriculum history as a speciality within the curriculum field, distinct from educational history. Its practitioners should be individuals whose primary training is in curriculum, not educational historians who happen to be interested in the nature of the course of study within the schools." (Franklin 1977: 73, 74).

In relating life histories with curriculum history Goodson suggests that in regard to contemporary curriculum, there are three levels of curriculum that can be considered to be amenable to studies in curriculum history:

"1 The individual life history. The process of change is continuous throughout a person's life 'both in episodic encounters and in long-lasting socialisation processes over the life history'.
2 The group or collective level: professions, categories, subjects or disciplines, for instance, evolve as social movements over time. Likewise schools and classrooms develop patterns of stability and change.
3 The relational level, the various permutations of relations between individuals, between groups and between individuals and groups; and the way these relations change over time." (Goodson 1988a: 95).

The Analysis of Documents

Studies in Curriculum History can be considered to comprise both the analysis of documents, and of oral narratives. Goodson sees the analysis of documents as allowing the researcher to travel back and to gain "insight into how those circumstances we experience as contemporary 'reality' have been negotiated, constructed and reconstructed over time" (Goodson 1985: 126).

Another reason for conducting an examination of documents, in addition to collecting life histories, is to allow for a 'triangulation' between these sources, so
increasing the likelihood of getting the complete picture. Problems however exist with the reliability of documents necessitating care in their interpretation:

"Documents have differential survival rates and those which do survive do not always provide all the information required. The fundamental difference between historical research and other forms of social inquiry is the impossibility of 'going back' to ask for further explanation and elaboration. This leads to all kinds of problems. The answers to a great many questions are simply not available, since the records either never existed or failed to survive" (Andrews 1983: 156).

**Life History Materials**

Arda Cole describes *life stories* as "personal retrospective accounts of experience usually collected through a series of unstructured and loosely connected conversations between a researcher/story writer and a participant/story teller." (Cole 1991: 188). Little has been written about the technique of interviewing, but in life-story interviews, Cole declares that, procedurally it differs little from journalistic interviewing, with recall, reflection, and probing being the means of gathering data. The researcher plays a passive role, merely probing these recollections and reflections, whilst the participant freely recalls and reflects on life experiences.

She suggests that *life history* methods begin with, but build on life-story information, as supplementary information is obtained through conversations with other people, and through archival data such as newspaper accounts, records, curriculum documents, or other historical evidence. This cross validation of information is what constitutes the essential difference between the two methods. In her paper she draws on relevant literature and on some of her own experiences with life history interviewing to reflect on some of the more critical ethical and political issues encountered in this area. The life history researcher is more than 'an elicitor of and listener to life stories', and the participant is more than 'a teller of tales'. Interpretation and story reconstruction become the focal point.

"Life history research involves preliminary analysis and selection of key points or events for further inquiry - verification, cross-validation, clarification. And it requires the researcher to seek out supplementary
information sources and, at times, to possibly 'challenge' the participant on a recollection or statement. The researcher/participant relationship, then, is central to life history research." (Cole 1991: 191).

This implies a necessity to consider the ethical issues and to negotiate the research relationship. In her paper, Cole goes on to discuss some of the practicalities involved in interviewing, such as the style of the interview, what constitutes appropriate dress for the interviewer, the issue of who should operate the tape recorder (the interviewer or the participant), and how 'off the record' comments should be handled. She stresses that both the quality and the quantity of information obtained in a life history interview relies, to a great extent, on the nature of the relationship between the researcher and the participant.

"Interpretation is the focal point in life-history research. Because it is a collaborative undertaking, both researcher and participant are involved in the interpretation and reconstruction of the life history. The life-history interview is the forum where much of the interpretation takes place. Here points are clarified, statements verified, and information from previous interviews and from supplementary sources validated." (Cole 1991: 203).

Oral narratives involve the eliciting of memories from those involved in the process being researched, in order to gain a first hand view of not only what happened, but a perspective on why it happened as well. Faraday and Plummer describe how "... the life history technique documents the inner experiences of individuals, how they interpret, understand and define the world around them." (Faraday & Plummer 1979: 776). Tesch makes the point that "In this vein, life history studies no longer are limited to biographical and autobiographical documents, diaries and letters, but include in-depth interviewing and some focused observation." (Tesch 1990: 26).

Perhaps it all seems a little too obvious, but as Maslow says, if we want to find out about developments involving people, why not just ask those people who have been involved?

"By far the best way to learn what people are like is to get them, one way or another, to tell us, whether directly by question and answer ... to which we simply listen, or indirectly by covert communication,
paintings, dreams, stories, gestures etc, which we can interpret." (Maslow 1966: 12).

Studies in life histories have also been called 'biographical ethnography' (Werner & Schoepfle 1987) as, rather than representing just the usually quite static sociological descriptions of patterns and systems, they include a dimension of time.

"When one conducts a life history interview the findings become alive in terms of historical processes and structural constraints. People do not wander round the world in a timeless, structureless limbo. They themselves acknowledge the importance of historical factors and structural constraints (although of course, they would not use such pompous language). The analysis of life histories actually pushes one first of all to the problems of constraints bearing down upon the construction of any one life ..." (Faraday & Plummer 1979: 780).

Hammersley remarks on the often expressed concern about the ahistorical character of much ethnographic research, and sets out to argue the need for links to be made between historical and ethnographic analyses. He argues that history and ethnography are complimentary and share much in common. He remarks that much recent ethnographic work has been concerned with "making the familiar strange" and how historical research can serve this function in regard to school subjects. A particular example is in documenting the origins of school subjects in case we were to consider them as "basic forms of knowledge" and so that we will not forget "the struggles that were involved in their establishment, the alternative versions that were promoted by various groups, and the changes in content undergone." (Hammersley 1984: 16).

Goodson (1991b: 134) quotes from Bogdan to support his argument for the value of using life histories. Bogdan suggests that a well-produced life history should enable us to:

"see an individual in relation to the history of his time, and how he is influenced by the various religious, social, psychological and economic currents present in his world. It permits us to view the intersection of the life history of men with the history of society, thereby enabling us
to understand better the choices, contingencies and options open to the individual." (Bogdan 1974: 4).

The question of the reliability of life histories when attempting to generalise to wider issues, is one of considerable importance. A problem to which I will return in my discussion of data collection is that the interviewer must inevitably have some effect on the interview. This cannot be avoided and allowance must be made. Issues of partial, or selective recall and of lapsed memory of the interviewee must also be faced. Another issue is how faithfully the interviewer has interpreted what was said in the interview. Goodson recognises these problems and suggests that 'triangulation' through the collection of a number of life histories, and the development of a documentary history of the context can, at least in part, reduce this problem.

"But the development of research which moves from a range of life stories to curriculum history concentrates the focus of the work; arguably in a way which challenges the authenticity of the accounts and certainly in ways which challenge the relationship between the life story teller and the researcher. By moving from life story to curriculum history control is passing irrevocably to the researcher." (Goodson 1991b: 135).

He goes on to suggest that the combination of life histories and curriculum histories offers a good strategy to triangulate the data and so to assess the reliability of the findings. This combination resembles the methods adopted (in other contexts) in many recent oral histories.

**Limitations of the Curriculum History Approach**

Most published studies in curriculum history relate to secondary school curricula. The question must then be asked whether this methodology is also appropriate to studies of curriculum at a tertiary level. Granted, there are major differences between tertiary and secondary education both in the way that new subjects are introduced and accredited, and in the way that they are taught. The institutions themselves are also quite different. Some examples and some of the theorising, such as the influence of external examinations, or any possible influence of secondary on tertiary studies, is thus not appropriate. There still seems, however,
no reason why the methodology of curriculum history should not be applicable at the tertiary level, but an evaluation of this study should shed further light on this matter which I will take up again in Chapter 5.

Another consideration is the relevance, or otherwise, of curriculum history to an area like computing. There do not appear to be published studies that examine the relevance of curriculum history to an area which is subject to such rapid social and technological change. As Goodson notes, curriculum history is not history in the conventional sense, and does not use the same methodology nor demand the same standards of proof as historical study. It is a study in curriculum, with its own methodology, which aims to shed some light on issues in the curriculum field.

Selective Review of Curriculum History Literature.

Literature searches and discussions with those involved in this curriculum area indicate that no study concerned with the evolution of curricula in Business Computing has been carried out in Victoria, and probably not within Australia. There are several histories of computing in Australia, including Pearcey's account of which I have made use, but these touch only briefly on issues of tertiary curricula. Likewise, histories of some of the tertiary institutions mentioned in this study have been published, but neither do these give detailed attention to Business Computing. There is thus no possibility of here reviewing literature concerned with the evolution of curricula in Business Computing. I have, however, drawn on the experience of curriculum histories written for other curriculum areas, and will selectively review these here.

The Work of Ivor Goodson

As previously mentioned, interest in curriculum history is not new and goes back at least to Professor Foster Watson in 1909. In recent times, however, its greatest proponent has surely been Ivor Goodson, Professor of Education, University of Western Ontario. Goodson has written, co-authored, and edited a number of books relating to a view of curriculum history. In the introduction to their recent book, Goodson and Walker assert that their theme is a "restatement of the central role that people play in the educational process" (Goodson & Walker 1991: 1).
This section provides a selective review of these books and of other papers relating to curriculum history.

In much of his own work, Goodson details the development of secondary school subjects in England, and describes the change and conflict involved in this process. He makes clear his central belief in a socio-historical approach to curriculum studies and remarks on the centrality of school subjects and his fascination as to "where subjects had come from and why they were as they were" (Goodson 1987: viii). He questions the reasons for the reluctance to accept new subjects that attracted and motivated large numbers of students, and that these subjects were often judged unacceptable as 'real' or 'examination' subjects.

Goodson researched the curriculum history of the subjects: Geography, Biology, Rural Studies and Environmental Studies in England and much of his work refers to this research. For example, he refers to Rural Studies and its change from being a utilitarian subject based on gardening in the 1920s to a subject offering 'O' and 'A' levels in Environmental Studies in the 1970s, and explains how, "by collecting the life stories of key participant teachers spanning this generation it was hoped that insights might be provided not only of how the curriculum changes but of how structural constraints are evidenced in such a process" (Goodson 1991b: 119). The point of the study in this case being to understand more about the curriculum innovation involved in the launching of a new subject, in this case Environmental Studies. Goodson describes how this required a detailed understanding of the historical context of this development, and goes on to detail how life stories provided a valuable access point. He makes three main hypotheses:

"1. That subjects are not monolithic entities but shifting amalgamations of sub-groups and traditions. These groups within subjects influence and change boundaries and priorities.
2. That in the process of establishing a school subject (and associated university discipline) base subject groups tend to move from promoting pedagogic and utilitarian traditions towards the academic tradition.
3. That in the conflict over environmental studies much of the curriculum debate can be interpreted in terms of conflict between subjects over status, resources and territory." (Goodson 1984: 28, 29).
Goodson then examines these hypotheses within the context of the curriculum history of the three subjects (Biology, Geography and Rural Studies) involved in the conflict over the introduction of Environmental Studies in England. He describes the factors that explain the evolution of a school subject from its inception right up to the point of its full acceptance.

The main thrust of his work is a discussion of what is involved in *Becoming an Academic Subject*. He considers the relationship between subjects and how this can produce subject conflict. In doing so, he considers the subject histories of Biology, Geography, Rural Studies and Environmental Studies in some detail. By examining these studies in curriculum history, Goodson hopes that we might gain insight into issues of "politics and governance".

"This should make it more difficult to present certain selected styles of education, examination or 'standards' as timeless 'givens', in fact they are socially constructed statements of priority and preference as many of the following papers eloquently attest." (Goodson 1988b: iv).

Goodson (1991b: 118) suggests that although Young (1971) speaks of school subjects as 'no more than socio-cultural constructs of a particular time', curriculum history would attribute considerably more significance to school subjects than this.

"In choosing to research school subjects I was cognisant that in studies of schooling the subject provides *par excellence* a context where antecedent structures collide with contemporary action: the school subject provides one obvious manifestation of historical legacies or as Waring puts it 'monumental accretions' with which contemporary actors have to work." (Goodson 1991b: 118).

**Goodson's study of Biology**

In the early nineteenth century in Britain, scientific subjects were included in the school curricula. Advocates of the inclusion of science at the secondary school level stressed both the "intrinsic value of their subject as a disciplinary training but also the utilitarian potential" (Goodson 1987: 41). The leading scientific subjects
were Physics and Chemistry, with some emphasis on Zoology and Botany. Biology hardly existing as an identifiable discipline, which can be explained by reference to the two factors mentioned above. The utilitarian and applied aspects of Biology were undeveloped, and its value for discipline training unexplored (Goodson 1987: 42). This was the time of the Industrial Revolution in Britain, and the achievements of the physical sciences were clear to see. Goodson asserts that:

"The consequent chronological priority of the physical sciences was probably of considerable import for the history of biology in schools and it has been claimed that because physics and chemistry were 'first in the field' the task of establishing biology was rendered immeasurably more difficult." (Goodson 1987: 42).

Goodson quotes Tracey (1962: 424) on some of the difficulties faced by early teachers of Biology who were not, apparently, academically well equipped to teach the subject efficiently, nor did they have the experience of their own school days to fall back upon. According to Goodson, a growth in the utilitarian aspects of biology led to an expansion in the subject in the 1920s and 30s, and contributed to its gradual acceptance. But Goodson states that, in the 1950s it was still noted that "The place which is occupied by advanced biological studies in schools ... is unfortunately that of vocational training rather than of an instrument of education." (Goodson 1987: 53). Subjects seen as being utilitarian were still given only a low status until "the work of Crick and Watson on DNA confirmed biology as a laboratory-based hard science" (Goodson 1987: 53). Biology had finally made it.

A response, reported by Grobman (1969), to the claim that biology lacked the clear unifying structure characteristic of physics and chemistry, was that biology was not, in fact, an immature study but a highly sophisticated one.

"The nature of biology itself, as a science built upon the physical sciences, is automatically of a more inclusive level of complexity and so characterisation of its structure appropriate for secondary school students may involve increased complications." (Grobman 1969).
Goodson's study of Geography

Goodson states that "The promotion of geography has taken place against a background of social change which has provided a range of arenas for subject advocates to react to and utilise." (Goodson 1987: 57). In the late nineteenth century, Geography was achieving some success in the process of establishing itself as a subject in English schools, but only in a few of the universities.

"In the late Victorian period, a period of rapid imperial expansion, geography was promoted by strategies such as Sir George Robertson's description of it as 'the Science of Distances - the science of the merchant, the statesman and the strategist'; as Gregory (1987: 21) notes, 'a characterisation which appeared to make a command of geography vital both for the maintenance of the empire itself and the ascent of man to the most acclaimed positions of profit and power within it." (Robertson 1987: 447-57).

The Geographic Association, since its formation in 1893, played a central role in promoting the position of geography as a discipline. Amongst other things, it encouraged universities to set up Schools of Geography, and persuaded many secondary schools to place geography teaching in the hands of a trained geography master rather than just an enthusiastic amateur. (The ACS, however, can claim no such pivotal role in the promotion of computing as shall later be seen.) The expansion of Geography in schools, however, resulted in it being labelled as a 'school subject' so making its acceptance in universities much more difficult. The opposition of other subject groups at the university level also hampered the early growth of Geography, making its quest for academic status a slow one. It was not until 1954 that Honeybone could claim that "at long last, geography is forcing its complete acceptance as a major discipline in universities, and that geographers are welcomed in to commerce, industry and the professions, because they are well educated men and women." (Honeybone 1954: 186). Geography had made it, only to shortly face a 'challenge' from a new subject trying to establish a place in schools: Environmental Studies.
Goodson's study of Rural Studies

From origins dating back several centuries, Rural Studies had input from two major sources: utilitarian studies based on husbandry and agriculture, and from what was seen as the pedagogic potential of nature, based on Rousseau's arguments in 'Emile'. In many rural areas, Rural Studies was seen as "a major influence pervading the curriculum, the 'hub of the curriculum wheel'." (Goodson 1987: 99), but the perceived low status of the subject had a major influence on its subsequent transformation into Environmental Studies. By the mid 1950s, in response to problems of its low status, and a threat to its very survival, some rural studies teachers began to see an urgent need to organise themselves into a subject association: a strategy which had been followed by many subjects successfully embodied in grammar and secondary modern curricula (Goodson 1987: 99).

The establishment of CSE examinations in the early 1960s presented a quandary for the Rural Studies teachers. A report at the time stated that Rural Studies teachers "are by nature opposed to the competitive and restrictive aspects of examinations in schools, and for this reason have only accepted the position reluctantly" (Goodson 1987: 96). The problem was that, despite the rhetoric of the subject association, most rural studies teachers continued to base their work on gardening, which was not amenable to written examinations. Rural Studies had the problem that the only way in which it could obtain credibility and status was to adopt formal examinations, but to do so would mean a fundamental change in the nature of the subject.

Goodson's investigation of the birth of Environmental Studies

By the mid 1960s it was clear that Rural Studies must undergo a major redefinition. In 1965 the term 'Environmental Studies' was suggested for a new subject to replace the old Rural Studies. Goodson describes how he obtained data on the transition.

"The school subject in question, Rural Studies, changed from being a deeply utilitarian subject based on gardening in the 1920s to a subject offering 'O' and 'A' levels in environmental studies in the 1970s. By collecting the life stories of key participant teachers spanning this generation it was hoped that insights might be provided not only of
how the curriculum changes but of how structural constraints are evidenced in such a process. Understanding a curriculum innovation such as the launching of environmental studies required a detailed understanding of historical context, and life stories provided a valuable access point to this context." (Goodson 1991b: 119).

He describes some problems that now emerged, the biggest being that he had been speaking with a group of innovators who had "hijacked" the subject association so changing the direction of the subject. The problem, of course, was that this group in no way represented the range of traditions and "alternative visions" among the teachers of the subject. He describes how, at this point, he identified three directions in which sustainable research might proceed. Firstly, he considered whether he should work on the life stories of the key participants to fill them out into fully fledged life histories of sufficient depth to capture and portray the main issues within this curriculum area. The next option was to gather a wider range of life-stories and so try to cover the main "traditions" and sub-groups within the subject. The last option was to develop a detailed documentary history of the subject, over a period of more than fifty years, considering the conflicts generated over the innovations (Goodson 1991b: 119,120).

Goodson explains how he rejected the first strategy as the focus of the innovation in-group seemed unrepresentative and in a strong sense 'against the grain' of much of the history of the subject, and decided to proceed with a combination of the second and third strategies.

"This was a period of considerable educational innovation and rapid organisational change to a comprehensive system. But in order to attain their goals (promoting environmental studies) the innovators had to accept the existing structure, the existing 'rules of the game' if you will. To gain status and resources, they were forced to stress the academic knowledge and 'discipline' element of their curriculum when their prime purpose was to promote something practical, immediate and locally relevant." (Goodson 1988a: 8, 9).

On another level the proponents of Geography, after finally winning the battle for 'respectability', felt challenged by the emergence of the new subject. In a similar way to that in which Geology had seen Geography as a threat, Geography saw the possibility of Environmental Studies taking over some of its territory and reacted
against the redefinition of Rural Studies. In interpreting this reaction by Geography, Goodson suggests that established structures effect subsequent action in complex ways and that this takes us beyond seeing schooling as a structure that then facilitates 'domination' by dominant interest groups.

'On Becoming an Academic Subject'

Hirst (1967: 44) argues that "the central objectives of education are developments of mind" and that such objectives are best pursued by "the definition of forms of knowledge" (Hirst & Peters 1970: 63, 64). This philosophy gives an explanation for the school curriculum 'aspiring to promote the intellectual development of pupils'. Goodson comments that:

"In this model of school subject definition it is often implied that the intellectual discipline is created by a community of scholars, normally working in a university, and is then 'translated' for use as a school subject. Phenix (1964: 317) defines the intellectual discipline base in this way: 'The general test for a discipline is that it should be the characteristic activity of an identifiable organised tradition of men of knowledge, that is of persons who are skilled in specified functions that they are able to justify by a set of intelligible standards.'" (Goodson 1987: 4, 5).

In attempting a description of the relationship between school subjects and curriculum change, Goodson (1987: 10) employed Layton's (1972) model for the evolution of science in nineteenth century England. The evolution of the subjects investigated by Goodson occurred slowly, Geography for example, taking over 80 years to achieve its current form. Layton's model has been shown to be useful in examining this kind of slow subject evolution, and limited use is made of some aspects of this model in describing the rapid emergence and evolution of curricula in business computing. Layton defined three stages in this evolution:

"In the first stage:

the callow intruder stakes a place in the timetable, justifying its presence on grounds such as pertinence and utility. During this stage learners are attracted to the subject because of its bearing on matters of concern to them. The teachers are rarely trained
specialists, but bring the missionary enthusiasms of pioneers to their task. The dominant criterion is relevance to the needs and interests of learners.

In the interim second stage:

a tradition of scholarly work in the subject is emerging along with a corps of trained specialists from which teachers may be recruited. Students are still attracted to the Study, but as much by its reputation and growing academic status as by its relevance to their own problems and concerns. The internal logic and discipline of the subject is becoming increasingly influential in the selection and organisation of subject matter.

In the final stage:

the teachers now constitute a professional body with established rules and values. The selection of subject matter is determined in large measure by the judgements and practices of the specialist scholars who lead inquiries in the field. Students are initiated into a tradition, their attitudes approaching passivity and resignation, a prelude to disenchantment." (Layton 1972).

The growth of prominence of science in the school curriculum during the nineteenth century is a matter about which Mary Waring (1985: 122) writes. She notes that in the late 1860s there was a period of intense activity and pamphleteering by scientific pressure groups, which were urging the government to take action on scientific and technical education. The government's response consisted of a twenty year long series of commissions, "against a background of deepening economic recession and gloom." Appropriately titling her article: *To make the mind strong, rather than to make it full*, Waring describes how the arguments for the inclusion of science in schools were twofold: firstly there was the view that science provided "important knowledge", but also that as a practical subject, it could assist with "hand and eye" training. Goodson (1991: 117) describes Mary Waring's 1979 study of Nuffield Science as a "blending of individual history and curriculum history" and notes that Waring believes that the understanding of curriculum innovation is simply not possible without a history of context:
"If we are to understand events, whether of thought or of action, knowledge of the background is essential. Knowledge of events is merely the raw material of history: to be an intelligible reconstruction of the past, events must be related to other events, and to the assumptions and practices of the milieu. Hence they must be made the subject of inquiry, their origins as products of particular social and historical circumstance ...." (Waring 1979).

In an observation that relates to the pressure of tertiary on secondary studies, Goodson and Dowbiggin note that "As the university definition of science grew in power and prestige in the twentieth century, the pressure on school science teachers to conform to scholarly criteria rather than respond to the immediate problems of teaching the subject effectively has grown apace." (Goodson & Dowbiggin 1991: 243). Societal views on what constitutes "culturally valuable knowledge", and which studies are attributed high status, had an effect on what was taught in science in schools.

Curriculum History and Related Studies

The following papers cover a wide range of curriculum matters, and come from a variety of countries. They are included to provide a comparative element. Goodson (1988b: 1) notes that the collection developed from "a highly personal belief that we need to develop further our 'sense of history' about curriculum so as to develop and deepen our understandings of the curriculum endeavour", and from a growing conviction that curriculum histories are now being undertaken by an increasing and impressive body of scholars from "varied disciplinary bases and with differing political orientations."

Important points to emerge from these papers include:

- The importance of external constituencies in determining the curriculum: this issue is touched on by Cooper and Ball.
- The importance of student and teacher perception of a subject, for its acceptance, and papers by Burgess and Measor address this issue.
- Issues connected with the conduct of life history and curriculum history studies such as those discussed by Purvis, Smith and Woods.
Cooper's study of the Secondary Mathematics Project

Barry Cooper (1984) reports of the empirical history of the Secondary Mathematics Project (in the UK) and proceeds to construct a generalisable model of subject change. He argues for an understanding "of the nature and effects of interaction across a series of boundaries between subject sub-cultures practising ... mathematics and science in different social locations, and between these sub-cultures and other non-disciplinary arenas." (Cooper 1984: 45). Drawing on the work of Kuhn (1962) on theory change in the sciences, he notes that:

"... the history of established sciences is characterisable in terms of periods of 'normal science' during which a community of scholars sharing a 'paradigm' engages in problem-solving, punctuated by periods of crisis and revolution during which the previously dominant paradigm ... is displaced by a new contender from amongst those developed by scientists increasingly insecure in their paradigmatic understanding of the world." (Cooper 1984: 46).

He considers the issue of the redefinition of school subjects, not as the emergence of new disciplines but as the provision of a new definition for an existing discipline, and observes that it might be expected that older teachers, who "owe their positions to achievements under established definitions" to be more likely to resist any redefinition than younger teachers who do not have as much to lose, and who also might also be seen as having an interest in "undermining the ideational basis of their seniors' positions."

Cooper proposes a model for the 'analysis of changes in the legitimacy of particular versions of school science and mathematics'. Although this model is based in secondary, rather than in tertiary education, at least parts of it are still of interest here. In summary, this model states that:

- A subject can be seen as 'a set of segments or social movements, with distinctive missions, or perspectives, and material interests.'
- The relations of conflict and cooperation between these segments, and their alliances with groups inside and outside the subject, should be seen as major explanatory factors in accounts of change in these subjects.
- The relative power of these segments, and of individuals, can be analysed in terms of the resources available to them.
• Particular attention should be paid to understanding changes in the conditions for action for subject members, especially for changes in the distribution of resources over time.

• Segments from within university subject communities (and industry/commerce) can be expected to compete for influence over the redefinition of relevant subjects in secondary schools, and in the nature of textbooks utilised.

• We should consider the perceived career consequences of various proposals for subject redefinitions as important factors.

• Reaction to textbooks, materials and proposed changes might be accounted for as consequences of sub-cultural conflict of perspective and interest.

• As redefinition of any school subject involves compromise, we should expect its legitimacy to be under continuous attack as changes occur in the distribution of resources and opinions (Cooper 1984: 60, 61).

Purvis’s study of Schooling in Nineteenth Century England

This study is considered here not for its content, but for the fact that because of the elapsed time, Purvis (1984) needed to conduct her studies without access to 'first hand' oral history. Purvis begins by remarking that the history of education has traditionally been concerned with administration and educational provision rather than subjects. She raises the difficulty of investigating these experiences given the lack of access to oral history and how she overcame it by reference to texts containing personal accounts and autobiographies. She considers the curriculum and the educational experiences in 'Dame Schools', 'Sunday Schools' and 'Day Schools'.

Ball’s study of Social Control and the Colonial Curriculum in Africa

Ball (1984) describes how demands from the indigenous population played the role, described by Reid (1984), of an external public in defining the school curriculum. He contrasts this with the view that the curriculum was imposed externally by the colonising powers, and describes how the indigenous people of Africa were "not just simply passive recipients but played an active role in attempting to shape the education being offered to them." (Ball 1984: 117). He further describes how the history of colonial schooling is characterised by contest between rival social and political groups within Africa and with the colonial
authorities and missionaries. He remarks that it was necessary to take account, in particular, of the role of African resistance to colonial policy on education. This resistance took several forms: pressure to increase the provision of schools, pressure to provide secondary and further education for the African pupil, and opposition to attempts to 'adapt' the curriculum of the African school. In summary, Ball notes that "... the realities of African education cannot simply be read off from the colonial policies formulated in London." (Ball 1984: 138).

Smith's study of an innovative school

Smith (1984) describes a study, involving a mixture of history and ethnography, in Kensington Elementary School, Milford School District, USA. This was a fifteen year follow up on an innovative elementary school with open space, team teaching, individualised curricula, democratic administration and pupil control of learning. Again, the study is considered important not so much for its content as for Smith's comments on his methods. He comments on the triangulation possibilities between history and ethnography, but states that one of the biggest problems he faced was 'imagining oneself back in the historical period'. The method by which he solved this problem consisted of two parts: open-ended oral history type interviews with professional staff and community residents, and reading histories of all kinds.

Burgess's study into Student and Staff Perceptions of Newsom Courses

As a result of the Newsom Report (Newsom 1963) into provision of schooling for average and below average students in the UK, and pressure from the raising of the school leaving age, Bishop McGregor Comprehensive School introduced an experimental course called Newsom, intended to appeal to students of this type, and also to be of use to them. Burgess (1984), however, reports that the course was held in very low regard and commanded a low status by both students and teachers, so greatly reducing its effectiveness. One of the reasons advanced for the unpopularity of Newsom was in the naming of its subjects. Newsom subjects were given names that it was thought would appeal to students. Mathematics was delivered in a subject called 'Money matters', geography in one called 'The Post Office' and so on. To the pupils, however, this resulted in a lowering of the status of the subjects. This study further adds substance to arguments concerning the
importance of student, as well as community and academic acceptance of a new subject area.

Measor's Study of Pupil Perceptions of Subject Status

Measor (1984) makes a more wide ranging report on the ways students perceive school subjects. Different areas of the curriculum are shown to have different meaning and status with students. More importantly, she suggests a link between student perception of a subject and their actual behaviour in lessons of that subject. The topic of student perception is an important one for a study of computing, which currently is very highly regarded by students (at both the secondary and tertiary levels). While this, no doubt, has something to do with career aspirations, it bears further investigation.

Woods' Discussion of the Life History Study of a Subject Teacher

Woods (1984. 239), gives the perspective of a subject teacher in presenting the life history of 'Tom', an art teacher. He asks the questions: "To what extent does a teacher find self-expression within the curriculum? How far is a subject as practiced in the classroom a realisation of an individual teachers' self?" This is another example of a study, important here not for its content but for how it illustrates the use of life history material.

In Summary:

Goodson sums up the importance of curriculum history quite succinctly as follows:

"I have been concerned to show that curriculum histories can be a valuable complement, indeed at times an active agency, in the development of explanatory frameworks. The essential value of such histories is that they are immersed in the complexity of the social process. They develop from the desire to understand particular events not from a desire to prove particular theories." (Goodson 1984: 42)
Data Collection and Analysis.

Before data can be analysed, it must be collected. In his writings, Goodson gives little specific advice on how one should go about selecting which data to collect. As previously discussed, he advocates the value of collecting life histories of key participant figures along with relevant documents, but does not give much more guidance on how to go about choosing these. He does however, stress the need to obtain whatever is available: a major concern of researchers considering a study like this, is the availability of sources (Goodson & Anstead 1992: 128). He goes on to mention these as including the collection of documents (including minutes of meetings), administrative records, and oral testimony.

In this study I began by collecting life history data from Peter Juliff and Gerry Maynard, two of the 'elder statesmen' in the tertiary computing education field who had both had an early and long involvement with business computing. Juliff and Maynard each identified events in the 1960s and 70s at Caulfield Institute of Technology (CIT) - later Chisholm Institute of Technology and now Monash University (Caulfield), as the key to the evolution of business computing education in Victoria. Monash University, and several of the (then) Institutes of Technology and Colleges of Advanced Education (RMIT and Bendigo Institute in particular), were also identified as having played a significant role. Another very important factor, brought to my attention by both Maynard and Juliff was the growing need in the 1960s of the Commonwealth Government for computer professionals to staff the administrative computing projects in the Department of Defence and the Post Master General's Department (PMG). The Programmer-In-Training (PIT) scheme set up to alleviate this need had a considerable influence on early developments in business computing courses.

Fortunately, Gerry Maynard is one of those people who never throws out old documents and I was able to collect ten cartons full of old course notes, syllabuses, memos, letters, reports, and booklets relating to early tertiary computing courses from his garage. Gerry had gathered the documents during his years in the PMG, the Public Service Board, and at Caulfield Institute. The data obtained by sifting through these documents proved invaluable. But where do you begin in an analysis of ten cartons full of documents? The part played by the Commonwealth Government, with its Programmer-in-Training scheme, seemed like a good place to start work so I decided, first of all, to find all the documents relating to the PIT scheme, which I then proceeded to read. I found it useful to
mark 'interesting' points using a post-it-pad, (I couldn't, of course, actually mark the pages themselves) then to type these points into the word-processor, using one word-processor document to store everything relating to this topic. I included everything that I thought might be of interest and so ended up with several pages, rather than several boxes of data on this topic. Later when I was incorporating this data into the study, I had only occasional need to again refer to the original documents.

I next sifted the documents for everything relating to Organisation and Methods (O&M) and to Systems Analysis, and typed up everything of interest relating to these. All of this meant several sweeps through the documents, but in the process, again using a post-it-pad, I identified possible other areas of interest. These included course notes, syllabuses and memos. By the end of several such sweeps I had extracted much useful data. Of course any examination of documents requires that a constant watch be kept for any bias, mistakes, or inconsistencies with other data, and this was done, note begin made of any such possibilities at the time. Not to rely too much on one source, I also started collecting documents from other places such as course booklets, histories and notes from other tertiary institutions including: Bendigo, Swinburne, RMIT and Footscray Institutes of Technology, and La Trobe and Monash Universities.

I then began planning and conducting life history interviews of the 'key players' who had been involved at the time events were unfolding. Fortunately, the beginnings of business computing were small enough that those involved in one institution knew most of those involved in the others, so identifying the key players could be done quite systematically. The only problem was that several of those who had been influential in the 1960s and 70s could no longer be contacted, but a visit to each institution soon identified the longest serving staff member who was able to assist. By the end, I had conducted a series of life history interviews covering the part played by each of the following people:

Gerry Maynard	Gerry has had a most varied career, starting off as a postboy and rising to an O&M Inspector with the PMG, he moved on to become an Inspector with the

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6 The yellow, sticky pads are ideal for this purpose.
7 It should be noted that the style of 'life history' interview used in this study was rather more restricted in scope than is sometimes the case with the use of this tool. It was my concern here to elicit details of certain aspects of the curriculum developments in particular institutions, rather than to provide full details of the lives of these individuals.
Commonwealth Public Service Board and eventually took up an academic position at CIT.

Peter Juliff
From an accounting and auditing background, Peter took up a position as a lecturer at CIT. After some years he went at Health Computing Services and later returned to academia first at Prahran CAE, then to Victoria College, before returning to CIT.

Pearl Levin
Starting off as a Laboratory Assistant at Caulfield, Pearl went on to become a lecturer at CIT and eventually director of the Pearcey Centre, the commercial training arm of CIT.

Peter Goddard
Peter has had a long involvement with computing at Bendigo College of Advanced Education.

Geoff Dober
Geoff was a trainee from one of the first Programmer-in-Training courses. He is now Executive Director, Information Technology, at Carlton United Breweries, and President of the ACS.

Geoff Sandy
A former school teacher who took up a position at Footscray Institute of Technology in the early 1970s.

Brian Belcher
Brian was appointed to Footscray Institute of Technology at the time it was beginning to consider business computing in the late 1960s.

David Wilde
Coming from IBM, David has been at Swinburne Institute from the beginning of its move into business computing in the late 1960s.

Tony Adams
Tony's first position was in the Monash Computer Centre. He later moved to RMIT where he has worked in both Computer Science and Business Computing.
David Woodhouse  David established the Department of Computer Science at La Trobe University and planned its early courses.

Tony Montgomery  Tony was trained as an engineer, before being appointed to the new Department of Information Science at Monash University. He was then appointed to head the Computer Science Department, and later the Division of Information Technology at RMIT.

A question as to the reliability of life histories material, particularly in regard to the memory of the interviewee has already been raised. Failed or selective memory of the interview subject is an important issue in some instances of the collection of oral history due to the fact that sometimes the interview subjects are quite old, and the events under consideration may have happened many years ago. In this particular case, the events under consideration are comparatively recent (1960s - 1980s) and the interview subjects range in age from late forties to sixties, so failed memory should not present a great problem. However, as Goodson cautions, "In the case of oral testimony, memories can be coloured by later experiences, or can be simply mistaken." (Goodson 1992: 134). Furthermore, Goodson makes the suggestion that 'triangulation' through the collection of a number of different life histories and the comparison of these, along with an analysis of relevant documentary history of the context, can reduce the problem and, as previously discussed, this approach has been followed.

In researching this study I have taken pains to triangulate, where at all possible, accounts from the key players. In many cases, important verbal accounts from these participants have been verified by asking similar questions of others, and in some cases it has been possible to achieve this triangulation from the examination of written documents. Thus a combination of life history interviews along with the investigation of documents such as letters, the text of papers and addresses, course notes, course handbooks and memos has resulted in a reliable account of these events.

The conduct of the life history interviews is also an important issue. To what extent should these be structured by the interviewer? Who should identify the key issues: the interviewer or the interview subject? I decided to use a semi-structured style of interview, determining only its general direction. A completely unstructured interview situation would not be tolerated by the subjects who are
busy people who, although pleased to be able to assist, really do not have the time to 'beat around the bush' too much. On the other hand, an interview structured to the extent of a questionnaire would be of no value in providing useful data. The middle course of determining the basic direction of the interview, but allowing the subject a good deal of freedom in determining the way in which they answer each question, seemed the best one, so I set out with my tape recorder and notebook to do just this.

At the end of each interview I thus had a tape recording, and some jotted notes indicating both what was said, and some of the reactions of the interviewee to the questions: in many cases body-language can give the interviewer extra clues. I then immediately typed up as near to a verbatim transcript of the tape as was possible, interspersing my notebook observations into this. Each interview was typed up on my computer as a new word-processor document, of which I then printed out a copy: I still find the analysis of printed documents much easier than trying to do all of this from the screen.

Although I make extensive use of a computer in many activities, I decided that I would not attempt the use of text analysis software in handling this material. I have found that a quite useful approach is first to sit down in my chair to select appropriate material from the printed copy of the interview, then to cut-and-paste this material into a new word-processor document. In some cases I found it was then necessary to again contact the interviewee for clarification of a particular point, or for a further question. In this way I built up the final versions of the life history materials.

Another problem, of course, is the classic difficulty of the interviewer affecting the nature of the data he is trying to measure. A parallel with the case of Schrodinger's Cat, a mythical beast from quantum mechanics, may be appropriate. In quantum theory, the making of a measurement inevitably affects the object being measured: Heisenberg's Uncertainty Principle. There is no way around this, although the degree to which this is a problem depends on the scale of the phenomenon. With interviews of the type proposed, all that the interviewer can do is to be aware of this difficulty and take as much care as possible not to lead the subject into making particular responses.
On the matter of interpretation placed on the material by the interviewer, it is perhaps appropriate that as I cannot separate myself from my own background, I should declare it here.

As a former secondary school physics teacher, I had always been interested in computing, dating back to a brief brush with Fortran programming (using punch-cards) in my science degree at Melbourne University in the mid 1960s. I only became actively involved in computing when my school obtained an Apple II computer in 1977. After devising, developing and teaching Computer Awareness and Computer Studies courses for a couple of years, I enrolled for a Graduate Diploma of Computer Science at La Trobe University. In 1981, after completing the course, I took up a half-time position as 'Computer Education Consultant' in Northern Metropolitan Region (Education Ministry), while teaching at school for the other half of my time. I retained this role in 1982 and in 1983 moved on to a full-time position as a 'General Curriculum Consultant' in South Central Region, where I was called upon to assist schools with a variety of curriculum-related matters. I continued as a 'General Curriculum/Computer Education Consultant' during 1984, although back in Northern Metropolitan Region.

From 1985 to 1987 I worked as 'Educational Computer Systems Analyst', at the State Computer Education Centre, leading a team in the evaluation of computer systems for possible selection to the 'Recommended List of Computer Systems for use in Victorian Schools'. This job involved considerable contact with both the education sector and with the computer industry. It was also during this period that I developed a strong involvement with the Australian Computer Society (ACS). I had actually been an ACS member since 1981, but it was not until 1985 when I took on the organisation of the School's Congress of the First Pan Pacific Computer Conference, that I became really involved. Later I organised the School's Congress of the 1987 Australian Computer Conference, became a member of the Victorian ACS Branch Executive and Editor of the ACS Victorian Bulletin. Since its inception in 1981, I had also been a member of the course committee, and an examiner for HSC (year 12) Computer Science. Although I did not become involved for this reason, membership of the ACS Branch Executive, and the Computer Science course committee put me in close contact with many of the leaders in the field of computing (both commercial and educational), so assisting with this research. It was through these avenues that I came into contact with people such as Gerry Maynard, Peter Juliff, Pearl Levin, Tony Montgomery, Geoff Dober and others of importance to this study.
Having some personal knowledge of many of these 'key players' in the evolution of business computing certainly made conducting the life history interviews much easier than would otherwise have been the case, as I could talk to these people as colleagues and even, in some cases, as friends. As a consequence, I make no claim to be a 'completely disinterested' researcher: after having worked with a number of these people, I was personally keen to find out what had motivated them and why they had designed the courses they did. My interpretation of the interview data should however, be viewed from the standpoint of someone having no involvement in the development of these early business computing curricula being, through much of this period, a secondary school science teacher. If anything though, coming recently into this area perhaps assisted me to more successfully ask naive questions on why things developed as they did. My contacts in the computer industry - some of whom had themselves been a product of one of the early courses, while several others had at least worked with someone who had been - likewise provided another perspective on the conduct of the study.

In 1988 I resigned from the Ministry of Education to take up a position as lecturer in Information Management and Computing in the Faculty of Business at Footscray Institute of Technology. Going to work in a Faculty of Business involved quite a shift from my original career as a secondary school science teacher. On reflection, however, this does seem to represent the culmination of a trend beginning with my move into curriculum consultancy in the early 80s. Following this, I developed an interest in small business through my wife's directorship of the educational software company Seasen Software, my recent work in managing Data Publishing, and through the business connections developed from my work on the evaluation of educational computer systems. Meeting with computer professionals in the ACS furthered this interest.

Initially as a school teacher, and later as a curriculum consultant, I had been involved in the development of curricula at the secondary school level over many years. I suspect that my first interest in curriculum history really began after my appointment, in 1981, to the curriculum committee of the newly created year 12 subject: Computer Science. At the committee meetings, I began to wonder about new subjects in general, and how other subjects areas had begun. I wondered whether they had been through the difficulties we were now experiencing and how they had resolved them. I was, however, unable to follow up this interest at the time. After my move to tertiary education, into an area the developmental
history of which I know little about, I again became interested in the question of where new curriculum areas came from and why they developed as they did.

In summary then, the background that I bring to this study is one of little knowledge of commerce/business studies at the school level, and a fairly recent interest in this area at a tertiary level, but a considerable and growing interest in business computing. Not having any of the 'baggage' brought of a long association with this field has meant that I have had to do more investigative work, but it has also allowed me to bring a different perspective to its study. I was not (until very recently) involved in determining the way things are in tertiary Business Computing, and so have no vested interest in why they have developed as they did, only a curiosity to find out.

Analysis of the Data

In qualitative research, however, as Tesch (1990: 95) points out, analysis is not the last phase in the process, but is concurrent with the collection of the data. She suggests that, in fact, the collection of data and its analysis 'drive' each other along. How should the data be analysed? An important issue here is the location of the analysis in an appropriate frame. Most of Goodson's work has involved the study of secondary school subjects, and his findings on the pressures caused by innovators, 'warring academics', school practitioners, and the need for the new subject to gain 'respectability' are not all appropriate in this case. Many similar pressures however do occur, and it has been one of the tasks of this study to uncover them. More words of caution from Goodson, however, should be noted:

"A crucial component of historical studies is the way in which pieces of evidence are addressed. In other words, what is accepted as a close approximation of past reality? Documents and other pieces of evidence originated not so that historians might know what had really happened, but for other contemporary purposes. Sometimes the authors of documents faced constraints in the knowledge they had, or time available to check their sources. People make mistakes, but they can also exaggerate or misrepresent." (Goodson & Anstead 1992: 133).

An important factor taken into consideration during the analysis is that of the part played by educational constituencies. Reid, along lines derived from Meyer
(1978, 1980), argues against the assumption "that what is taught and how it is
taught results essentially from decisions and initiatives taken within educational
organisations" (Reid 1984: 68). He suggests that a crucial aspect is the role
played by external 'publics' or 'constituencies' which act as 'gatekeepers' and
ultimately determine whether a given curriculum innovation will survive. He also
outlines the role played by teachers in not introducing their own new initiatives
into new categories, but claiming that they properly belong within existing
categories. The role of educational constituencies in influencing curriculum is an
important one, and the part played by professional associations like the Australian
Computer Society (ACS), commercial organisations including the computer
hardware manufacturers, and bodies such as course accreditation panels, have
been examined in this regard.

The unique aspect of the evolution of Business Computing, which differentiates it
from many other curriculum areas is, however, the role played by technology. The
rapidity of the changes in computer technology provided the major impetus for
tertiary courses in Business Computing. It also had an important effect on what
was taught in these courses.
Chapter 3:  
Machines and Methods.

Education in any form of computing, more so than almost any other curriculum area, involves a study of the interactions of machines, methods and people. Poster (1990) notes that computer science is the only scientific field to be established on the basis of the study of a particular machine. He then asks the question "If the essence of Computer Science is a machine, how is the boundary between the science and the scientist to be drawn and maintained?" (Poster 1990: 148). This problem is illustrated by the anthropomorphism inherent in the following definition of Computer Science: "The machine - not just the hardware, but the programmed, living machine - is the organism we study." (Newell & Simon 1976: 125). What is needed is a useful way to consider the contributions of society, the computer hardware itself, and the methods adopted in making use of the machines in business. In particular, a way to consider the effects on courses in business computing, of the rapid advances in computer technology occurring at this time.

In the study of socio-technical systems, it is common to consider either the social or the technical aspect, and to treat the other as context. A radical but perhaps more useful approach is that pioneered by Bruno Latour and his colleagues. In what they call a theory of actor-networks, neither the human nor the non-human actors are privileged or considered as distinct entities. Latour (1991) suggests that both sets of actors join to make society a "durable whole". He acknowledges that distinctions between "material infrastructure and symbolic superstructure" have reminded us of the important part played by non-humans, but considers this separation to inaccurately portray socio-technical interactions. He believes that a major difficulty in considering how technology and society interact is the lack of suitable words, as long as we consider the two as acting separately. Latour argues that this dividing line should be abandoned in our consideration of the contributions of human and non-human actors.

"Contrary to the claims of those who want to hold either the state of technology or that of society constant, it is possible to consider a path of an innovation in which all the actors co-evolve." (Latour 1991: 117).
Rather than subject this data to a full Latourian analysis, I have found it more useful to draw on some aspects of Latour's work to help describe the socio-technical interactions which have taken place in the evolution of business computing. In this chapter I will concentrate on the non-human actors and briefly outline the evolution of the machines and the methods employed in using these machines. I will leave to the next chapter a discussion of the formal means by which knowledge and skills about the machines and their usage, were taught: courses in business computing.

The idea of using computers in business grew up slowly. Last century Babbage's mechanical computers and Hollerith's Tabulating Machine, along with the new concepts of information handling they introduced, paved the way leading to the use of punch-card accounting machines in business in the first half of this century. With improvements in available technology, punch-card accounting machines gave way to electronic digital computers using punch-card input devices. To help people think through the solution of information processing problems, Organisation and Methods (O&M) and Systems Analysis techniques were adopted. These techniques were evolved to meet the needs of the people whose job it was to make the machines of use to business.

To put the events leading up to our present tertiary courses in business computing into perspective, I will go right back to take a look at the part played by Babbage, by Hollerith and by punch-card accounting machines to examine whether there is a link. In referring to the part played by Warnerke and Eastman in the development of a mass market for cameras, Latour asserts: "Either we give this work a place in our analyses, in which case the link is not fortuitous, or we don't, in which case the link between the two is nothing but an artefact of the technical history of technology." (Latour 1991: 114). In the case of Babbage, Hollerith, and punch-card accounting machines in relation to business computing, I would maintain that the link is real, and so rather more than "an artefact of the technical history" of this technology. A discussion of punch-card machines is important in a consideration of business computing courses, and many of those with whom I have spoken (Maynard 1990; Juliff 1990, Adams 1992; Montgomery 1992; Wilde 1992; Belcher 1992) assert that aspects of the training necessary for the use of these machines found their way into courses relating to the use of computers. As shall be discussed later, it was not so much the punch-card technology that provided the link to later courses in business computing but the information processing concepts which had to be formalised in order to teach these courses.
Early courses in computing were designed on the basis of the equipment available, or envisaged at the time, and this then influenced later developments, contributing to the cyclical nature of curriculum development in business computing. Even during the 1960s, Caulfield Technical College (amongst others) was still offering courses in Punched Card Systems and Accounting Machine Applications, along with its courses in Commercial Data Processing. In fact, Maynard (1990) recollects that in the mid-1960s most educational institutions, if they were doing anything at all in this area, were still teaching about punch-card operated accounting machines which were still in widespread use at the time. The industry itself, was still trying to move itself out of punch-cards into the computing arena, not much aided by the slowness of IBM in moving from accounting machines into computers.

The 'Pre-History' of Business Computing.

Babbage's Mechanical Computers

Although never actually built at the time, Charles Babbage's Difference and Analytical Engines, conceived over 150 years ago, advanced much of the theory necessary for today's computers. In designing the Difference Engine, it was Babbage's intent to produce a machine to generate navigational and mathematical tables, rather than one that had any direct application in the processing of commercial data (Jones G. 1991). Babbage had established that there was a need to generate such tables, and been commissioned to design a machine for their production.

This is not to say that the generation of navigational tables had no commercial value as, to the contrary, the use of these tables was essential to the conduct of international trade. Babbage's machines were, however, not designed with a view to handling business data and he neither considered nor, would it appear, had any inkling of the concepts of what is now called business computing. Babbage's mechanical 'computers' were designed, using the technology of the day, to tackle known tasks needing to be performed at the time. Although referring to Newton, perhaps the words uttered by de Gemaches in 1740 are also applicable here: "His work did not bear on any subjects except those that could be treated by means of
the calculations he knew how to make." (Duhem 1962: 49). Babbage, and British society in the mid 1800s, could not possibly have been expected to guess the uses that are now make of computers as there was no perceived need for such machines in the commercial world of the time. Isaac Asimov apparently also once remarked that there was no way that the inventor of the motor car could have envisaged its almost universal acceptance and use, let alone the parking and pollution problems it would later cause. Babbage later went on to design an Analytical Engine that had all the elements of a stored program computer.

It would take some time for society to come to grips with the wider significance of Babbage's invention and to think of new uses for this technology in the commercial world of the future. As Latour remarks: "... the force with which a speaker makes a statement is never enough, in the beginning, to predict the path that the statement will follow. This path depends on what successive listeners do with the statement." (Latour 1991: 104). In Babbage's time, few were the listeners even interested in his statement, which would still have to go through many transformations before reaching a generally accessible form. To borrow some more from Latour: "the fate of a statement is in the hands of others. Any vocabulary we might adopt to follow the engagement of non-humans into the social link should consider both the succession of hands that transport a statement and the succession of transformations undergone by that statement." (Latour 1991: 106).

Punch-Card Accounting Machines

Jacquard is generally credited with the invention of punch-card technology when, in 1801, he devised a means of using cards punched with various arrangements of holes to control his looms, so producing different patterns of cloth automatically. In 1885 Herman Hollerith took the idea a good deal further in the development of a machine that would automatically produce the tabulations necessary to complete the processing of the 1890 United States census results. The importance of Hollerith's contribution was not so much the tabulating machine itself, as in changing our concepts of the recording of data in such a way as to facilitate the use of machines in its processing.
"The importance of this invention lay not in any technical advance, but entirely in the concept it embodied. In recording bits of data, each on its own card, by means of a system that gave to each column and range of the card a specific meaning, the punched-card system made available a means of 'reading' and 'interpreting' simple data without direct human participation. Now, through one means or another of sensing the holes, machines could sort and classify, combine and tabulate, the bits of data on the cards. The significance of the method lay in the recasting of the form of the information so that it could be picked up by a machine." (Braverman 1974: 55).

Although they had been in use in business for some years before this, it was during the economic recession of the 1920s in the USA that punch-card tabulating machines became very important to commerce: they helped cut costs. The formation of the International Business Machines Corporation (IBM) in 1924 saw the accounting machine come of age.

"Before the punch-card machine, bookkeeping had been performed manually. Wearing a green eyeshade and garters to hold up his sleeves, an accountant sat on a high stool to pore over and pencil his books each day." (DeLamarter 1986: 15).

By the 1930s the accounting machine, or tabulator, had evolved into a quite sophisticated electronic calculator capable of performing complex arithmetic tasks and of processing dozens of punched cards per minute. By this time, IBM accounting machines were controlled by a special control panel rather like the old telephone switchboards. The machines were then programmed by the use of this plug-board and a series of switches: the concept of programming was thus well known to the business world before the use of digital computers became common. IBM did very well commercially during this period, particularly with its policy of functional pricing, where a machine delivering twice the performance cost twice as much to hire, even though it cost IBM only fractionally more to manufacture (DeLamarter 1986: 19). IBM also offered its own training courses, using its own equipment of course! With such a successful commercial operation, IBM was not keen to see it all made obsolete by the advent of the electronic computer and did its best to delay the widespread use of computers in business (DeLamarter 1986). To move a few years ahead for a moment, after it was clear that computers were here to stay and that punch-card machines were out, IBM began using the same
tried-and-true techniques: functional pricing, making machines that were not compatible with those of other manufacturers, and running its own training courses on its own equipment. In the computer arena it quite quickly became just as successful.

By the 1920s and 30s, operations requiring large amounts of computing were common, but such operations were still carried out using analogue devices, desk calculators or punch-card machines. Punched cards were used widely at this time for commercial accounting and inventory control. Large commercial organisations in Australia, including the major banks and insurance houses began using batteries of punch-card machines for their statistical calculations and data processing. Pearcey (1988) notes that by far the largest user of punched card systems in Australia was the Commonwealth Bureau of Census and Statistics which used the punch-card machines for the purpose Herman Hollerith had designed them: census data analysis. The operation was labour intensive and tedious but represented another step towards the adoption of computers in business:

"The problems and processes involved in handling large amounts of data ... were thus understood before the advent of the stored program computer and could be transferred to the much faster, automatic aids that were to become available." (Pearcey 1988: 135).

Punched card machines could, however, do more than just perform standard, preset, operations. Punch-card equipment had eight basic functions: key punching, verifying, sorting, tabulating (accumulation, comparison, selection and printing), collating, reproducing, interpreting and calculating (add, subtract, total, subtotal, multiply and divide) (NCC\textsuperscript{8} 1968: 7). Groups of the machines could be organised to perform quite complex and sophisticated operations. Extended computations could be achieved by programming the operation of each machine: setting up their plugboards in a specially organised way, and by operators passing decks of cards from one machine to another.

Even before useful computers came onto the scene, the growth of business that followed World War II underlined the need for quick accurate accounting methods, and the major problems of data processing began to emerge at that time. With the benefits of hindsight, the British National Computing Centre was able, in 1968, to describe these problems as including: the increased volume of data and

\textsuperscript{8} National Computing Centre (UK).
paperwork; a greater demand for up-to-date, speedily produced information; the increasing costs of staff, stationery and space; and the need to maintain accuracy, regardless of the volume of the data (NCC 1968:1).

The earliest attempts to improve accounting were the so-called peg-board systems, the purpose of which was to eliminate copying as a separate process, but advances in automating the process further were rapidly made. Although the early accounting machines were basically just a combination of a typewriter and an adding machine, the addition of extra registers and input/output devices made them into quite sophisticated mechanisms, paving the way towards a transition to electronic computers.

"Accounting machines were developed to speed up the processing of information not only by eliminating copying as far as possible, but also by doing simple calculations automatically ... both of which led to greater accuracy. The task of selecting where entries should be made was still left with the operator, but modern machines can guard against wrong selection to some extent, eg by use of magnetic stripes on the back of the ledger cards." (NCC 1968:2).

Early Computing Developments in Australia

Babbage's designs, along Jacquard's card-operated loom and Herman Hollerith's later invention of the punch-card operated Tabulating Machine to process the results of the 1890 United States census, were perhaps the beginnings of modern computing. Many developments followed including, in the 1920s, an early Australian developed 'computing' machine: the totalisator, which went on to become a great commercial success in providing gambling facilities to the horse racing world (Pearcey 1988: 2).

Australia was quite well placed for an entry into 'the computer age', particularly as it also had a manufacturing base for the 'high technology' of the day: the vacuum tube. Pearcey describes the transition from analogue type instruments like the slide-rule and the simple desk-calculator, along with a book of mathematical tables, to the digital computer, and how it was made possible by the prior development of a large scale domestic radio industry during the 1920s and 30s in
this country, which was served by a reliable vacuum-tube-based radio technology (Pearcey 1988: 6).

All that was now missing technically, was some of the expertise in television and radar (again based on the vacuum tube) developed in Britain during the 1930s and 40s. The close relationship between Australia and the UK at that time, and the fact that Pearcey and others who were to become involved in computing in Australia had worked on radar in the UK during the war, provided this last technical ingredient.

"... Further, by the end of WW2 the techniques of the early high-definition television developed by EMI and L Baird in the UK during the 1930s and the radar technology which stemmed from it by 1945 provided all the technology needed to create the electronic computer." (Pearcey 1988: 6).

As a consequence, Australia made its move into electronic digital computing quite early. The CSIR Mk1 (CSIRAC) was built by Trevor Pearcey and Maston Beard in the late 1940s. It was Australia's first internally stored program computer, and the world's fourth. From 1948-1956 it was located in the Basser Laboratory, University of Sydney. In 1956 it was moved to Melbourne and set up at the CSIRO Division of Radiophysics in the University of Melbourne, where it remained in service until 1964 (Pearcey 1988: 104). More recently it was displayed, with pride, at Chisholm Institute of Technology, before being finally moved (in 1992) to the new Victorian Museum of Science and Technology at Spotswood.

According to Maynard, Pearcey had the ideas, and Beard the technical skills and the knowledge. Pearcey got his ideas on computing from two physiologists who had described how they thought the human brain worked. "Pearcey really built his computer (CSIRAC) up from first principles and was not influenced greatly by overseas developments." (Maynard 1990).
The fact that it was the CSIRO, with its connections to the universities and to government, that led the way into computing in Australia, probably assisted in the early introduction of computing courses in our universities. Trevor Pearcey, prominent in building CSIRAC, joined the Division of Radiophysics (CSIRO) at the end of 1945 where he worked for some years, during which time he introduced, at Sydney University, what he claims to be Australia's first university course in computing. On returning from working overseas on EDSAC II, Pearcey took up a position at the CSIRO's Division of Mathematical Statistics in 1959, and in this same year, introduced a formal computing subject at Melbourne University (Pearcey 1988: 60). But Pearcey's later career is also of interest. According to Adams (1991), Pearcey's 'purchase' by Caulfield Institute of Technology (CIT), in 1972, was a brilliant public relations move by the Institute, which added, as I will later elaborate, to the already very successful marketing of CIT's courses. From his position as Head of the Electronic Data Processing (EDP) Department he was, in 1980, appointed Dean of the new School of Computing and later of the new Faculty of Technology (Greig & Levin 1989: 16). Adams (1991) claims that "Chisholm [then Caulfield Institute of Technology] was arguably the most important influence on professional computing education in Victoria, if not Australia".

The First Electronic Computers and their adoption by Business

Commenting on the construction, during the World War II, of ENIAC, the first real electronic computer, Goldstine, a computing collaborator of von Neumann, suggests that "the ballistic needs of the United States were to be a primary incentive for the development of the modern computer." (Goldstine 1974: 72). Bailey (1992) describes how Goldstine had personally managed a staff of 176 people, whose job it was to compute ballistic range tables. Despite their best efforts, they were not able to do the job quickly enough and automation of this process was thus to be "the raison d'être for the first electronic digital computer." (Goldstine 1974: 72).

These early digital computers were used only for scientific and military purposes until, in 1951 in the United States, Mauchly and Eckert (designers of ENIAC) formed a company to build the UNIVersal Automatic Computer (UNIVAC). The company was acquired by Remington Rand which launched UNIVAC-1 as the first electronic computer system designed as a commercially useable general
purpose computer (DeLamarter 1986: 26, 27). The first UNIVAC-1 was delivered to the US Bureau of the Census in 1951 for use as the first computer dedicated to business applications. It was at about this time that it became generally clear that the electronic computer could be much more than just a simple arithmetic calculator, and could be used to process all types of symbolic information. It was also then becoming clear that the computer could be of use to businessmen as well as to scientists, and that "It would easily process all those billions of punch-cards IBM's customers were then cranking through accounting machines." (DeLamarter 1986: 27).

International Business Machines had been producing computational devices since its formation in 1924 from the Computing-Tabulating-Recording Company (C-T-R), the company originally set up by Hollerith to market his Tabulating Machine. During the 1920s - 1940s, much of IBM's revenue came from the supply of accounting (tabulating) machines and so it was reluctant to see the new digital computers supplant this lucrative market. It is said that in 1943, IBM Chief Executive Thomas Watson remarked that "I think there is a world market for about five computers." While it is possible that this oft-quoted statement is apocryphal, it does nevertheless accurately reflect the view that IBM was keen to project to the world at this time: "stick with IBM accounting machines". It cannot be claimed that IBM was caught by surprise by digital computer technology as it had partly funded the Harvard Mark-I computer project in the years before the war, and had specially modified its accounting machines to perform the precision arithmetic necessary to the Manhattan Project. What was more likely, was that there was a fear within IBM that "the fast-developing technology of electronic computing might sweep its lucrative empire of mechanical punch-card machines into the junk heap." (DeLamarter 1986: 27). Nevertheless, after a slow start, in 1953 IBM produced the IBM-650 - its first electronic digital computer suitable for business applications, and soon gained market leadership in the field. When asked how IBM took the lead so quickly, Thomas J. Watson Jr, son of the IBM founder and now IBM Chief Executive, replied:

"Traditionally, we had a big share of the punch-card accounting machine market. So we had a large field force of salesmen, repairmen and servicemen. They were perhaps the only people in America who understood how to put in an automated bookkeeping system." (Watson 1973: 41-45).
At a computer conference in Sydney in 1951 Trevor Pearcey was apparently asked "Do you think these things will be of any use in the commercial business area?" to which he replied with an emphatic "No!" (Philcox 1978a: 3). Maynard says that Pearcey believed that "you would not waste expensive computing resources on such mundane things as business computations" (Maynard 1990). Many computing pioneers came from a scientific/mathematical background, rather than one in business or accounting, and with a background in physics, Pearcey was little different. He most certainly had a major impact on technology in Australia, but according to Maynard, Pearcey never really understood the importance of commercial data processing. Maynard himself, coming from the Postmaster General's Department (PMG) and the Public Service, seems to have had a significant influence on business computing in Australia.

From this point on, the adoption of computers was quite rapid. Perhaps, as Bailey suggests, the first electronic computers of the 1940s succeeded so quickly because they copied the "sequential architecture of human computers", and in doing so, inherited the sequential ways of "expressing and formulating science that had developed over twenty-five hundred years" (Bailey 1992: 67), a period during which Bailey suggests that our methods of computation shaped science far more than science shaped them. Bailey also asserts that people did not delay to use the results that the first electronic computers produced, and were not anxious about their validity, because it was possible to directly check these results manually (Bailey 1992: 84). Latour, however, cautions that one should not be too quick to draw conclusions about relative slowness and then great speed of innovations and that time, like everything else, is constructed. In describing the diffusion of photography into a mass market last century he argues:

"Should we then conclude that the innovation 'drags its feet for thirty years' and 'accelerates brusquely' in 1887 as historians often say? We could indeed reach this conclusion, but words such as 'fast' or 'slow', 'mature' or 'premature', 'feasible', 'utopian', 'real', merely float on the surface of translation movements without explaining anything." (Latour 1991: 119).
Content of Computing Courses in Australia

Australia was also not backward in introducing tertiary courses in computing, and in the development of these courses there was no deliberate attempt to copy overseas patterns. The next chapter describes how courses in computer science and business computing, along with socio-technical factors, *co-evolved*. When business computing courses emerged in the 1960s, course content quickly settled down to contain the same three major components that are found in similar courses today: computer hardware, programming, and systems analysis. In considering the interaction of machines and methods, it is thus convenient to consider these same three components, all of which can be seen as further actors (Latour 1991) in the development of business computing.

Components of Business Computing Courses.

The Machine: Computer Hardware

As I have shown, in the late 1940s and early 1950s the digital computer was an expensive and complex machine, and was seen almost exclusively as a high speed calculator for use in the scientific laboratory. In the mid to late 1950s, business management *began* to think about computers, but at first regarded them simply as faster, more powerful accounting tools: a bit more powerful than punch-card processing machines (Maynard 1990). These computers were still exceedingly expensive, and SILLIAC built for Sydney University in 1956, cost about £75,000. (In today's terms this would have been a great deal of money: much more than all but the most powerful supercomputers of today.) Braverman (1974) reports that during the 1940s and early 1950s, when tabulating equipment based on the punched-card dominated the 'computer' industry, data processing occupations displayed the characteristics of a craft. He describes each tabulating *craftsman* working on several types of machine: sorters, collators, tabulators, and calculators, but generally not on the key-punch machine as "being a keyboard machine, this was immediately recognised as a job for 'girls'."9 (Braverman 1974:

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9 Further to this point, most of the photographs of punched-card equipment of the time show young *women* doing the key punching. Similarly, most of the manuals and other writings make almost exclusive use of the feminine pronoun in referring to data entry operators. Pearl Levin was originally employed at Caulfield, essentially in the role of a data-entry operator.
57). Learning to use punched-card machines involved the equivalent of an apprenticeship where a period of learning was done on each type machine, and the programming (wiring a panel board for each machine) done at this time was "simply the highest skill of an all-around trade." (Braverman 1974: 57).

In 1964, 80% of the computer time in the USA and UK was spent on processing accounting information (McRae 1971: 11). McRae recounts that up until that time, neither management, nor the computer technologists themselves really knew how best to use computers in business. Perhaps the accountant really knew: "He did - but only to process more accounting information!" (McRae 1971: 11). Not long after this period, Gerry Maynard (1971) described the 1960s as the 'Integrated Systems Design Period', offering great promise, but full of repeated and costly failures. The emphasis was on information processing and information flow concepts, with a growing awareness of the importance of systems analysis and design, of programming, and of the need for suitable people trained in this work. In the late 1960s, business began to investigate the possibilities of the computer as a management tool. Computers had, for some time, also been used for generating routine report listings, and management looked forward to using them to cut clerical costs and reduce administrative delays. The technology of the day was still, however, somewhat primitive and even in 1965 Gerry Maynard's lecture notes (Maynard 1971) on file design refer mainly to the use of magnetic tape. It is not until the early 1970s that some reference to the use of magnetic disk packs begins to appear. Peter Juliff (1990) reports that in tertiary institutions, the equipment-based subjects of the 1960s typically spent roughly equal amounts of the time discussing accounting machines, punch-card machines and computers. Computer input/output (and storage) was by use of either punched-cards or paper tape. There were no terminals, and programmers often did not enter their own code. Juliff remembers how the paper tape was more amenable to the data preparation operators, who sat "at a sort of typewriter while they typed up your program. Paper tape however, also used to tear." (Juliff 1990).
In the 1960s computers were all just computers, the terms mini and mainframe not yet having come into use. RMIT had an Elliot 803\(^{10}\) and Caulfield Technical College had a Ferranti Sirius (which used nickel delay lines one step up from the mercury delay lines used by CSIRAC), and later a Control Data 160A with 4k of core memory and paper tape input and output. There were no printers, the paper tape was put through a flexowriter to be printed (Juliff 1990). Pearcey (1988: 57) describes these machines as "office sized systems". Juliff describes them as small pre-cursors of the mini: of machines like the DEC 11/03. He speaks of how Pearl Levin was running the computer centre at Caulfield in the 1960s: "She was chief operator, data-prep person, the works, and spent most of her time feeding data through computers and running other people's programs." (Juliff 1990). Levin came to Caulfield as "a sort of data-prep laboratory manager". Her background, in South Africa and then in England, had been as a biology laboratory technician. Franklin (1990: 105) suggests of technology in general, that the work of women like Pearl Levin is typical of the poorly paid development engineering necessary for the social acceptance of any technology. Levin, like other women that Franklin describes however, did not see her work in these terms. She saw her role in those early days as providing a technical service, and providing it to the best of her ability, rather than in developing new ways to use computers in business (Levin 1991).

By the late 1960s it was clear that the CAEs were not going to get far on small machines like the Elliot 803, and there was a move by the Commonwealth Government\(^{11}\) to inject a major amount of funds (Juliff 1990). Caulfield, RMIT, Swinburne and the smaller colleges like Footscray and Prahran were all involved in the same buying exercise. The Victorian Government, for what Juliff suspects were reasons based on our balance of payments, said that "an ICL computer was the one to get". Juliff remarks that Caulfield had originally wanted to buy a CDC machine as many of their 'clients': Government Departments like the Commonwealth Bureau of Statistics, all had CDC machines - the number crunchers of the time. Juliff remembers that the choice of equipment was quite crucial, and how manufacturers thus had a considerable influence. It was regarded as a great coup for ICL when many of the Institutes of Technology purchased ICL equipment. Juliff suggests that the money for these machines would have come from the Victorian Education Department, as there was no industry involvement in the way of sponsoring hardware (Juliff 1990). He suspects that

\(^{10}\) The process whereby RMIT and Caulfield Technical College acquired their computers is accounted in Chapter 4.

\(^{11}\) Following on from it's Programmer-In-Training courses: see Chapter 4.
computers would have been "fiendishly expensive" at the time. One advantage of the CAEs all going for ICL was, of course, commonality in software: ICL compilers and utilities, and the George operating system. This led to a "reasonable amount" of commonality of curriculum content across the college courses.

According to Juliff, in the 1960s manufacturers did not really try to affect what was taught, but did still have a greater influence than they do now. For instance, when Caulfield first tendered for computer equipment, there was considerable debate on whether to stick with tape drives rather than moving to the new disk drives. The manufactures kept saying "a file is a file - it doesn't matter if it's on a tape or a disk" (Juliff 1990). The problem was that most of the machines then used in business still had tape drives and the Caulfield staff were worried about students having to go out and use these tape drives, knowing all about disks, but little about tapes. "Courses were much more practical than today, but this fitted in with the needs of industry. Programmers had to operate the computers after 5pm when the operators went home, so they had to know how to load cards and tapes and to clear tape jams." (Juliff 1990).

It was not until the 1970s that the terminal began to replace punched-cards and paper tape. The September 1970 issue of the ACS Victorian Computer Bulletin contains an article on 'Office Computers'. These mini-computers, apparently fairly typical of those around at the time, had a memory capacity of 8k - 64k bytes, and a cycle time of about 1 microsecond (1kHz). At a time when $5,000 per annum would have been considered a respectable annual salary, they cost between about $20,000 and $30,000. In today's terms, these machines would have been somewhat less powerful than a $500 Commodore C64.

In the early 1970s, the business community was becoming increasingly aware of the potential of mini-computers, but the industry was still tending to cling to the mainframe and to the punch-card. In a letter to the Editor of the ACS Victorian Computer Bulletin in March 1971 Henry Couchman, a lecturer at RMIT, writes of how he saw it as regrettable that many people in the computer industry were tending to ignore keyboard programmable machines such as the Hewlett Packard 9100 series.
"It is a common statement that desktop computers are really only
calculators; this appears to derive from the belief that a computer is a
device serviced by peripherals, and addressed in machine code through
a compiler language. This is not true, a computer is best defined as a
device in which a program may be listed, stored and used; whether the
use is to process data or to control external devices or to perform some
other function for which data is not required, is immaterial to the
definition. A calculator differs in that while quantities may be stored,
there is no provision for programmed operations." (Couchman 1971).

With the advent of the mini-computer, the possibility of departmental, rather than
only enterprise computing, became a reality. When an expensive mainframe was
the only option, few organisations could afford more than one computer,
necessitating a centralisation of all computing resources. In business, Data
Processing departments had grown up around the mainframe, and all computer
requests were handled by this central group. With the availability of the lower cost
mini, it became feasible for large departments, within the organisation, to have
their own computer, so reducing the need to centralise. It was, however not until
the arrival of the micro-computer in the 1980s that it was possible even to
consider doing entirely away with the central mainframe. Before the trend
towards decentralisation had continued very far though, networks came onto the
scene to connect the machines up again. The whole issue of centralisation versus
decentralisation in computing is a fascinating one, but goes beyond the scope of
this thesis.

In the late 1970s a number of these smaller 'departmental' machines were being
brought into the CAEs. These were computers like the Prime and the Data
General which were larger mini-computers, and forerunners of the VAX systems:
PDP-11/23 and PDP-11/45. Previously, a single computer had been used for all
teaching, research, and administration. Now it was possible to separate these
functions onto different machines. The big advantage of such a separation was
that "In playing around with these machines in teaching, you wouldn't screw up
the whole college operation" (Juliff 1990).
Juliff says that for several years the universities had tended to have numbers of these smaller machines, because they had tended to diversify their computing resources a lot more than the colleges. The universities used larger machines, like the CDC 3200 or the Burroughs 3500, to run their major processing but then the Maths and Computer Science departments and the Engineers would have their own PDP-11/23. The colleges, on the other hand, had previously tended to go with the large central machine. "Nobody thought of upgrading resources by buying a machine just for this department, or just for that course. There weren't any that were economical. The conventional wisdom said that if you were given $1,000,000 you wouldn't buy ten $100,000 computers as these would be just toys." (Juliff 1990).

In the 1970s many courses began to move students off the use of punched-cards and onto terminals, but this was a slow operation taking ten years to complete. Mini-computers could still be run on cards, and it took quite a while for some institutions to be weaned off them. "Cards were much more concrete: you could take a pack of cards with you." (Juliff 1990). It is interesting to see that even in this curriculum area where technology was galloping along at a pace and change was the norm, there was a tension between established curriculum practices and a movement to the limits of the possible. Clearly it would have been possible for these courses to have moved off punch-cards and made use of terminals much earlier than they did.

In a paper presented to the 16th Annual Computer Conference of the Australian Colleges of Advanced Education in 1985, Graeme Knox from RMIT sums up these developments:

"The first phase [in the development of college computing facilities] was to provide compile, edit and go type facilities to relatively small local groups specialising in computing. Firstly this service was provided by (now) relatively small mainframes and minicomputers. Towards the end of the period (1975 to 1978) the central/non-central war was fought and networking emerged as a timeshare function rather than a bulk batch function." (Knox 1985).
Knox goes on to describe the second phase (1978-1985) as the additional provision of 'application engines' to a much wider range of disciplines. He notes that during this period the microcomputer was introduced and networking developed incredibly quickly. He then suggested that we were about to enter a third phase: Information Technology, which would also require access to organised information which can be "intelligently manipulated by innocent users." (Knox 1985).

The nature of the available computer hardware and software played an important role in the shaping of business computing curricula. Latour would see these non-human actors as having a limited repertoire so that they could only be 'persuaded' to behave in certain ways. Another way of looking at this is to consider the role of computer technology in terms of framing, or of limiting the business computing curriculum, while technological determinists see a much more active role for the technology.

In summary then, I will suggest that in relation to the development of tertiary courses in business computing, the evolution of computer hardware can be seen as comprising four periods over roughly the following years:

1940s, 50s Early Mainframe Computers.
These were very expensive, and were used mainly for scientific and mathematical applications.

1960s Business Data Processing.
Computers were still expensive, but were now beginning to be used for business data-processing in large organisations. This use mainly involved the processing of accounting information. The technology involved punch-card (or paper tape) input, with program and data storage on punch-cards or later, magnetic tape.

1970s Terminals and Minicomputers.
Terminals began to become available as an alternative to punch-cards making computing less highly centralised in many organisations. Another contributing factor was the availability of lower cost
minicomputers, allowing the possibility of
departmental rather than just whole enterprise use.
Computers began to be used in management
information applications as well as in data
processing.

1980s

Micro-computers and Software Packages.
The low cost and ease of use of the micro made large
scale use of computers in education a possibility. The
application software package contributed to this
general use.

Articulation between People and Machines: Programming

It was not until the late 1950s that high-level programming languages like
FORTAN and COBOL - useable on a variety of different computers, appeared.
Prior to this time, programming a computer meant learning the machine code or
assembly language of the specific machine being used. In the early 1960s, the
techniques of programming were quite different from those used today, and at this
time Edsger Dijkstra, of Eindhoven University, cautioned programmers of the
dangers of the indiscriminate use of the branch instruction (GOTO). In 1966
Böhm and Jacopini demonstrated that "no program needs to consist of a
combination of any more than the three control constructs ..." (Juliff 1986: 6)
leading to the concept of 'Structured Programming'. This, and the work of others
including Yourdon, DeMarco, Weinberg and Jackson, necessitated the rethinking
of much of the previous teaching of computer programming.

In those days, of course, there were no independent software companies like
Microsoft, and any software that an educational institution used, it either wrote
itself or else it purchased from the hardware manufacturer. According to Peter
Juliff, in the 1960s armies of programmers were needed to write the software.
"When you got the computer you got the proprietary operating system, some
languages and a handshake. If you wanted an accounting package you wrote your
own, and quite likely there was also someone over the street writing one too."
(Juliff 1990).
In the early days, as Juliff remarks, you had either to write your own software or else to buy it from your hardware manufacturer. You really had little choice, and the manufacturer chosen did influence the courses you were able to deliver, even if this influence was not overt. Even today Swinburne, with its preference for IBM mainframe computers, puts considerable emphasis on teaching the MVS operating system, whereas many other institutions teach some other operating system, dependant on the hardware they are using, or perhaps the more generally applicable UNIX or even PICK. The PC revolution, peaking in about the mid-1980s, has made a huge difference to the content of tertiary courses, but one still sees different computing cultures in institutions using MS-DOS computers compared to those using the Apple Macintosh. Application packages such as WordPerfect, dBASE-IV, Excel, Microsoft Works and the like, unknown before the arrival of the micro, now take an important place in most courses.

In the 1970s the content streams were pretty much the same as now, with a "three pronged attack: programming, systems analysis and hardware." (Juliff 1990). These were seen as the three areas that students had to have some knowledge about. Programming started off with an assembler then moved to COBOL, and perhaps FORTRAN. Juliff recollects how Caulfield used to introduce programming using "a little teaching language called ACOL, or assembler for the 1900 - that was PLAN". (Juliff 1990). COBOL was fairly machine independent, as were the principles of assembler. Juliff notes that they were trying to teach programming rather than just the syntax of a programming language. "The hope was that if they understood the underlying principles students could convert to another language when they got a job." (Juliff 1990). Maynard stresses that Peter Juliff had "an enormous influence on the programming side of things, not just at Caulfield, and how this developed." (Maynard 1990).

Along the same lines as computer hardware, and with a similar set of dates, I will summarise the changes in computer programming thus:

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<tr>
<th>1950s</th>
<th>Switches, First and Second Generation Languages.</th>
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<tr>
<td>Computers</td>
<td>Computers were first programmed using electric</td>
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<td>switches, then later in machine code and assembly</td>
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<td>language. Programming was specific to each</td>
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<td>particular make and model of machine, and strictly</td>
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<td>a job for 'experts' only.</td>
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See Chapter 4.
1960s  High-Level Languages.
The development of high-level programming languages such as COBOL and FORTRAN, made programming largely machine independent. This meant that programming courses could become more general, and could concentrate on the principles of programming rather than the syntax.

1970s  Structured Programming.
The use of structured techniques in designing computer programs changed the way that programming was taught.

1980s  Micro-computer based programming.
The relative ease of using micro programming languages like Turbo Pascal and Microsoft QuickBASIC made programming much more accessible. The use of macros and programming tools in various application packages made 'programming' relevant to a wide range of students.

Analysing business needs:
Organisation & Methods, Systems Analysis

Prior to the use of electronic computers, data processing needs had already existed in commercial and government organisations, as had techniques for their analysis. One such technique was known as Organisation and Methods.

Organisation and Methods (O&M) may be defined as "the systematic and objective examination of an organisation and its detailed methods of working in an endeavour to gain increased efficiency." (Maynard 1982). Relating to an important aspect of systems theory, and going back to the 1920s and before, the 1950s were the boom years for O&M groups. Most Government departments and large private organisations had units at this time.
"The existence of Organisation and Methods units introduces two new ideas: of systematic study and that of a full-time specialised staff. The ideas are comparatively new in relation to the Government Service, but have been accepted in the industrial and commercial world for a number of years." (Miles 1951).

Miles notes that the idea of a systematic study meant that the work of revising and reviewing methods was regarded as part of the continuous process of management, and not just confined to the times when new functions were introduced, or in emergencies created by changed circumstances. This opened the way for a continuous review of methods, and led to the need for special training for the people who would perform these functions.

In the late 1940s and early 1950s there was a considerable growth of interest in O&M by governments around the world. In a document written for the United Nations, Miles (1951) lists the countries with O&M offices in the Public Service in 1951 as: Austria, Belgium, Brazil, Canada, Denmark, France, Greece, Mexico, Netherlands, Norway, Philippines, Puerto Rico, Switzerland, United Kingdom, United States, Venezuela. (It is interesting to note that Australia is not one of them.) In a 1947 document on O&M, the British Select Committee on Estimates noted that the purpose of O&M in the Civil Service was to secure "maximum efficiency in the operation of the Government's executive machinery" and, by the "expert application of scientific methods to organisation", to achieve economy in costs and labour.

Another technique being refined at around this time was the measurement of the output and efficiency of office workers. The beginnings of office automation had not only made these tasks more routine, but also more amenable to objective measurement. Hoos (1961: 53) reports that in 1958 in the US, papers at the Seventh Annual Conference on Systems and Procedures stress that the systems profession should be devoted to methods improvement, to 'working smarter'.

Systems theory began with the work of men like Henderson, Cannon, Kochler, and Angyal, but is generally considered to have gained major importance only after Ludwig von Bertalanffy's formulations (in the 1930s to 1950s) of the concept of an open system. Many had high hopes for its use and Lilienfeld reports on the widespread view that "General systems theory, then, will be a discipline that develops, tests, and demonstrates laws that apply equally to a variety of
fields." (Lilienfeld 1978: 25). Although von Bertalanffy was a scientist, the relevance of systems analysis techniques to business, but not particularly to computing, was soon under consideration.

Ida Hoos (1972: 42) discusses the origins of systems analysis, describing it as a linear descendant of operations research, a technique dating back to the Industrial Revolution. She notes that operations research emerged in its present form during World War II, when the British High Command engaged teams of physicists, biologists and mathematicians, to devise strategies for incorporating the new, advanced and un-conventional equipment, such as radar, into the air defence system. These new weapons systems were so completely different from anything previously known to the defence forces that traditional military experience was of no relevance. The new analysis techniques developed, known at the time as operations analysis, were subsequently refined and eventually evolved into what is now called operations research, systems engineering, management science, cost-effective analysis, and systems analysis (Hoos 1972: 42).

From these beginnings, Ways (1969: 375) describes how systems techniques were adopted "as an institution" by the postwar Rand Corporation, which was then doing systematic comparison of weapons systems for the US airforce. Ways goes on to describe how in 1961 President Kennedy appointed as US Secretary of Defense, Robert S. McNamara, a former President of the Ford Motor Company and a "genius in industrial management". McNamara "restructured the whole of the department in this style, programming all planning and procurement around missions or objectives that cut across the boundaries of the three services and extended beyond the confines of annual budgets." (Ways 1969: 375). Ways goes on to describe the wide appeal of the new techniques. He quotes Arjar Miller, then President of the Ford Motor Company as saying that:

"Hunches and cut-and-try methods are giving way to the systems-analysis approach, a whole new way of perceiving problems and testing in advance the consequences of alternative actions to solve those problems. Computers and other technical devices, including mathematical models, have extended greatly our ability to understand and cope with the complex problems we face in today's world." (Ways 1969: 376).
Hoos notes that in the organisations of the late 1960s, the management of information was being equated with the management of the whole enterprise, and the concept of using computers for Electronic Data Processing (EDP), common in the late 50s and early 60s, was rapidly being supplemented with that of the Management Information System (MIS). We now know that some of the claims made for MIS at this time were quite far fetched, but they did give computing a new dimension: the possibility of efficiently providing useful information to management. To do this however, it was first necessary to analyse the needs of the organisation.

"The notion of systems analysis as an effective management tool, once endemic to the Department of Defense, spread in various forms into all branches and permeated all layers of government, down to the least township." (Hoos 1972: 60).

It is important to note that these early systems analysis techniques had, at first, nothing to do with computers: they were developed as management and planning tools. However, as Arjan Miller's comments above suggest, it was not long before the connection with computing was made, and soon systems analysis became closely associated with business computing.

Education was not slow to take up the teaching of systems analysis, and by the late 1960s, Ways was able to say that: "Business schools and corporate planners began developing the new technique at about the same time as the Rand Corp's early work for Defense." (Ways 1969: 376). It could be suggested that systems analysis allowed the movement of computers into business by providing for the otherwise elusive connection between the two. It was not the computer as such that was important in business, but an understanding of how to use such a machine to allow business to perform its functions more efficiently. In answering a question on how IBM transformed its dominant position in the use of accounting machines into an early lead in computing IBM Chief Executive Thomas Watson Jr replied:

"The invention [of the computer] was important. But the knowledge of how to put a great big system on line, how to make it run, and how to solve problems was probably four times as important." (Watson 1973: 41-45).
Montgomery (1992) speaks of Organisation and Methods in the 1960s, and remembers how some of the O&M symbols became standard IBM flowcharting symbols. "O&M had diagrammatic representations of all manner of industrial processes and had as a sub-set of this a set of symbols, such as merge and sort, that were for information-flow." (Montgomery 1992). He describes how the next phase before strictly computer-based systems analysis, was that which grew out of the pin-board plugging for accounting machines. There were some really quite effective card-processing systems of accounting machines and punch-card equipment that could do "quite nifty things" like searching, sorting, selecting on columns and selecting on values, just by plugging up the plug board. "Good stuff but just a little slow. Of course, if you dropped a deck of cards you were in some trouble." (Montgomery 1992).

Systems analysis and programming, as they are know today, were the logical follow on from Organisation and Methods, with some influence from Operations Research (Maynard 1990). In discussion with me, Maynard went on to describe how in Organisation and Methods, "you did an analysis of the problem and then had to get out a description of the process: to work out the programming of a punch-card system or an accounting machine" (Maynard 1990). These old accounting machines had a program bar which could be programmed so that the machine would perform particular functions. Maynard says that programming was well know at that stage, and that it was realised that the real power of the machines lay in the program rather than the hardware. There were no internally stored programs; the programs were all external (either in the bar or in a plug board) and quite inflexible in that you could not change an operation, only select between them. In the early stages programmers just went in and wrote a program with little extra design effort: basically they just converted existing systems. "This meant that the people who had worked on punch-card machines initially used the new medium to write programs that simply emulated those punch-card machines." (Maynard 1990).

The evolution of new machines and new methods had a crucial influence on courses in business computing, but so also did the advancing needs of a society which was just beginning to come to grips with the business possibilities offered by this technology. Returning finally to Latour, considerations of the co-evolution of the various actors: the machines, the methods of using these machines, and society seeking appropriate ways to use the new machines in business, can
provide a useful clue to why business computing courses developed as described in the next chapter.
Chapter 4:
Computing Courses in Victoria.

In the 1950s and early 60s when electronic digital computers began to become generally available, Australia had quite a small number of universities. As some of the very early developments in computing occurred in the University of Sydney, and to a lesser extent some of the other interstate universities, a discussion of the evolution of courses in Victoria would make little sense in the absence of an overall Australian perspective. In addition to a consideration of developments in the 1950s and 60s at the University of Melbourne and at Monash University, what was happening in the CSIRO and in the Universities of Sydney, NSW, Adelaide and Queensland was also of considerable importance to subsequent Victorian courses.

Early University Courses around Australia.

Probably the first tertiary studies in computing began in 1947 in the University of Sydney's Department of Mathematics when Trevor Pearcey introduced a course in *The Theory of Computation, Computing Practices, and the Theory of Programming*. Pearcey believes this to be the first course in Australia in numerical mathematical methods and computing for non-statisticians. The course was an early one, and was offered before CSIRAC\(^\text{13}\) became operational in 1948, in the Basser Laboratory of the University.

Australia's early computers were based in the universities, with CSIRAC operating in the University of Sydney from 1948 - 1956, and at the University of Melbourne from 1956 -1964, and SILLIAC in the University of Sydney from 1954 - 1956. At the University of NSW, UTECOM commenced operations in 1956. From the mid-1950s onwards, a number of university computer systems were opened to general use, and practical training in programming and the application of computers was introduced at the Universities of Melbourne, Sydney, and NSW. Early training courses, of a few weeks duration, were offered in the techniques of programming appropriate to each machine. (At that time, of

\(^\text{13}\) Australia's first computer - see Chapter 3.
course, to use a computer at all really required a knowledge of programming.) It was, however, some time before education in computing was seen anywhere other than university departments of statistics and mathematics.

The study of statistics is a field which has always required a knowledge of mathematical and computational processes. Up till the 1950s, university departments of statistics provided such knowledge from their own resources, and until then:

"Departments of mathematics tended to ignore the matter of theory and practice of handling numbers: numerical mathematics, and considered advanced numerical skills to be somewhat undignified. To some extent this attitude was to continue as a resistance by the educational establishment to the new Computer Science, arguing that it was not an academically well-founded discipline." (Pearcey 1988: 103).

Attempts to put down computer science in this way parallel the battle fought over the establishment of Geography in Britain, where similar resistance was encountered from the established subject areas. Beginning last century Geography had a considerable battle, lasting over 50 years, to gain acceptance as an area of study in its own right (Honeybone 1954: 186). The arguments, by the universities, against the acceptance of geography were similar to those against computer science: it was not considered an academically well-founded discipline. After final acceptance by the British universities, Geography itself showed extreme reluctance, in the 1960s and 70s, in accepting Environmental Science as a new subject area (Goodson 1987). There are clearly parallels here with the grudging acceptance, by the universities, that Computer Science was a different discipline to mathematics and the subsequent reluctance of some academics involved in Computer Science Departments, to see any academic credibility in Business Computing (Montgomery 1992).

In 1959, the University of Sydney first offered a Post-graduate Diploma in Numerical Analysis and Automatic Computing, and created the Basser Computing Department. J. M. Bennett became Professor of Physics (Computing) in 1961. A full range of undergraduate, honours, masters, and doctoral programs soon followed. In 1972 the department divided into the Basser Department of Computer Science, and the University Computing Centre (Pearcey 1988: 104).
At the University of NSW, the establishment of a computing centre to serve the wider requirements of various university departments was the chosen direction, rather than towards the teaching of Computer Science. Academic teaching in computing only began in 1965, and took place in the School of Electrical Engineering. In line with the nature of the university, the Department of Computer Science was biased towards Computer Engineering (Pearcey 1988: 107).

Programming courses were given regularly in the University of Melbourne from 1956, and in 1959 a formal subject in *Numerical Methods and Computing* was developed by Pearcey as part of the undergraduate BA course in pure mathematics. Undergraduate courses in the *Theory of Computation* commenced in 1964 with the establishment of the Department of Information Science (Pearcey 1988: 106-109).

In 1968 Monash University commenced academic computing when the Department of Information Science (later Computer Science) was set up, within the Faculty of Science. For some years before this however, the Monash Computer Centre had been active in providing computing services to the various university departments since Cliff Bellamy had been appointed director of the Centre in the early 1960s. The centre had a considerable number of academics on its staff, many of whom later became members of the Department of Computer Science (Montgomery 1992), and is significant not only in the strength of its research, but also in its entrepreneurial activities with government and with industry. The centre was also a significant source of advice to other academic institutions, and must be given credit for assisting Caulfield Institute of Technology in the development of its business computing courses. In these days, Caulfield was Monash's biggest external customer for computer time and some of Monash's software was used to teach Caulfield students. Bellamy had a considerable influence in these early years as "the first person in Victoria to offer programming to a wide range of students at both the school and tertiary levels" (Adams 1991).

At the University of Adelaide also, a Computing Centre was set up much earlier than a Department of Computer Science. Computer oriented teaching tended (in the early days) to be carried out by the Department of Electrical Engineering under W.O. Willoughby whose research interest was analogue devices. A Department of Computer Science was established in 1964 with the appointment
of J.A. Ovenstone, instigator of the Defence Department's computing programme\textsuperscript{14}. At the time he accepted the Chair at Adelaide University, Ovenstone had completed the planning of the Defence Computing Project and the establishment of a training scheme for that department (Maynard 1990; Pearcey 1988).

At the University of Queensland, computing course work commenced in the mid-1960s with a Diploma in Automatic Computing (later Diploma in Computer Science). A Department of Computer Science was created in 1969, and undergraduate courses started in 1971. A Diploma in Data Processing had been available within the business studies area for some time. In 1962, the University had appointed Donald Overheu as Manager of its Computer Centre. Like Ovenstone, Overheu came from the Weapons Research Establishment\textsuperscript{15}, and had been involved in the Defence Computing Project. After leaving the University in 1965, Overheu took charge of the Defence Department's Data Processing Project in Canberra from 1965 until 1971 when he moved on to become head of the School of Computing Studies at the newly established Canberra College of Advanced Education.

\section*{Intervention of the Commonwealth Government.}

\subsection*{The Defence and PMG Computing Projects}

In 1957, at the time of the second conference on \textit{Automatic Computing and Data Processing}, Pearcey reports that there were no computers in commercial use in this country, and the only machines in existence were in the universities and at the Weapons Research Establishment, Salisbury (Pearcey 1988: 47). The conference was divided into three sections: Programming and Mathematics, Engineering, and Business Applications. Along with the large number of papers on topics such as programming and systems design, were several papers by J.A. Ovenstone, a scientist at the Weapons Research Establishment, discussing commercial and administrative applications of computers. From this beginning, things began to move rapidly during the next few years. The Commonwealth Government was beginning to discover some useful applications for the new technology, and so proceeded to acquire the computer hardware.

\textsuperscript{14} This important programme will be discussed shortly.
\textsuperscript{15} Salisbury, South Australia.
"The first computer used for commercial purposes was a small scale machine installed in the Bureau of Census and Statistics in 1958. The first large scale machine was acquired in 1962. At 30th June, 1968 there were 57 computers installed or on order. ... Geographically the 57 computers are distributed as follows - ACT 15, NSW 12, Victoria 19, South Australia 5, Queensland 2, Western Australia 3, Tasmania 1." (Commonwealth of Australia 1968).16

It can be argued that the Commonwealth Government was the pacesetter in computing in Australia during the 1960s, and that in many ways the Commonwealth Public Service, rather than commerce in general, paved the way for business computing in Australia. In the late 1950s and early 1960s, partially due to the efforts of several individuals, such as Ovenstone, and partially as a response to worldwide enthusiasm with systems analysis and computers, the Commonwealth Public Service, and in particular the Department of Defence and the Postmaster General's Department (PMG), began to investigate the advantages of using computers in administration.

In 1958, J.A. Ovenstone was appointed Controller of Automatic Data Processing (ADP) in the Department of Defence, Canberra. While working at the Weapons Research Establishment, Ovenstone had become interested in the commercial and administrative applications of computing, and had seen possibilities for the "systematic processing of administrative and technical data for the armed forces and the Department of Defence." (Pearcey 1988: 120). In 1960, in his new position, Ovenstone set out to apply "automatic computing methods" to the administration of the four complex and largely technical Commonwealth Government Departments that made up the defence sector. His implementation plan involved centralisation of the administrative and processing operations, and the continuous flow of information via the Defence Communications Network, run at this time (separately from the normal phone system) by the Postmaster General's Department. The Defence Project lasted for over six years of continuous development, but this was generally considered to be justified as, according to Maynard (1990), the total cost of the project was saved during the first year of full implementation of the scheme.

16 Even at this stage, Victoria took an early lead in computing.
Although implementation of the Defence Project proceeded well, a severe lack of personnel sufficiently knowledgable in computing, along with difficulties with the acquisition and installation of equipment, caused some delays. Perhaps an even bigger problem was the fact that these projects used all available qualified computing personnel, leaving few available to undertake other tasks (Maynard 1990). The need for trained staff, created by these projects, very soon had considerable repercussions on the tertiary education system: new courses were created at the CAEs, key people moved from industry to academia, and the Commonwealth took an interest in the provision of suitable courses.

A little later, the PMG's Department began its own computing project to automate, amongst other things, telephone accounting. It was significant for the development of tertiary courses in Victoria that the PMG Project was based in Melbourne, and that Gerry Maynard then worked for the PMG as an Assistant Inspector, Organisation and Methods Branch. As an 'O&M man', one of Maynard's jobs was to investigate the introduction of new systems, but at this time not all such new systems involved computers. In a 1962 report on the automation of 'States Works Programmes and the Material Supply Records' in the Long Line Equipment Section of the Engineering Section, Maynard and Harnath (an Engineer in the Engineering Section) suggest, given the lack of suitable computer hardware in the PMG, the use of a punch-card system.

"... A preliminary survey has been made ... and this suggested that a mechanised system would be more efficient than extending the existing manual methods to cope with the growth of recording and other clerical work in the Section. ... The Inspector (Office Machines, Organisations and Methods Branch) agreed that there appeared to be scope for using punched card methods for the several systems involved."

"The possibility of A.D.P being applied to the work concerned was also considered but ... until such time as the Department is operating a computer, it is doubtful whether A.D.P. would be more economical than a small punched card installation." (Harnath & Maynard 1962).

The commencement of the PMG project exacerbated the shortage of computer personnel in the Commonwealth Public Service, and as the success of Ovenstone's Defence project led to the acceptance of computing by other Commonwealth
Government Departments, many of which were now also planning the introduction of computers, a significant lack of trained personnel was becoming apparent.

This staffing crisis was further aggravated by commercial projects beginning to be undertaken in large companies such as BHP, CRA, CSR, the banks and the airlines. (Because of the cost of computers at the time, it was only large companies, and the government itself, which could even consider their use.) All these commercial projects required systems analysts, systems programmers and application programmers who were in very short supply and commanded very high salaries. Feasibility studies took years to complete; long periods were taken up with planning, tendering for hardware and operating system software, selection of supplier, installation and formal acceptance. Supply delays of 1-2 years were normal.

"It was clear, from difficulties than Ovenstone had in finding competent analysts and programmers for his initial studies and, later, in training of service people to manage and operate his systems, that a massive educational problem would arise as large computing systems became planned and implemented in both public and private areas. Government in particular would require very large and complex systems and need many people with computing expertise." (Pearcey 1988: 121).

In 1959 the Public Service Board had sent John Shaw on a fact finding trip overseas, to investigate how best the Board could move to introduce computer technology to the Commonwealth Public Service. In relation to training, Shaw found inadequacies, particularly in the training of systems analysts, and reported that many organisations considered that a four-week course by a manufacturer coupled with a knowledge of the job, in the firm, was sufficient qualification. On the other hand, he noted that the United States Government realised that the ability to think "creatively, imaginatively and analytically" was very important, but that a knowledge of higher statistics, often taught in university courses in computing, was not seen as being particularly useful. The US Civil Service commission required candidates for computing positions to have had two years experience in Organisation and Methods and one as a systems analyst, or else to undertake a six-months systems analysis course full time. In his report, Shaw stressed that the Commonwealth Public Service Board should provide leadership
in course provision and that "the control of the training function should be centralised." (Philcox 1978b: 98-125).

Wasting little time, in 1960 the Commonwealth Public Service Board ran its first course in Analysis and Design of Mechanised Systems with Ovenstone as one of the lecturers (Philcox 1978b: 206-224). Also in 1960, Ovenstone organised a training scheme for the Department of Defence, and the Board ran over twenty Systems Analysis and Design courses each of twelve weeks duration for its middle management officers. In a forward to its 1966 ADP Course Outline and Syllabus, Board Commissioner K.E. Grainger could state:

"The Public Service Board has been conducting courses in A.D.P. Systems Analysis and Design since 1960. These courses have provided essential training not only to a large number of practitioners in the Commonwealth Service but also to personnel engaged in A.D.P activities in Commonwealth Instrumentalities, State Government Departments and in Departments and Authorities of Malaysia and Singapore. Technical Colleges in Victoria and a number of State and overseas organisations have adopted the course as a basis for their A.D.P. training." (Grainger 1966: Forward).

These courses involved twelve consecutive weeks of full-time training, both theoretical and practical, and were conducted by the Board at its ADP Training Centre in Melbourne. Course content included: Introduction to Systems Analysis and Design (1 week), Basic Programming (5 weeks), Equipment Characteristics (1 week), and A.D.P Systems Analysis and Design (5 weeks). The course outline also advises potential participants that, although not essential for selection, "weight is given to tertiary qualifications which may be held." (Commonwealth Public Service Board 1966).

The three month courses continued for some years, and Gerry Maynard describes the courses he ran before 1965, whilst working for the PMG's Department, as about half systems analysis and design, and half programming. He relates how he used to "bring key people in" to lecture in the courses, as expertise was in short supply. The programming component of the courses in which Maynard was then involved was undertaken on SILLIAC at the University of Sydney, but courses also ran in Canberra and Melbourne. Maynard emphasises the importance of these three month courses in "getting commercial data processing up and going"
(Maynard 1990). After joining the Commonwealth Public Service Board (CPSB) in 1965, Maynard continued to run the three months courses, but now for other government departments, until 1969. Maynard is quite explicit in stating that the CPSB realised that there was, and would continue to be an increasing need for trained people to do the systems analysis, design, programming and implementation of its proposed computer systems, and that it was clear that the universities were not currently filling this demand.

What the Commonwealth was doing in computing at this time was extremely significant because of the large size of the Public Service, and the power, finances, and influence of the central government. A pamphlet giving an introduction to the Public Service states that "The Commonwealth Public Service is Australia's largest single organisation; it is the biggest employer, consumer of goods and spender of money." (Commonwealth of Australia 1968). When an organisation this large and powerful gets behind a new development, it is likely to have an impact, and the Commonwealth certainly did put considerable weight into sponsoring training in business computing. "A considerable proportion of the Board's A.D.P. resource has been expended on Training in A.D.P."

(Official of Australia 1968).

Effectiveness of the Universities in Providing Suitable Courses.

During the 1950s the universities had only been gradually coming to grips with the issue of whether computing was a part of mathematics or should be considered as a new discipline. With courses which were quite theoretical in nature, relatively few staff and sparse facilities, the universities were largely unprepared for the demands of the 1960s when the Commonwealth Government's Defence and PMG Computing Projects, as well as the needs of industry, produced a requirement for trained computing personnel that was massive in comparison to previous requirements.

"This input could not have been provided by the universities since their resources were entirely inadequate, but there remains a question whether they could have played a more positive role. Outside university walls, there appears to be general agreement that the universities missed the boat." (Philcox 1978b: 206-224).
What was needed were courses with a substantial component that was vocational in nature and the universities were not interested in providing such courses. By 1964, the bulk of ADP\textsuperscript{17} training was being done outside the universities, much of it by the Commonwealth itself which was somewhat critical of the universities in this regard. In a document discussing 'Recruitment, Education and Utilisation of ADP Staff', Public Service Commissioner Grainger comments on the Commonwealth's ADP staffing problems and the fact that 90\% of the world's computer time was by then used in business:

"In the development of A.D.P. the Universities have played a prominent part, particularly in the significant areas of research and scientific applications ... Unfortunately for the commercial user, Universities throughout the world have been slow to respond to the changing pattern of demand."

"With few exceptions, the evolution of university education in A.D.P. has resulted in a concentration on courses in 'Computing Science'. While I am sure that everyone will agree on the need for this type of sophisticated training ... [such courses] will by no means solve our A.D.P. staffing problems." (Grainger 1965).

It could be said, perhaps a little unkindly, that "universities bought computer equipment to support their research activities but then thought that they must begin to teach a few undergraduates about this" (Adams 1991). The universities focus was internal, rather than on the needs of industry. Grainger comments on the problem, stating that although the computer equipment suppliers were well organised to provide some training in programming, they were not able to provide education in systems analysis and design.

"It is highly important to get the Australian tertiary education system working so as to meet as soon as possible the growing demand for well-trained programmers, but it will take time to have appropriate courses established and for people to complete their training and gain experience. In the longer term this is the prime answer to the programmer shortage..." (Grainger 1965).

\textsuperscript{17} Automatic Data Processing, later known as EDP - Electronic Data Processing.
It would also appear that in industry at the time, and at least in Victoria, the general level of understanding of the scope of the computer revolution which was about to happen, was poor. A survey carried out by Bellamy in 1963 showed that:

"According to managerial opinion, only ten programmers would be required in the State of Victoria during the next ten years!" (Pearcey 1988: 110).

But such gross underestimates were common, and not only in Australia. To remind us of public perceptions of computers at this time, it is useful to look at part of the text of an address given by Gerry Maynard, providing an Introduction to Computers and Programming to the Melbourne Junior Chamber of Commerce in 1965:

"Glossy magazines and science fiction would have us believe that computers can think and that, before long, humans will be redundant. This, of course, is sheer nonsense. However, to the layman, the subject of computers is surrounded by an aura of mystery. Despite popular belief, a computer is not an electronic brain. A more accurate description would be that it is an extremely fast moron." (Maynard 1965).

In Sydney in 1962, several Commonwealth Public Service Board Officers wrote a minute to the Board criticising currently offered ADP courses and suggesting that "the major problems were that there was a lack of knowledge of the implications of A.D.P. within the NSW Technical Education Department, and of people who had practical experience." (Philcox 1978b: 206-224). Computer equipment manufacturers were regarded as of little use in the provision of suitable courses. The minute also suggested that it would be useful if the Board could have "effects" on university computing courses to create a useful avenue of recruitment and reduce the need of the Board to do its own training.

Philcox quotes from Bennett speaking at a conference organised by the Sydney University Appointments Board in 1964, where Bennett discusses problems faced by the University. Bennett describes the difficulty in obtaining suitable teaching staff: most people who worked with computers had insufficient academic background it seems. The issue, apparently, was one of academic standards. With academic staff in computing not having "adequate qualifications", Bennett's
university colleagues were expressing concern that they remained to be convinced that what was proposed to be taught in computing courses was not "merely vocational material" (Philcox 1978b: 206-224). There was also concern that the very nature of computer science had been overshadowed by the service function of computing and so could not be considered to be academic work.

"The belief that education has a purpose other than that of providing vocational training, that is, to provide a long-term expansion of mental abilities, is deeply rooted in the minds of university academics ... When, however, education or training is linked to growth in an industry or economy, it becomes intertwined with the belief that education should provide a direct return." (Philcox 1978b: 206-224).

Computing courses at the universities were not, in general, providing this direct return, leaving the way open for the soon to be created Colleges of Advanced Education (CAEs) to do so. Until this time, the former Technical Colleges had been considerably less concerned with computing than the universities, but this was soon to change.

It is interesting to note that, even by the late 1970s, university courses in computing were still not seen, by employers, as providing the best EDP training. The following figures are from a survey, conducted by the Department of Employment and Youth Affairs in Victoria in 1979, of respondents from 186 commercial and other organisations, and provide an assessment of the EDP training provided by various institutions. The universities clearly had some way to go in making their courses more relevant to employers. Compared to courses offered by the CAEs, the one piece of solace the universities could take from the survey is that courses at the commercial computer houses were held in even lower regard.

<table>
<thead>
<tr>
<th>Institution</th>
<th>EDP Training Assessment</th>
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<tbody>
<tr>
<td></td>
<td>Poor</td>
</tr>
<tr>
<td>Universities</td>
<td>38%</td>
</tr>
<tr>
<td>CAEs</td>
<td>10%</td>
</tr>
<tr>
<td>Computer House courses</td>
<td>39%</td>
</tr>
</tbody>
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(Department of Employment and Youth Affairs, Victoria 1979)
The Programmers-in-Training Scheme

Although regarding its 12 week training as highly successful in providing 'crash courses' in computing, the CPSB recognised the need to set up longer courses and began the design of a twelve months long Programmer-in-Training (PIT) course. The first PIT course ran in 1965 and initially drew upon the Defence staff's experiences with both computerised, and existing non-computerised, administrative systems in the Commonwealth Public Service. Maynard was involved in running PIT courses for the Board from 1965 until he joined the Department of Civil Aviation in 1969 as a senior programmer in charge of application programming. He remained in this position for about a year before taking up a position at Caulfield Institute of Technology in 1970 where his involvement with PIT courses continued (Professional Computing 1992: 20).

In a forward to the course outline and syllabus for the new Programmers-in-Training course, Public Service Board Commissioner K. E. Grainger, borrowing somewhat from his earlier statement, describes the Commonwealth's involvement in the provision of computing courses.

"The Public Service Board has been conducting courses in A.D.P. since 1960. These include appreciation courses for management, specialised programming courses for professional and technical officers and a three months full time course in systems analysis and design for potential ADP staff within the Service. The latter has provided essential training to officers who formed the nucleus of ADP teams in Departments.

In recent years, in association with Departments the Board has extended its ADP training and is conducting courses which form part of a twelve months Programmer-in-Training Scheme. This scheme has become the major source of trained recruits both from inside and outside the Service, for duties in the analysis, design and implementation of ADP systems in the Service." (Grainger 1967: 1).

He then went on to outline how similar courses were conducted by the Department of Defence, the Bureau of Census and Statistics, and the Postmaster-General's Department. Gerry Maynard describes the PIT course as a "double-
decker sandwich course of one year duration combining periods of formal classroom education with on-the-job training" (Maynard 1990).

Grainger (1966: 1) indicated that the course was designed "to provide formal training to personnel who have been promoted to, or recruited as, Programmers-in-Training in the Commonwealth Public Service." Upon successful completion of the course, trainees were to be advanced to Assistant Programmers. Programmers-in-Training could also be selected from outside the Public Service and, although no previous ADP experience or training was considered necessary and the only formal qualification required was that "candidates must be eligible for appointment to the third division on the Commonwealth Public Service" (Grainger 1966: 1), most trainees were, in fact, graduates in arts, commerce or science.

Geoff Dober who is currently Executive Director Information Systems at Carlton United Breweries, and in 1992 was elected President of the Australian Computer Society, described to me some of his experience as an early Programmer-in-Training. In 1966, after completing his commerce degree at Monash University, Dober intimated that he was looking for something interesting to do with his future (Dober 1992), and decided to apply to undertake a Commonwealth Programmer-in-Training course. Dober described the general excitement in sections of commerce at the time with the possibilities of the computer, and how this avenue seemed to offer the best possibilities for a career. He was accepted into the 1967 course along with twenty or so other participants from all around Australia, and given a job in the Department of Supply. During the course he spent 50% of his time in formal classroom training and the remainder in on-the-job training as a programmer with the Department of Supply. After completing the course, Dober initially took up a position as a systems programmer at the Weapons Research Establishment (Salisbury) before later moving into the private sector to work on large commercial systems, and eventually into Information Technology management.

Although the PIT scheme was limited mainly to graduates (not necessarily from any particular background) Maynard describes, with some glee, how when running PIT courses for the Commonwealth Public Service Board, he "took other people including some of those who had failed the aptitude test just to prove that the aptitude test was no good". The fact that they "invariably did very well" either supports this claim or else it endorses Maynard's understanding of the skills that would make a good trainee programmer!
The PIT courses took over 20 hours/week of formal class time for one year, and operated initially in Canberra and Melbourne. Later, courses operated in other capital cities (Maynard 1990; Pearcey 1988). The forty-six week course outline was as follows:

**Phase 1 (10 weeks)**
- Introduction to the Course and to the Service 1 week
- Computer Equipment and Techniques - Stage 1 1 week
- Computer Mathematics - Stage 1 1 week
- Programming - Stage 1 5 weeks
- Systems Analysis and Design - Stage 1 1 week
- Examinations 1 week

**Phase 2 (12 weeks)**
- Departmental training - Stage 1

**Phase 3 (12 weeks)**
- Computer Equipment and Techniques - Stage 2 1 week
- Programming - Stage 2 4 weeks
- Systems Analysis and Design - Stage 2 4 weeks
- Mathematics - Stage 2 (Statistics) 2 weeks
- Examinations 1 week

**Phase 4 (12 weeks)**
- Departmental training - Stage 2

Although there was no formal syllabus for Phases 2 and 4, the Commonwealth Departments who took on trainees were required to prepare, in advance, a programme for each trainee. This programme had then to be submitted for approval by the Public Service Board (Grainger 1967).

The needs of the PMG's Department were so great that they obtained approval to run their own PIT courses, as did the Commonwealth Departments of Census and Statistics, and Defence (Maynard 1990). Whilst working for the CPSB and conducting the Board's own PIT courses, it was also one of Maynard's tasks to vet other Department's PIT courses to ensure that the standard was adequate and that appropriate content was being undertaken.
According to Maynard, the programming part of the early PIT courses started off with a study of machine code then moved to assembly language before finally getting down to Business FORTRAN, which was a very powerful language developed by Control Data. Later, studies of COBOL and PL1 were also introduced. In the early PIT courses he ran in Melbourne, Maynard describes how they began programming in machine code on an Elliot 803 machine at RMIT before moving on to assembly language on the 803 and on a CDC 3200 computer at the Commonwealth Department of Census and Statistics in Melbourne. Without the amount of hardware and software standardisation that is found today, the type of computer equipment used inevitably had a considerable effect on the content and nature of the courses, and Maynard relates how he designed and ran one PIT course on IBM equipment in Canberra for the Commonwealth Department of Social Security and Repatriation, and several others on a CDC computer in Melbourne. And it was not just programming and operating systems that differed because of the use of different makes of computer system. The different equipment suppliers each had an entirely different approach to computing and this needed to be considered when designing systems analysis courses also. As well as the PIT courses, Maynard continued to run short systems courses all over the country. For instance, he described how he spent some time "running around the countryside to give systems analysis courses to the NSW police" (Maynard 1990).

PIT courses continued, under the Commonwealth Public Service Board until late in the 1960s when responsibility transferred completely to the tertiary education sector. The PIT courses were oriented towards training staff for the establishment and running of commercial and administrative applications of computing and they set the style for many of the courses later offered in the Colleges of Advanced Education and Institutes of Technology (Maynard 1990). On the significance of the Commonwealth's initiatives, Pearcey adds that:

"In many of these institutions [the CAEs offering PIT training], teaching in computing started as a result of the staffing crisis that arose first from the Defence and PMG's projects." (Pearcey 1988: 120).

In 1963 John Shaw, the Public Service officer who had undertaken the overseas fact-finding trip for the Board in 1959, attended a conference at Caulfield Technical College, along with representatives from the University of Melbourne,
Monash University, and officers from both the State and the Commonwealth Public Service Boards. The attempt was to get a computing course, acceptable to all these groups, off the ground. Although some seeds were planted, no agreement on a course was reached (Philcox 1978b: 206-224).

At about this time (early 1960s), and almost in unison, three key personnel who had been closely associated with the old Commonwealth Systems Analysis courses: Jack White, Westy Williams and Brian O'Donaghue left the Commonwealth Public Service Board to become academics. White took up a position at Caulfield Technical College, Williams at Bendigo Technical College, and O'Donaghue at RMIT. According to Peter Juliff, they were "three wise men of computing" who had all worked together in the Computing Section of the Board (Juliff 1990). These three were then instrumental in setting up computing courses in their respective institutions. Pearcey elaborates:

"Most of the academics who staffed those departments came from the early computer projects established in academia, and in the technical government departments who first installed computing systems for research purposes, or the descendants of those projects." (Pearcey 1988: 4).

Establishment of the Colleges of Advanced Education

In 1961, under Commonwealth Government direction, the Australian Universities Commission established the 'Commonwealth Committee on the Future of Tertiary Education in Australia', chaired by Sir Leslie Martin. Its report, published in August 1964 and presented to Parliament in March 1965, was to have profound effects on Australia's tertiary institutions. It was also to have considerable, indirect, effects on the direction taken by tertiary courses in business computing.

It is well known that Martin recommended a binary system for tertiary education where the established universities of the time would remain as highly academic, research-based institutions, and the new Colleges of Advanced Education (CAEs), proposed by the report, would be initially restricted to a teaching role. The CAEs would be allowed to award only diplomas, and were not to be offered research funding. Rasmussen (1989) notes that prior to the Martin Report, the Victorian Technical Colleges were the most highly developed and regarded in Australia, and
greatly influenced Martin's conclusions. John Gorton, then Commonwealth Minister for Education, is quoted as saying at a public meeting at RMIT that the colleges should be: "... biased more towards practical attainment in some specific form combined with general education, and less towards pure scholarly research." (Murray-Smith & Dare 1987: 389). The Martin Committee proposed that the new CAEs were to be "equal but different" (Rasmussen 1989: 142).

"Yet, at the same time, its recommendations were clearly based on the assumption that there were two kinds on 'minds' and two distinct styles and purposes for the education of these minds. There were those suited to the abstract thinking and research orientation of universities, and those who would most benefit from applied, vocational education. The Martin Committee proposed that the weaker students were suited to the latter and should therefore attend the new Colleges of Advanced Education." (Rasmussen 1989: 141).

Some cynics in the CAEs, however, suggested that the term "equal but cheaper" (coined by Treyvaud & McLaren), in many ways better summed up the resulting distinction between the established universities and the CAEs.

In 1965 the Victorian Government adopted one of the major recommendations of the Martin committee in setting up the Victorian Institute of Colleges (VIC) to "co-ordinate the revitalisation and development of the State's technical colleges" (Murray-Smith & Dare 1987: 385). A number of the former technical colleges, which then became Institutes of Technology (RMIT, Caulfield, Bendigo, Swinburne and Footscray) were soon to become seriously involved in computing.

In his paper on 'Recruitment, Education and Utilisation of A.D.P. Staff' in the Commonwealth Public Service, already mentioned, Grainger describes how diploma courses in Business Studies were currently being developed, particularly in the Victorian Technical Colleges, with combinations of subjects chosen as in a university arts degree. Subject groupings included accounting, administration, data processing, economics, humanities, law, mathematics, secretarial practice and science. He suggests further useful courses in computing which could be offered by the CAEs.
"Courses which could be conducted by Colleges of Advanced Education, in keeping with the concept presented in the Martin Report could include the following:-

i A three year full-time ordinary level diploma course which would provide the option of a general coverage of A.D.P. similar to that given in present Commonwealth Public Service one year Programmer-in-Training course, against a background of commercial and allied subjects;

ii A further year's full-time study of A.D.P. for an advanced level diploma, with entry open to qualified programmers as well as ordinary level diplomats; and

iii A post-diploma course of one year's full-time training in A.D.P. for persons whose diploma, or other satisfactory educational background, did not include A.D.P. subjects.

Courses of this nature are an urgent need." (Grainger 1965).

A 1965 pamphlet of the Commonwealth Department of Labour and National Service on 'Employment in Electronic Data Processing in Australia' classifies such employment into three types:

- systems analysis and programming,
- computer operation, and
- data preparation and other staff.

Clearly it was the first of these categories to which Grainger was referring. It is also interesting to note that it seems to have been at about this time that the Commonwealth firmly recognised the need for a separate group of computer professionals, as distinct from operators, data preparation clerks, and accountants or scientists with some add-on computer training.

Courses in Colleges of Advanced Education.

Caulfield Institute of Technology

One of the first educational institutions in Australia to adopt computing as a priority teaching area was the (then) Caulfield Technical College. Maynard claims these courses to be the first electronic data processing courses in Australia, but adds that this claim will be disputed by others (Maynard 1990) As early as 1961,
Caulfield had offered a *Certificate of Accounting (DP)* course, and Maynard believes that things evolved from there. In his 1963 Principal's Report, Caulfield Technical College Principal Austin Lambert is quoted as saying:

"Apart from this general progress our College itself is making a big move in one particular direction. In Electronic Computing and Data Processing, the College has been giving short part-time courses for some years. It is now introducing full-time and part-time diploma and certificate courses in Commercial Data Processing. These will be the first courses of their type in Australia, either at universities or technical colleges." (Greig & Levin 1989: 2).

Lambert was an engineer who did not really know, according to Maynard, quite what commercial data processing was about, but did recognise that something must be done in this area. Lambert took advice on computing from Jack White who had recently arrived from Canberra after worked on Ovenstone's team as an O&M Inspector. White took the job as the new Head of Department in 1964 and brought in many of Ovenstone's total system concepts, which "fitted well into the business approach" (Maynard 1990) and balanced Lambert's engineering style. White has been described as "a determined and sometimes fiery leader, [who] put enormous effort into establishing the discipline and flavour of computing at Caulfield" (Greig & Levin 1989: 13). After taking up his position, White immediately began the development of commercial data processing courses, and the recruitment of staff and students. Levin (1991) suggests that it was through White's efforts that computing at Caulfield was not subsumed beneath another discipline, such as business or mathematics, as happened to some extent at several other tertiary institutions.

Prior to 1964 the College had offered a number of short, evening, post-diploma courses in various aspects of computing such as:

- Punched Card Systems
- Accounting Machine Applications
- Commercial Electronic Data Processing
- Principles of Analogue Computing

which were offered for a fee of £4 per term, and delivered (in the main) by lecturers brought in from industry (Greig & Levin 1989: 6). Maynard reflects that in both Australian and world-wide terms, these courses were very early: "people
were still teaching accounting machines - IBM punch-card machines. They were
trying to move from punch-cards into the computing arena, but IBM was very
slow in really getting computers into business." (Maynard 1990).

In 1964, twenty full-time and one hundred and twenty part-time students
commenced study in Caulfield's initial three formal courses: the Diploma of
Information Processing, the (Post) Diploma of Electronic Computing, and the
Associate Diploma in Accountancy (Data Processing). The Diploma of
Information Processing was aimed at educating students "in the operations and
capabilities of data processing equipment as well as an appreciation of the
principles involved in technical and commercial applications of this equipment."
(Greig & Levin 1989:6). The course later developed a more scientific bias,
concentrating on the technical aspects of data processing. The (Post) Diploma of
Electronic Computing was intended to educate "persons in scientific or
engineering occupations in the principles of computing and how computers could
be used in their chosen profession." (Greig & Levin 1989:6). Most students
enrolling in the Associate Diploma in Accountancy (Data Processing) had prior
tertiary accounting qualifications, but "had a need for knowledge of data
processing facilities and their application within their discipline " (Greig & Levin

Pearl Levin came to Caulfield Technical College in 1964 as a laboratory
technician and began to study computer programming at the college part-time
(Levin 1991). It was not long after this (1965) that she took up a teaching
position in White's EDP Department, taking on responsibility for the development
of the Certificate in Electronic Data Processing (Operating and Coding), which
was intended to provide practical training in computer programming and
operations. It was essentially a year 12, rather than a tertiary course, and was later
adopted by Holmesglen College of TAFE. It still exists in an evolved form today
(Juliff 1990).

In 1967 the Diploma of Business Studies (Data Processing) commenced as what
Maynard suggests was the forerunner of many of today's courses in business
computing. In 1968 Caulfield Technical College formally affiliated with the
Victorian Institute of Colleges to become Caulfield Institute of Technology (CIT).
In 1982 it amalgamated with the State College of Victoria at Frankston (formerly
Frankston Teacher's College) to become Chisholm Institute of Technology, and
again in 1990 to become part of Monash University.
In 1970 the Commonwealth Public Service Board decided to hand over the running of the Programmer-In-Training course to four selected institutions: Caulfield Institute of Technology, Bendigo Institute of Technology, the newly established Canberra College of Advanced Education, and New South Wales Institute of Technology (Maynard 1990). According to Greig & Levin:

"The Public Service Board believed that the increasing use of sophisticated computer equipment at the colleges and their need for increasing numbers of trained 'computer personnel' made such a development desirable" (Greig & Levin 1989:7).

In 1971, the first year of operation of the 'new' PIT programme, the scheme supported 235 trainees Australia wide (Philcox 1978b: 208-224). This new scheme had the wider objective of providing trained computer personnel to industry as well as to the Commonwealth and State Public Service (Pearcey 1988: 122). Although similar in content to the early PIT courses run by the CPSB, the PIT course delivered by Caulfield Institute in 1971, shows some maturation.

**Phase 1: Ten weeks, 9am - 5pm, Monday - Friday, at Caulfield Institute**

- Computer mathematics. Problem logic 2 weeks
- Data representation. Computer Equipment 1 week
- Principles of programming 3 weeks
- Applications programming 4 weeks

**Phase 2: Twelve weeks of on-the-job training in present organisation.**

**Phase 3: Ten weeks, 9am - 5pm, Monday - Friday at Caulfield**

- Statistics and Quantitative Analysis 2 weeks
- Systems Programming 3 weeks
- Data Communications 1 week
- Systems Analysis and Design 4 weeks

**Phase 4: Twelve weeks of on-the-job training in present organisation.**

(Maynard 1971)

When Pearcey moved to CIT in 1972, Peter Juliff had already been there for five years, coming from an accounting and auditing background with the Victorian
Public Service Board. Gerry Maynard, coming from a position as Senior Programmer with the Department of Civil Aviation, and with a background of running PIT courses for the Commonwealth Public Service Board, had taken up a full-time permanent position at CIT, two years earlier. Maynard had, in fact, done part-time work for and at Caulfield for several years prior to this time. A number of other, now prominent, computing professionals had also moved from industry to CIT in the late 1960s and early 70s, giving further credibility to its courses. According to Maynard (1990), apart from "some action" at Bendigo Institute of Technology and RMIT, Caulfield was the place "where it was all happening" at this time, and was thus the obvious place to go for someone interested in an academic career in business computing (Maynard 1990). With regard to the evolution of Business Computing, the influence of Maynard, Juliff and these others was considerable, and certainly greater than that of Pearcey. Nevertheless, Pearcey's close involvement with both the leading edge of Australian computer technology through the CSIRO, and with tertiary education, must have influenced the direction of tertiary computing courses in Australia, particularly those run by the universities.

Peter Juliff believes that the Programmer-in-Training course in 1971 really gave computing at Caulfield Institute of Technology (as it was now called) a big boost. In that year the Institute took in two contingents, each of about forty trainees, one group attending formal classes while the other was doing its industry-based training. The PMG's Department (soon to break up into Telecom and Australia Post) was the major employer involved at that time, and the course attracted funds and new staff, as well as improving the profile of the Institute (Juliff 1990). Juliff describes Caulfield's PIT course as essentially the pre-cursor of the Graduate Diploma in Data Processing, which it soon (1973) became. When the course was known as the Programmer-in-Training course, students were not awarded any certificate upon completion, but they were given some exemptions towards other Caulfield courses. According to Juliff the major reason why, after several years, the PIT course was made into the one year full-time Graduate Diploma (later renamed Graduate Diploma in Computing) was to give the students a 'certificate'. Not only at Caulfield but also in the other CAEs, by 1975 the PIT scheme had effectively ceased to exist, being by then completely replaced by the new Graduate Diploma courses.

In the early 1970s Caulfield introduced what it claims (Greig & Levin 1989: 8) to be the first commercial computing degree in Australia: the Bachelor of Applied...
Science (EDP). The course was later renamed: Bachelor of Applied Science (Computing), and had as its primary goal "developing computer professionals for employment in government and industry" (Greig & Levin 1989: 8). During the mid-1970s, a joint course combining the core elements of the Bachelor of Applied Science (Computing) and the Bachelor of Business (Accounting) was instigated. The course was conceived as being of particular value to both students and prospective employers, as students completing it gained accreditation from both the Australian Computer Society (ACS) and the Australian Society of Accountants (ASA).

The late 1970s and early 80s saw the introduction of three new graduate diploma course in computing at Caulfield (or Chisholm as it was soon to become). In 1979 the Graduate Diploma in Information Technology was introduced as a 'higher' diploma to further the education of students who already had a qualification in the computing discipline. Graduate diplomas in Digital Communications and in Business Technology were introduced in the early 1980s. In 1985 Chisholm took its first enrolments in the Master of Applied Science (Computing) which, being Victoria's first 'in-depth' computing course outside the universities, attracted considerable interest from the computing industry (Greig & Levin 1989: 9).

Despite rapid developments at Chisholm however, in 1982 Maynard was still expressing concern that not enough computing was being taught in general business courses.

"There is a need to introduce more business technology material into business courses, and a further need to educate people who will interface with management personnel." (Maynard 1982).

According to Maynard, Caulfield stayed at the forefront of commercial data processing all the way through the 60s and 70s. He recounts how they were never really interested in Computer Science, whereas in the early stages at RMIT, "the maths people developed computing which led into computer science rather like the universities." (Maynard 1990). In the 1970s Business Faculties in the CAEs started offering Bachelor of Business courses, including data processing subjects. Maynard recollects that business courses concentrated more on accounting and management, and "the data processing side was starved as the poor relation". What happened at Caulfield was that DP was soon shifted from Business to Applied Science. The course then became truly a computing one, and was funded
at a more appropriate rate, particularly after Data Processing / Computing became a school in its own right. Maynard expressed the fear that now the "Monash-connection" will cause Chisholm’s courses to become more traditional: "which would be a shame".

The Caulfield Students

Peter Juliff took most of the programming classes in the early PIT courses run by Caulfield. In format, the classes could perhaps best be described as a 'long short-course'. They did not involve lectures in the normal university mould, but a much more intense six (or more) hours of class time per day, five days per week, during the three months periods the students were on campus - rather more like the sort of offering in the two or three day short courses offered by the industry training houses today (Juliff 1992).

As far as Juliff remembers, computing classes at Caulfield have always been made up of two hours of lectures and two hours of tutorials per subject each week. Lectures were the typical 'chalk and talk' affairs, given to large groups of students, while the tutorials were discussion groups of perhaps fifteen to twenty. No supervised laboratory classes were timetabled, even in the programming subjects, the students being expected to enter and run their programs in their own time. Up until the time Juliff left Caulfield in 1978 to take up a position at Health Computing Services and later at Prahran CAE, all student programming was punch-card based; it was not until the early 1980s that the use of terminals became the norm. In the 1970s, Juliff remembers a punch-card room at Caulfield, with ten or twelve old IBM punch-card machines. Students designed their programs using coding sheets, and could then use these machines to transfer their programs to punch-cards, or alternatively, they could have one of the computer centre's half dozen punch-card operators type the program onto cards for them. This service was intended to speed up program entry for slow typists! In either case, the students had to make their own corrections to the cards in the debugging process. Turn around - punching and running the program - normally took up to about 48 hours.

Juliff has perceived no noticeable shift in the type of students undertaking computing courses over the years apart from the recent increase in the number of Asian students. He believes though that some of the bandwagon effect, present in the early days of computing, has worn off and that perhaps a greater proportion of
students now select computing as their second or third, rather than first choice (Juliff 1992).

**Proliferation of Courses at other CAEs**

Not satisfied with the results of his earlier meeting at Caulfield, in 1964 Shaw began discussions with RMIT on the possibility of it conducting a Systems Analysis and Design course. He indicated to RMIT that "it had always been the intention of the Board to withdraw from training when an alternative could be found" (Philcox 1978b: 208-224). Shaw also remarked that it was fortuitous that ex-Board training officers now worked at Caulfield, Bendigo and RMIT, and that use should be made of this. Unfortunately, Shaw and RMIT were unable to reach agreement, possibly due to Shaw's insistence on the right of the CPSB to retaining 'control' of the curriculum. Apparently there was also some doubt, on behalf of the Board, as to the standard of the course proposed by RMIT, and thus the approach to RMIT was deferred and the Board continued to run its own courses for somewhat longer than originally hoped (Philcox 1978b: 208-224).

Peter Juliff reflects that the courses developed by Jack White at Caulfield grew and grew, and that those established in Bendigo by Westy Williams (from 1964) also did very well. RMIT's course, however, never really took off properly: it got "swallowed up in the School of Business" and competition arose from other courses started in mathematics (Juliff 1990).

The PIT course at Canberra College of Advanced Education was considered, by the Commonwealth Public Service Board, to be the benchmark, designed to meet the needs of the Public Service.

"Under Overheu's direction with the Canberra College of Advanced Education, [about 1971] a range of courses was developed which were suited to the needs of the Public Service which, at least in the early days, was concerned mainly with the design, installation, operation, management and further development of very large and complex systems." (Pearcey 1988: 117).

Other courses which were considered, by the CPSB, as being *equivalent* for purposes of qualifying applicants for the position of Computer Systems Officer
Grade 1 were at: Queensland and Monash Universities, and at the Bendigo, Canberra, Caulfield, Darling Downs, Gordon, NSW, Queensland, RMIT, South Australia and Western Australia Colleges of Advanced Education. Suitable post graduate courses were at: Adelaide, New England, and Queensland Universities, and at Bendigo, Canberra, Caulfield, and South Australia CAEs (Philcox 1978b: 208-224).

Later Swinburne Institute of Technology and Footscray Institute of Technology also began to offer similar courses. In a number of cases, such courses grew up in the respective departments of Business Studies, some grew from Engineering areas, while others originated in Applied Science. At Caulfield, the original Department of Electronic Data Processing was always separate from other operations, "so avoiding the difficulty of being embedded within other fields of interest that have troubled others" (Pearcey 1988: 123). Maynard (1990) agrees, describing the courses at Footscray as "a real dog's breakfast with bits everywhere". Maynard recollects how, at Footscray, Doug Mills had the view that computing was just something that you should let evolve, and that anyone could do it. He considers this approach to have been a mistake.

Bendigo Institute of Technology

Westy Williams - the second of the group Peter Juliff described as the three wise men of computing - had moved to Bendigo Technical College (in central Victoria) and, according to Maynard, his courses were well accepted. By 1970 Bendigo Institute of Technology (BIT), as it had now become, was offering a number of computer-related courses. An examination of the Institute's 1970 handbook shows that of the thirteen courses offered in the Faculty of Business Studies, six were computer related. In what had now become the tertiary sphere, the Faculty offered two post year-12, three-year diploma courses: a Business Studies (Data Processing) Diploma, an Information Processing Diploma, and a one-year post-graduate Electronic Computing Post-Diploma. In what would now represent the TAFE arena it also offered two certificate courses: the one year Coding and Operators Certificate, and the Electronic Data Processing Certificate. The latter course was taken part-time over three years by students already holding an accounting certificate. There was also a short Management Appreciation Course in EDP, consisting of twelve weeks of evening study. The Business Studies (Accounting) Diploma also contained several computing subjects.
Apart from one subject in the *Electronic Engineering Diploma*, Business Studies was the only faculty at the time offering computing subjects. The other faculties: Art, Applied Science, Humanities, Mathematics and Physics and the Trade Division offered no computer-related subjects at all (Bendigo Institute of Technology 1970).

A Bendigo pamphlet in 1973 described the introduction, by the Institute, of courses in the new Information Science Department:

"Computers are coming into widespread use throughout industry, commerce, government and education, giving rise to a new field of study called Information Science.

The course is concerned with the study of design, development, construction and application of computing machines, algorithmic processes, computer languages and automatic control systems. It includes scientific computation, data recognition, storage, information retrieval, file manipulation and simultaneous processes.

In addition to analysis and design of Information Systems, the course provides for broad elective study of related areas of mathematics, statistics, electronics, philosophy, linguistics, industrial engineering and management." (Bendigo Institute of Technology 1973).

Things continued to move in Business Studies during the 1970s, with the 1974 handbook indicating that a number of business courses now contained data processing (computing) subjects. In the Department of Accounting, the *Diploma of Business Studies (Accounting)* had two data processing subjects and in the Department of Management and Economics, the *Diploma of Management* also contained a computing subject. Courses in the Department of Information Science had now been rationalised to two: the *Diploma of Information Processing*, and the *Post Diploma of Electronic Computing* (Bendigo Institute of Technology 1974). In 1976 the Bendigo Institute of Technology merged with the State College of Victoria (Bendigo)\(^{18}\) to form the Bendigo College of Advanced Education. A 1977 course report on the *Diploma of Business (Data Processing)* indicates a recent increase in student numbers. In the period from 1970 to 1974,
from three to seven students completed the course per year. In 1975 this rose to eleven, and then to twenty one in 1976 (Bendigo College of Advanced Education 1977).

In 1984, the Business Studies Faculty still had all the running in computing, with the Faculties of Arts, Education, and Engineering and Science still offering no relevant subjects. The Faculty of Business Studies then had a total of nine courses, including four relating to computing: Bachelor of Business (Data Processing), Bachelor of Applied Science (Computing), Graduate Diploma in Electronic Computing and a two year Associate Diploma in Information Processing. Two data processing subjects were compulsory in all undergraduate business courses.

It is interesting to compare the content of the Bachelor of Business (Data Processing) and the Bachelor of Applied Science (Computing), both offered by the Faculty of Business Studies. The Bachelor of Business (Data Processing) had a design that was to become common in such courses:

- a group of six general business subjects: General Accounting 1, General Accounting 2, Economics 1a, Economics 1b, Business Statistics 1, Business Law 1;
- ten data processing subjects: Business Data Processing 1, 2, 3, 4, 5, 6, 7, 8, 9, and Contemporary Developments in Computing;
- and eight electives.

The Bachelor of Applied Science (Computing) had rather more in common, on the other hand, with a typical computer science course: Computer Programming 1, 2, 3; Information Systems 1, 2, 3; Finite Mathematics (one semester); Elementary Calculus (one semester); Information Processing Projects 2, 3; Quantitative Management Techniques (one semester); Computing Machines 3; and 5 electives (Bendigo College of Advanced Education 1984).

**Royal Melbourne Institute of Technology (RMIT)**

The teaching of accounting as a professional subject had its origin in Melbourne in the 1930s when A.G. Robinson, an accountant in private practice, began conducting evening classes in his offices in the city, at Footscray Technical College, and then at Melbourne Technical College (Murray-Smith & Dare 1987:}
221). These courses were to prepare students for the examinations of the various institutes of accountants.

In 1944 at Melbourne Technical College, the recently established Department of Commerce offered three-year courses for students wishing to gain admission to the Commonwealth Institute of Accountants. Completion of a fourth year gave students a Diploma, but the majority were happy with the three year course (Murray-Smith & Dare 1987: 307).

In 1961 several things, important to all the technical colleges, occurred: the Royal Melbourne Technical College changed its name to the Royal Melbourne Institute of Technology (RMIT), but without any change in its status; the Victorian Government asked A.H. Ramsay (a retired Director of Education) to set up the 'Committee for Development of Tertiary Education in Victoria'; and the Commonwealth Government set up the 'Commonwealth Committee on the Future of Tertiary Education in Australia', chaired by Sir Leslie Martin.

In 1962 the Head of RMIT's Mathematics Department, Hartley Halstead, began to give serious thought to computing after being offered a used computer at a substantially reduced price. He was then instrumental in the setting up of a computer committee which soon granted approval in principle for the Institute to acquire a computer. An Elliot 803, at that time regarded as a medium-sized computer, was obtained under a hiring arrangement over five years. This arrangement gave Elliot the right to let out excess capacity on a commercial basis during this period. The arrangement inevitably produced some conflicts.

"No institute staff were involved in the computer's day-to-day operation, a matter of some concern to the institute. In 1964, in an attempt to bring the centre more firmly under institute control, the Computer Centre was officially linked to the Department of Mathematics. Two years later the centre was still without any full-time institute staff."

"The Department of Mathematics was responsible for mathematical, scientific and technological applications of the computer while the other major user, the Department of Accountancy, was responsible for commercial data processing. Four hundred students were studying computer subjects in 1965. It was decided to investigate the purchase
of a larger, more up-to-date computer." (Murray-Smith & Dare 1987: 344).

The third of the wise men did not have as much success in business computing as the others. According to Peter Juliff (1990), Brian O'Donagheue's RMIT courses never really took off, "they got swallowed up in the School of Business, and people like Raj Vasidiva in the Maths Department really took the running" (Juliff 1990). Montgomery (1992) also describes O'Donagheue as the least successful of the three wise men, and believes that he was 'ground down' by RMIT's internal politics.

Tony Adams completed a Diploma of Physics at RMIT in the early 1960s. While studying at RMIT he also held the position of Secretary of the Student Representative Council (SRC) and so managed to get into a course in ALGOL programming intended for RMIT staff, when the Elliot 803 computer\(^{19}\) arrived in 1962. Adams then undertook a machine code course, after which he went out to Caulfield and did some subjects out of one of the courses offered by Jack White. About this time he decided that computing was more interesting than physics, looked around for some jobs, and took up a position at Monash Computer Centre (Adams 1992). I will later return to Adams to follow up this aspect of his career.


The Department of Mathematics and Computer Science had, up until the late 1970s, offered what was basically a mathematics degree with some computer science subjects: Computer Science, Industrial Systems, and Electronics and Computers. The Bachelor of Applied Science (Computer Science) course had grown out of the fellowship diploma course (with only a few minor changes), which had in turn derived from the still earlier mathematics fellowship diploma. Schaefer, an RMIT lecturer, describes the department's resources in 1972 as follows:

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\(^{19}\) A 40-bit serial machine using paper tape, and fairly slow.
"Computer equipment at RMIT consists basically of an I.C.L. System 4-50 with 196 kbytes of core, four R.D.S. and six M.T. units, card and paper tape readers, paper tape punch, incremental plotter and line printer. Fast in-core compilers are expected shortly. A number of on-line terminals are expected to be available to users in 1972, including one terminal to be located at the Department of Mathematics and Computer Science." (Schaeffer 1972).

By the late 1970s this course was to change to become a true Computer Science degree. In 1978 Karl Reed, a lecturer who was also on the advisory committee for the new degree, offered Tony Adams a six months contract lecturing position, which later became permanent. Milton Pine had recently been brought in from Caulfield as 'Principal Lecturer in Charge of Computing' to head up the computer group, but when a new Department of Computer Science was created in 1981, Pine did not get the position. This was re-advertised several times, and eventually filled by Tony Montgomery (coming in from Monash University) in 1982 (Adams 1992). Until this time, RMIT had offered little in business computing but, perhaps somewhat perversely the new Computer Science degree was to put around 70% of its graduates into positions in business. "The course did not have much in the way of business subjects, but it was still really preparing people for careers in business." (Adams 1991).

The new Department of Computer Science was initially very "under-resourced". Adams remembers Montgomery, the new Head of Department, demanding that he needed 80 terminals, not the five currently available. Unfortunately, those who would have to pay for the upgrade considered this an outrageous demand (Adams 1991), and it took much argument and some years before the department was adequately equipped. Adams attributes much of the credit for this to Montgomery's constant pressure.

In 1985, Montgomery took up the newly created position as Head of RMIT's Information Technology Division. Adams (1992) relates that elements at RMIT had been keen to create a Faculty of Computing, but had been unable to get agreement from all the parties involved. Computer Science had no objection, but the Engineers did not want to loose their computing staff, and the group from the Faculty of Business also did not want to be a part of any such faculty. The compromise position was to establish an IT Division which was intended to be a matrix grouping that would drive all the departments involved in a common
direction. RMIT's idea of an IT Division was unique in Victoria and Adams believes that it worked pretty well for a while, but that in the end 'democracy' created problems. Montgomery originally worked with the heads of the groups (or departments) concerned, with whom he met once every couple of weeks. Then the Academic Board insisted on the inclusion of staff representatives in this group, resulting in a new group of 20-30 people. This turned out to be quite unworkable, and the Division was disbanded in 1990 (Adams 1992).

Since the early 1970s, most of RMIT's computing had grown up as Computer Science, in the Faculty of Applied Science, rather than in business. Brian O'Donaghue was teaching business computing back in the mid 1960s, but the Business Faculty had no formal courses in computing. By the time that Adams arrived at RMIT in 1978, he says that O'Donaghue had "lost any vision he might once have had" (Adams 1991). In 1978 the Faculty of Business's Administrative Studies Department, began its first computing course: the Graduate Diploma in Computer Studies.

By the early 1980s, Adams had been promoted to Senior Lecturer in Computer Science. In Business, the Department of Administrative Studies had a computer group and a principal lecturer had recently been recruited from 'down town'. He had been given a mission to "clean up the act, and to get hard service subjects". According to Adams (1992), he was told "You are teaching COBOL programming to bloody accountants and you've got to make it hard. The reason for making it hard is that they have got to know it, and to know that computing is a non-trivial thing." Failure rates were 40%, he could not get used to RMIT politics and left within a year. Adams was asked to fill the position on a temporary basis, and stayed on.

Some years later, in 1987, the separate Department of Business Information Systems was set up with Adams at its head. Adams (1992) relates that as a latecomer to the area, the department decided "not to take on Chisholm at producing COBOL programmers", but to go for a niche market, catering to an intelligent user approach. They were looking for people like the accountant who had been told that next year her company was to buy a million dollar computer, and that she should go and find out about computing.

The way that the department got its degree course is also interesting. Adams relates that RMIT had run "brilliant" Secretarial Studies degrees and graduate
diplomas in the 1960s and 70s and had an outstanding reputation in this area. In the late 70s, a razor gang went through it and said "well Secretarial Studies is not really degree stuff so it's going" (Adams 1992). An attempt was then made to redefine the degree as an Office Systems degree. Adams says that this was "an appalling degree, very badly structured" (Adams 1992), but it was a good shell, it was running, and it had EFTSU[^20] (student places). With the creation of the new department this course became Adams responsibility, and he turned it into the Bachelor of Business (Information Systems). A Master of Business (Information Technology) was put together as a course work masters in 1988.

Montgomery regrets that it was not possible for the Departments of Computer Science and Business Information Systems to work more closely together. "What should be taught to a Business Information Systems person is in many respects what we are teaching to our Computer Science students: information processing techniques. There should be one decent systems analysis course at RMIT." (Montgomery 1992). In criticising the view that computing should be taught in a different way to Business and to Computer Science students, Montgomery says that:

"exactly because you teach in a different way is a reason why they will not be able to communicate one to the other. Surely we need to use the same language. Our guys need to know how your guys think and there will be a big plus if we have all in the one class instead of having two different cultures. The opportunity to have a closer coupling between their students and our students, between their staff and our staff, the opportunity to use our resources more effectively, to really have excellent teaching materials ... has been lost." (Montgomery 1992).

The similarity of this view to that espoused by Couger & McFadder (1975) and related in Chapter 1, should be noted. Maynard (1990) also considers that computing at RMIT has always been quite fragmented, with Engineering, Business and Applied Science each holding on to their own bits. He believes that "it is just territorial matters that keep them separate" (Maynard 1990).

[^20]: Equivalent Full-Time Student Unit.
Swinburne Institute of Technology

David Wilde was appointed to Swinburne Technical College in 1967 coming from a position as a Systems Engineer at IBM where he had worked on IBM System 360s. Matt Hunter, who had previously worked at RMIT, was then Head of the Commerce Department at Swinburne. According to Wilde, Hunter saw computing as a career path in its own right and not just as "a useful study for accountants", and appointed Ralph Treloar and David Wilde to this new area to establish computing courses at Swinburne (Wilde 1992).

Computing thus started at Swinburne in 1967 with the Diploma of Commerce (Computing). Treloar, Wilde and others collected a quantity of IBM training materials on Systems Analysis, Assembly Language and PL1 programming. They then used these to construct this first computing course at Swinburne, taking the IBM course materials and using them "pretty much as they were" (Wilde 1992). As Swinburne did not have its own computer, they used a 'scientific' computer at the State Electricity Commission (SEC). Intakes to the diploma were quite small and Wilde remembers class sizes of only five or six. Adams (1992) recalls being involved in sessional lecturing at Swinburne in the early 1970s, and of teaching about accounting machines there!

In 1972, with the commencement of the Bachelor of Business (Accounting) degree, which included several computing subjects, the diploma course was dropped. Shortly after this time a separate Department of Data Processing and Quantitative Methods was established. In 1974 a Bachelor of Business (Computing) was introduced. In 1976/7 there was a huge increase in numbers. Wilde does not know the reason, but remembers COBOL courses with over 120 students at this time. (Whether by accident or not, Bendigo also experienced an increase in numbers at this time.) Over the next five years the numbers in such courses declined to about 50-60. Today, Swinburne would produce around 80 - 100 business graduate each year who have studied a substantial amount of computing.

In 1980 a Graduate Diploma in Management Systems was introduced, which was a quite advanced management-based course taking about twenty-five to thirty students. In 1987 the Graduate Diploma of Business (Information Technology) took its first students. This course was more like the normal entry-level conversion graduate diploma catering for graduates with minimal experience of
computing. That year also saw the commencement of the new *Bachelor of Information Technology*, taught jointly with the Computer Science Department. The course is interesting in being full fee paying and involving the award of 'employer nominated places' or cadetships. It is heavily IBM sponsored: the development committee had considerable input from IBM users and the course stresses IBM mainframe COBOL and PL1, and uses quite a lot of IBM materials (Wilde 1992).

Computing courses at Swinburne have always been very much IBM-oriented. This is at least partially due to the large number of Swinburne staff who had come to the Institute from positions with IBM. About twelve staff were recruited in this way including David Wilde, Geoff Leonard, Ralph Treloar, Kate Behan, Diana Holmes, and Janet Munro. IBM thus had a considerable, if indirect, influence on computing course at Swinburne (Wilde 1992). This has been particularly the case in the area of system software where considerable emphasis was (and still is) placed on IBM operating systems such as MVS. Swinburne also teaches the IBM DB2 database system and ESE expert system. A minimal amount of UNIX is also taught, but the main emphasis is very much on IBM products.

In the early 1970s, Swinburne bought a small ICL 900 series computer on the advice of Cliff Bellamy from Monash University. This is the only non-IBM (or IBM look-alike) machine they have had. Not long after, money was allocated for the purchase of a computer system to be shared between Swinburne and Caulfield, but Wilde relates that somehow Caulfield ended up with the machine! Swinburne then obtained a General Electric System 4 (IBM look-alike) and later a Facom (now called Fujitsu and also an IBM look-alike). It currently has an IBM 3090.

Swinburne purchased its first IBM PC in 1982, importing it directly from the United States. Shortly after, the Institute Director purchased a number of PCs, one for the desk of each of his Heads of Department; he was determined to set them an example! Like most tertiary institutions, Swinburne now uses micros to a large extent as its main computing tool, even to the extent of having students develop their COBOL programs on the micros before porting them to the IBM mainframe.

In recent years a number of Swinburne staff, including Wilde, have also taught commercial courses for IBM. Swinburne Institute has an arrangement with IBM
such that the company pays Swinburne for the use of its staff and then the
Institute passes on some of this money to the staff involved. Swinburne sees this
as a good arrangement in that staff get commercial experience with IBM, while
the Institute makes a good deal of money.

Following the safe old line: 'no one ever got sacked for buying an IBM', Wilde
suggests that the attitude of Swinburne has been: "IBM will lead us in the market
place so you can't go too far wrong with IBM." (Wilde 1992). Interestingly,
Wilde now expresses some doubts as to whether Swinburne would in future stick
with an IBM which today seems to have lost much of its direction.

Although computing at Swinburne started, and for a long period exclusively
remained in Business, there are currently three departments concerned with
computing: the Department of Computer Systems Engineering in the Faculty of
Engineering, the Department of Computer Science in the Faculty of Applied
Science and the Department of Information Systems in the Faculty of Business
(formerly the Department of Data Processing and Quantitative Methods). The
Swinburne Computer Centre was built up by Graeme Hunt who also did a
minimal amount of teaching in Applied Science. Later (early 1980s) he was
appointed to head up the new Computer Studies Department which has since
grown to become the Department of Computer Science.

Footscray Institute of Technology

Brian Belcher was appointed to a new position in the Department of Business
Studies at Footscray Institute of Technology (FIT) in 1969, at a transitional
period when many staff still retained Education Department appointments at the
former Footscray Technical College which, in 1968, had become FIT. Prior to
this, Footscray Technical College had been among the first colleges to affiliate
with the Victorian Institute of Colleges in 1965. Belcher came from a position at
Taylors College where he had worked mainly in the Secondary School section. He
had then been still completing a Physics degree. While at Taylors he was sent on a
number of IBM 1400 series computer training courses in Sydney. The IBM low-
end commercial machines of the time still used punched cards for storage while
the high-end machines used magnetic tape. Belcher produced a quantity of
educational materials for Taylors, mostly in programming and systems analysis,
and also did some consulting work.
In 1967 Footscray Technical College's diplomas of Commerce and Commercial Practice were replaced with a Diploma of Business Studies, described as "a professional course of three or four years duration designed to train accountants, junior executives, private secretaries and systems analysts. The diploma could be taken in Accounting, Administration, or Private Secretarial Practice." (Rasmussen 1989: 155). In 1968 a Diploma in Business Studies (Data Processing) and others in Accounting and Administration were introduced. These were four year courses for students entering with the Technical Leaving Certificate (year 11). Students who had completed Matriculation (year 12) could complete the diploma courses in three years. The diplomas were accredited state-wide across the technical college system. According to Belcher, the standard of the work taught in these computing diploma courses was comparable with what is now taught in the degree. The aim was, essentially, to turn out programmers. There was a business emphasis, including some statistics, but the course had less business subjects than a typical Bachelor of Business now does. No time was allowed for practical work within the course structure and students were expected to do all of this in their own time. There was considerable stress on logic and logical design that was necessary for machines of the time "which had very small memory capacity, necessitating the use of a lot of overlays" (Belcher 1992). Typically, the Diploma had about twenty students per year. The students also did real outside commercial work, one example being the preparation of the statistics needed for a pay case by the Pilot's Association.

Footscray had a 32k byte ICL 901a with a card reader and also made use of RMIT's computer. The diploma course involved mainly programming, in FORTRAN, COBOL and Assembler (PLAN), with some Systems Analysis. At Footscray, all computing resources were supplied centrally, and after the ICL the next step involved the purchase of a number of on-line teletype terminals, followed by a system of remote job entry (RJE) to RMIT involving the use of mark-sense cards. Later (in the mid-1970s) the MONECS mark-sense cards system was adopted. In 1979 a number of Apple // microcomputers were purchased and after this, the number of microcomputers grew gradually until a lab of IBM PCs were obtained in about 1985.

Doug Mills, the newly appointed Director of FIT, had diplomas in electrical and mechanical engineering and a bachelor degree in electrical engineering. He worked first for the SEC, then took up a position at Footscray Technical School,
before moving on to Caulfield Technical School where he remained till 1964 by which time he was Head of the Computer Department. In 1964, he was appointed Inspector of Technical Schools, with special duties in higher engineering courses, and played an important role in the development of both engineering and computing courses in the Victorian Education Department. Later, he was to make good use of his network of Technical Schools Division contacts in his years at FIT (Rasmussen 1989: 158). At FIT, Mills views on computing had a considerable, but not necessarily beneficial, effect on the direction in which the discipline of computing was to develop there. Mills believed that "MONECS mark-sense cards were the way to go rather than on-line systems" (Belcher 1992) and that computing should be spread across all areas of the Institute rather than taught by one department (Maynard 1990).

Geoff Sandy took up a position as a lecturer in economics in the Department of Business Studies at Footscray Institute in 1973. He had previously been a high school commerce teacher. In 1973 approval was given to convert the Diploma of Business into a degree. The original intention was to produce a course with several strands much like many modern Bachelor of Business courses, so that appropriate majors would produce a BBus (Economics), BBus (Accounting), BBus (Data Processing) or BBus (Management). "Unfortunately, only the BBus (Accounting) was approved." (Sandy 1992). From the beginning, Data Processing was adopted as a core unit in the Bachelor of Business. In the late 70s computing was given two core units in the degree and it became possible to do a major study of six units in computing. In 1979 Business developed into a School containing several departments, the computing staff moving to the Department of Applied Economics.

The DP Diploma course was dropped when the Bachelor of Business degree came into being. Belcher believes that the reason was resource constraints: if a discipline area was to have subjects in the new degree, it could not also have its own diploma course. Sandy suggests that it was "because of a perceived lack of demand for computing courses at the time, by those making decisions within Business Studies." (Sandy 1992).

Right from the start (late 1960s), Footscray had offered an Associate Diploma in Secretarial Practice as one of its earliest courses. This course had no significant computing component, but in the mid 1980s was re-accredited as an Associate Diploma in Secretarial Studies with a substantial computing component.
processing, office automation, use of computer technology and electronic mail. The course made use of the Honeywell DPS6 mini-computer using Uniplex Plus software (Sandy 1992).

In the early 1980s there had also been a degree course in Secretarial Studies on the books, but the course had never been developed or offered. In 1983 Sandy was asked to develop this course into a degree course in Information Management, and in 1984 the BBus (Information Management & Communication) took its first intake of students and Sandy became senior lecturer in Information Management. Sandy describes the course as a pioneering one at the time, in that it attempted to stress that "information is a critical organisational resource that must be managed effectively and efficiently", rather than one concentrating on 'pure computing' where a study of the technology involved was the priority. "The course had an office automation / office systems flavour and involved a study of Office Automation packages and how technology can address the systems life cycle. The intention was to produce a broadly-based course with a syllabus strong in information management and in the management of information technology." (Sandy 1992). As well as a major in Information Management, the course had a compulsory minor in more traditional computing - programming, systems analysis and systems development. Students were, however, encouraged to do a double major of both Information Management and Computing.

By the late 1980s, there was growing support for the development of a computing course and as a consequence, in 1989, the Bachelor of Business (Information Management and Communication) was modified to become the Bachelor of Business (Information Technology). The new course had two strands: Information Management, and Computing (Systems Development). Students were again encouraged to take subjects from both strands.

Computing at Footscray started off in Business, but the Associate Diploma in Applied Science (Computing) was introduced in 1985. "At that time, Applied Science was quite small and there was a need to give them some courses of their own - hence the Associate Diploma." (Belcher 1992). This course always had considerable input from business and co-operation was also forthcoming in the other direction with business courses accepting input from Applied Science, particularly in the areas of mathematics and statistics. A Graduate Diploma in Commercial Data Processing was introduced by the School of Business in 1982.
Before 1968 Footscray Technical College had consisted of secondary (technical) school, apprenticeship and advanced education sections. The apprentice college was on a different site, but the secondary school shared the Ballarat Road campus with the Advanced Education College. The apprentice college eventually became a TAFE College which completely separated from FIT in 1982. There is no evidence that either the secondary school, the apprentice college or the (later) TAFE College had an effect on computing courses at FIT.

The Nature of the CAE Computing Courses

As I have shown, courses in business computing in the CAEs did not diverge from university computer science courses. According to Juliff (1990), and backed up by this study, it is useful to consider the relationship between three separate computing course entities during the 1970s:

- the 'academic' computer science courses taught at such institutions as Melbourne University and RMIT,
- the Applied Sciences type of business computing courses offered by Caulfield, Swinburne, Footscray, Preston and the smaller Institutes and CAEs and,
- from late 70s, courses in Business degrees like those offered at Prahran, Swinburne and Preston CAEs.

Juliff maintains that all three course types have grown up together to produce the spectrum we have now.

The typical Applied Science course would have had 18 computing units out of a total of 24, whereas only 10 or 12 out of 24 would have been more common in one offered in a Faculty of Business. "The emphasis would have been less on the technology and more on the business that goes on with it" (Juliff 1990), and courses offered in Business would concentrate less on topics like data communications and system software than those in Applied Science. It is probably true to say that, while both types of course were aimed at producing graduates with training useful to business, computing in Business Faculties was a sub-set of that offered in Applied Science, and Juliff notes that this was certainly true when he worked at Burwood. The aim of the courses was to turn out programmers, and the career path then was not a lot different from today. People went off course essentially as programmers, then went on to work in system analysis and system design.
Juliff suggests that university computer science has always been much the same as it is now. It has always been taught by people whose primary love was mathematics, so that was the flavour they gave to the course. "You would have got the same in business computing if everybody who came in had been interested in accounting - lots of debits and credits and very little computing." (Juliff 1990). He goes on to further outline the difference between CAE and university computing courses.

"Uni courses have never seen the need to be relevant to the real world. Uni students still tended to end up in business - but perhaps a little poorer prepared. Uni courses have done almost nothing in systems design, and programming has tended to be in languages like C, Pascal and ALGOL. Application areas tend to be in real-time monitors, operating systems and compilers, rather than the father-son updates and on-line inquiry systems you'd see in the CAE courses. Students who come out were not as well prepared for business as were their College counterparts." (Juliff 1990).

When asked whether it was it random luck whether data processing courses started in business or in applied science in a given institution, Maynard replied that they normally started in business, but that pressures would then often move them on. In his work in course accreditation with the ACS, he has found that courses tied very closely to business over the years have not done very well from a funding point of view, and have remained at a fairly low level of computing content. Programming got quite light treatment, and there was a reluctance to teach 'in-depth' systems analysis. But more important than the faculty offering the courses are the people involved. "The key is the people who are running these courses - the people in charge. They will influence the direction of courses quite dramatically." (Maynard 1990).

Maynard (1990) suggests that the term computing should today be used to refer to something wider than computer science. He also notes that the term information technology is now being used by both the ACS and the AIIA (Australian Information Industry Association) to encompass Computer Systems Engineering, Computer Science, and Information Systems. Computer science has a mathematical basis, and he prefers to use the term computing to refer, in the main, to applications. For example, to systems applications: how the systems programmer needs to amend operating systems to make them do what we want
them to do; to systems analysis and design; and to programming languages that are going to be used to solve applications problems. Beyond computer science, he believes that computing is now an important discipline in its own right. However, given that it took twenty years for computer science to achieve the recognised status of a discipline, widening this to include other aspects of computing must be expected to suffer some resistance for several years to come.

University Courses from the 1970s.

Monash University

Tony Adams took a job as Systems Manager at Monash University Computer Centre at the end of 1963. At the time, Monash had a couple of Ferranti Sirius computers and a CDC 3200 which arrived at the same time as Adams, who then installed it. Apart from being involved in giving advice to the first students taking computer subjects, Adams co-authored (with Cliff Bellamy) a book on FORTRAN programming which was a forerunner of the MONECS book by Bellamy and Whitehouse. Working in the Computer Centre, Adams basically taught himself computing, with assistance from several short courses. The CDC computer at Monash was one of the first to have a 'real' operating system, and Adams had to maintain this, working with the CDC technical people and teaching himself about the SCOPE and MS/OS operating systems (Adams 1992).

Adams worked at the Monash Computer Centre till 1969, the year that Tony Montgomery took up an academic appointment, after which he moved over to Monash's Health Computing Services bureau. Adams recounts how one of Cliff Bellamy's projects was the setting up of Health Computing Services (HCC), initially run by Monash University under contract to the Alfred Hospital and only later formalised as a company in its own right. In the late 1960s, the first big administrative systems were just going into production and Monash had recently bought a Burroughs B5500 system. Another similar system was also selected for Health Computing, the notion being to duplicate the machinery so that Monash and Health Computer Services, both running the same systems, could provide each other with backup. At HCC, Adams worked mainly in systems management. He recounts how HCC expanded too quickly. "It was essentially driven by accountants who could only understand one thing: the need to expand! They put

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21 Monash University's punch-card, and later mark-sense card system.
in a very complex payroll system, piloted it at a very small hospital for a few weeks, and then on the one day they installed it in the Alfred, Royal Melbourne, Prince Henry and Queen Vic hospitals and then expected it to work." (Adams 1992). The system was a highly distributed one, but with central hardware. Soon a classical problem situation developed which resulted in the users not feeling that the HCC was responding. Adams relates sadly that, under the circumstances, there was no way that it could respond. After four years of this Adams, who was responsible for these operations, decided that the problems were more trouble than they were worth and decided to give it up. He left to do some private consulting and to run a restaurant for a few years before later taking up an academic position at RMIT.

Tony Montgomery had trained and practiced as an engineer. In the late 1960s, while he was completing an MBA, Monash University was in the process of setting up its courses in computing. Montgomery describes how Cliff Bellamy (Director of the Monash Computing Centre), who himself had significant commercial experience, realised that Monash’s proposed computer science courses would need a commercial data processing component and so suggested to the head of the newly created Department of Information Science, Chris Wallace, that he appoint someone to this area. Montgomery was appointed, and commenced at Monash in 1969 where he developed and taught subject areas with a commercial data processing flavour: systems analysis, COBOL programming, and file processing (Montgomery 1992).

Montgomery spoke of accounting machines, of O&M, and of the way that many systems analysis courses had grown out of a consideration of these, but went to pains to point out that early courses at Monash did not have this as a starting point. Montgomery says that he felt that this would have been going backwards. The first computing course at Monash was the third year subject *Computer Science* (*CS301*). He describes how the subject started off with a discussion of sequential file processing of data held on tape, and how input/output, processing and storage were all predicated on a magnetic-tape environment. "Only briefly [in 1969] did we talk about random access (disk-based) systems because there were not a lot around. We talked about magnetic tape file processing operations." (Montgomery 1992).

In those days (early 1970s) Montgomery taught sequential file processing - editing, updating, and report creation - using Monash’s CDC 3200 computer, and
all in FORTRAN. He stresses how he always taught the importance of systems having a full set of controls on them, this was particularly important because of the "relative unreliability of systems at the time, but also because it is important to have a hierarchy of controls" (Montgomery 1992). The equipment scene at Monash shifted quite significantly when the computer centre acquired a Burroughs B5500 and then a B7600. Montgomery describes how this changed the whole environment in which COBOL, for instance, was being written and produced. "You could write COBOL on the CDC 3200 but it was very resource-hungry and compilation was slow and unreliable." (Montgomery 1992). With the Burroughs came the possibility of doing some 'database processing' so Monash's courses started to look more at random access files and the performance of such files.

With this interest in database management, at about that time Monash purchased a Hewlett Packard 2100a which was one of the first machines to have a disk system. One of Montgomery's research students (Graeme Bentley) wrote a mini database system in FORTRAN for this machine. (As an aside, he describes how this is still in use at RMIT today, and until recently also at Chisholm, as a teaching language for database management systems.) Montgomery believes that this was a good system "every bit as good if not better than TOTAL". It supported the network philosophy with a CODASYL language and was really an implementation of CODASYL. He says that had he been commercially aware at the time, he would have pressed Monash to exploit its possibilities. Montgomery says that the Burroughs had a database management system which was a variation on CODASYL, but was very complex to implement, even for simple applications. As an entrepreneurial activity the Computer Science Department produced a series of videotapes explaining the operation of the Burroughs database management system, which were then sold to a number of sites, including the insurance company CML.

Montgomery was also concerned with the question of where Commercial Data Processing ends and Computer Science starts. One of the things that the department was doing was measuring the performance of each of the various file structures and trying to relate these measurements to the theoretical estimate of its performance. He narrates how various honours and 3rd year students were doing this and trying to confirm that their methods of measuring file performance matched reality (Montgomery 1992). Postgraduate research activities were also important. Ken McDonell, for instance, wrote a prototype student records system
for Monash which used compression algorithms to store the records in a fraction of the space otherwise required. Many such projects bridged Computer Science and Commercial Data Processing.

In the early 1970s Monash introduced subjects at both higher and lower levels, almost simultaneously, with the introduction of an honours year (CS401), and then second year (CS203) and later first year (CS101) Computer Science. A little later (about 1974), the Graduate Diploma in Information Science was introduced. Montgomery realised that a lot of the material in the honours year was:

"exactly the stuff that people out in commercial DP who graduated many years ago, or who had never done a formal Computer Science course, would have been interested in. People had enrolled for masters programs at Monash because they wanted a top-up from either no formal training in computing, or else some formal experience from a long time ago. These guys had not been persisting with the masters programme, and needed something with course work only; and it needed to be short and sweet like a donkey's gallop - two years part time." (Montgomery 1992).

He describes the graduate diploma as being very successful. The students were very enthusiastic: "really good quality guys". After three or four years however, the new Dean, John Swann, terminated the course as "not being congruent with the aims and objectives of Monash University". Montgomery recounts Swann's view that "you don't have grad dips at real universities, only in Institutes of Technology." (Montgomery 1992) With some passion Montgomery went on to give his view that "what you should be doing in education is trying to provide courses that suit the needs of the community" (Montgomery 1992).

But there were other problems. Montgomery relates that Chris Wallace was an excellent boss. Whilst being a pure scientist himself, "he recognised the need for 85% of people to have an idea of the kind of stuff relating to commercial DP" (Montgomery 1992). Similarly, Cliff Bellamy strongly supported these things. The difficulty was a question, in the Faculty of Science, as to whether this kind of computing was indeed science. "They asked me: 'Is what you are doing information engineering or is it information science?'" (Montgomery 1992). This
issue also produced practical difficulty like getting research funds where the question would be asked: "Is this science or is it engineering, or what?"

Montgomery declares that it is a reasonable comment that Monash, in the 1970s, sat somewhere between the Computer Science purists at Melbourne University and the Commercial Data Processing of CAEs like Chisholm. Monash was trying to "bring the two together with an academic and scientific flavour to produce an understanding of how to make information processing more efficient and more effective." He quotes John Bennett, who was running a 'pure' Department of Computer Science at Sydney University as saying that there should be more departments in Australia like Monash, because "it brought to it a practical element that is not evident in any of the other departments." (Montgomery 1992). The model espoused by Montgomery was as follows: "In order to make information processing systems function efficiently and effectively you really needed some deep insight into the mechanisms which underpinned them, and those mechanisms might go right down to the computer architecture." (Montgomery 1992). This was a view that was later to be contested by some in the Faculty of Business at RMIT.

Up to this time all the teaching about computing at Monash was done in Computer Science. In the mid-1970s, Len Whitehouse, from the Monash Computer Centre, was asked by Cliff Bellamy to develop a cheap way of running "computer education for the masses", and MONECS was born. This punched-card, and later mark-sense-card system was initially intended to expose people - other than those from Computer Science - to the concepts of writing a computer program. Commerce/Business, in particular, was a target group for MONECS as before this time, not much computing had been done in this area. Montgomery related how Mrs Preston was lecturing in statistics and needed some programmatic way of teaching people how to compute statistical functions. MONECS was ideal for the purpose, and the teaching of computing in this area then began in earnest at Monash (Montgomery 1992).

Secondary schools also benefited from MONECS cards, of which they sent loads to Monash for processing. Adams relates that Bellamy was "quick to see a dollar" (Adams 1992) and saw hospital computing, geographical computing and then schools computing in this light. Monash had also done the administrative processing of Victorian year 12 results for a number of years.
La Trobe University

David Woodhouse was appointed as a Senior Lecturer in pure mathematics in the Department of Mathematics in the School of Physical Sciences at La Trobe University soon after its formation. In 1973 he took a sabbatical to Cambridge to complete his MSc in the study of Computer Science. Up until this time there had been no Computer Science undertaken at La Trobe University.

In 1975, Woodhouse introduced La Trobe's first computing subject: Computer Science III, as part of the Bachelor of Science degree. This subject was an introduction to computer science and involved some programming, as well as a study of hardware, software and operating systems. In common with many university courses of the time, a Science degree at La Trobe involved the study of four subjects at first year, three at second, and two at third year level. Computer Science III was thus a major study at third year level, the prerequisite being second year mathematics. The only other computing then taught was a small amount in Applied Mathematics II. There were no plans for the later introduction of Computer Science I or II, so Computer Science III started on the assumption that its students had no previous exposure to computing.

Prior to the setting up of a separate department in 1978, Computer Science was sponsored by the Mathematics Department. Woodhouse describes the resistance to this new subject from many of the other mathematicians (both pure and applied) who saw Computer Science as just another kind of mathematics. He describes the "constant battle to get the purists to accept Computer Science as a significant study in its own right" (Woodhouse 1992).

In 1975 Woodhouse put up a submission to the Academic Board for the formation of a Department of Computer Science, to commence in 1976. Knowing that funds were short after the recent Commonwealth Government cut-back in spending on tertiary education, his submission made no mention of the appointment of a Professor. The submission was knocked back on the grounds that every department needed to be headed by a Professor. Undaunted, he amended the submission, this time asking for funding for a Chair of Computer Science. This time the submission was rejected as being too expensive. Two years later in 1977, after some change in the university's internal politics, a Department of Communications Engineering was created, and Woodhouse saw the
opportunity to again press for a Department of Computer Science. On this third try his submission included provision for a Chair, but indicated that "the appointment of a Professor can be deferred until finances permit" (Woodhouse 1992). This time the submission was successful, and a Department of Computer Science was set up in 1978 with Woodhouse as its (non-professorial) chairman. In 1984 a new School of Mathematics and Information Science was set up with Woodhouse as its Dean and in 1985 (seven years after the department was created) the Chair of Computer Science was eventually filled.

In 1975/6 the Commonwealth Public Service Board commissioned Barry de Ferranti and Barry Smith to produce a report into Australia's 'manpower planning' needs over the next 10 years. As a result, the de Ferranti/Smith Report, more commonly know as the Barry/Barry Report, was published. It identified the severe lack of computer professionals as a major problem, indicating that there was a great need for more training in this area. The report suggested, amongst other things, that the introduction of one year courses in computing, for graduates of other disciplines, was the best way of overcoming the problem. It proposed the creation of more courses of the 'conversion graduate diploma' type (Woodhouse 1992).

At La Trobe University, Woodhouse immediately saw the opportunity to adapt Computer Science III - which was already one half of a year's work, to become such a graduate diploma, and in 1977 the Graduate Diploma in Computer Science took its first intake of students. Woodhouse saw computing courses of this type as a good thing for La Trobe, then still a young university, to become a leader in.

Not wanting to create a course in academic Computer Science of the type offered by Melbourne and most other universities, which would be "of little use in producing employable computer professionals" Woodhouse looked at Computer Science III and saw that it needed to be supplemented with Systems Analysis and Design (not then really considered to be a proper part of 'real' computer science) and several ancillary subjects such as Management Accounting, Operations Research and Social Psychology.

In looking for the things that people aiming to become computer professionals and taking up business appointments would need to know, he also considered areas where there was teaching expertise in other parts of the university. He
describes how he had to develop the department "on a shoestring" and to use what expertise there already was in the university, rather than just appointing a number of new staff. For the new course he was able to generate only one additional tutoring position, and a half-time lecturing position. He was able to locate staff in other departments to take on each of the ancillary subjects, although he relates how working with the other departments and getting them to understand the needs of his students was always difficult. The one area still lacking was for someone to teach Systems Analysis and Design, and Herman Plustwick who had practical experience at both IBM and at Kodak, was appointed to take the Information Systems unit. (Plustwick was duly appointed, and spent half his time filling the lecturing position in the Department of Computer Science and the other half doing systems work for the library.)

The course had five ancillary subjects: Introduction to Accounting, Management Accounting, Social Psychology, Numerical Methods, and Operations Research. It thus consisted of the Computer Science components:

- programming - in ALGOL (and later Pascal), 6800 assembler, PDP-I1 assembler, and COBOL;
- software engineering;
- computer organisation and operating systems,

as well as:

- information systems;
- and a choice of four out of the five ancillary subjects.

In the late 1970s the course took 55 full-time and 25 part-time students. There were no major revisions before Woodhouse moved on and the new professor was appointed in 1985.

The development of this course was a most significant one: it was the first course of its kind at a university in Victoria, (the Graduate Diploma in Information Science at Monash notwithstanding) and despite the name 'Computer Science' was really, in many ways, a course involving a good deal of business computing. Woodhouse does not believe that he was under any external pressure to develop the course in the way that he did, he just believed that it was 'a good thing' to consider the employability of his graduates. Arthur Tatnall completed the Graduate Diploma in Computer Science in 1980.
Melbourne University

Computer Science began to be taken seriously at Melbourne only after the arrival of Peter Pool in the mid 1970s. In the early 1980s the Department of Computer Science, under considerable outside pressure, introduced a COBOL course to make its students 'employable' (Wilde 1992). While Wilde was completing his MSc at Melbourne, the Computer Science Department also introduced a Systems Analysis course, as it "just happened to have a staff member able to teach this" (Wilde 1992). These minimal concessions to the 'real world' were, according to Wilde, introduced only under pressure and because the department fortuitously had staff able to do it. Melbourne University seemed to be still disinterested in teaching about the commercial uses of computing and so contributed little to this area. The University has, however, looked at building computing tools for use in commercial situations and the Titan Database System (mid-1980s) is an excellent example of this. The algorithms used by Titan were developed by researchers at Melbourne and a company then set up by the University to commercially develop and market the product.

Wilde recollects Peter Thorn (from Melbourne University) saying in the early 1980s that he saw "the imminent demise of Melbourne's Graduate Diploma in Computer Science as it was not attracting students" (Wilde 1992). The CAEs had cornered the market in business computing and Melbourne was not really interested in this area anyway, apart from the teaching of several computing subjects in the Faculty of Commerce.

Deakin University

In 1980 the Department of Computing and Mathematics, in the Faculty of Science at Deakin University introduced a Graduate Diploma in Computing. The course was designed "to provide data processing and computer studies for graduates from disciplines generally considered to be outside the ambit of Information Systems or Computer Science courses." (Deakin University 1992). Its main stated objective was to provide these graduates with an opportunity to become professionally qualified in the computing field. Rather like La Trobe University's graduate diploma, the Deakin course consisted of a combination of subjects which could be described as computer science and business computing. The course was also extremely important in being the first to be offered in off-campus mode.
TAFE Courses in Computing.

As well as the more well known technical colleges like Caulfield, Melbourne and Footscray, Juliff (1990) recollects computing courses in the 1970s at places like Box Hill Technical College, Preston Technical College and Moorabbin Technical College. In the late 1970s, Juliff took class in *Data Processing Fundamentals* at Moorabbin on one morning each week. When the colleges split into secondary and tertiary components, however, the influence seems to have been all in the one direction: tertiary towards TAFE. There was no influence on tertiary computing courses from courses at Footscray TAFE (Belcher 1992), at Swinburne TAFE (Wilde 1992), or at RMIT TAFE College (Montgomery 1992). In the case of Caulfield Institute, a number of computing courses, such as the *Operators and Coders Certificate*, were taken over by Holmsglen TAFE, but there is no evidence of influence from TAFE on tertiary courses in computing (Juliff 1990).

Computing Courses in Secondary Schools.

In the early 1970s a small number of computers began to appear in Victorian Secondary Schools, often resulting from the exposure of certain teachers to computing during their university courses. These machines: typically small minicomputers such as the PDP-8 were expensive, difficult to use, and not very powerful. They were usually obtained by the school's mathematics department and were used solely for programming mathematical applications. Business computing was definitely not something that was given any consideration. The arrival of the Apple // in 1977 saw the beginnings of the real changes in the way schools used computers (Tatnall 1992: 209).

Right from the start, Education Ministry policy makers saw multiple roles for computers in schools. Somewhat in advance of the other states, in the late 1970s the South Australian Education Department had a policy on 'School Computing Activities' which, in part, stated that:

- computing is an object of study in its own right;
- computing provides the means of enhancing and extending traditional components of the school curriculum;
computing and related technology have the potential to change the curriculum, the manner in which that curriculum is implemented and to improve the general organisational procedures used by schools." (Shears & Dale 1983: 46).

When set up in 1983, the Commonwealth Schools Commission's National Advisory Committee on Computers in Schools (NACCS) reiterated this view. Nevertheless, this multiple aspect of computing in schools has caused a great deal of tension over the years, and has had a considerable effect on the study of the discipline of computing at the senior Secondary School level (Tatnall 1985).

In 1981, after several years of effort by academics including Peter Juliiff, Tony Montgomery and Gerry Maynard, Computer Science was first offered as a Higher School Certificate (year 12) subject in Victoria. Most of the pressure to introduce this subject came from outside the Education Department, and secondary school teachers had little involvement in determining its nature or content.

"The public: parents, students and employers, readily accepted HSC Computer Science, and student numbers taking the new subject increased rapidly. In its first year, 120 students from 10 schools studied Computer Science, but this number increased by over 50% in each of the next five years before making a slower increase to over 2200 in 1991 (only a little smaller than Geography) with virtually every secondary school in the state offering the subject." (Tatnall 1992: 224).

Melbourne and Monash university's rejected the new subject, not allowing its inclusion in admission scores for their courses. Their stated reason for this was based on the low proportion of the assessment allotted to the formal examination\(^{22}\). When pressed, several academics from these institutions admitted that they considered the subject of little serious academic worth, and "not an appropriate subject to study at a secondary school level". (Another parallel with Geography in Britain which, after gaining recognition itself, was less than generous in granting it to related areas such as Environmental Science.) Deakin University, La Trobe University, and the CAEs, however, quickly accepted HSC Computer Science as a valid study (Tatnall 1992: 224).

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\(^{22}\) 35% was allotted to the external examination, 35% to school-based but consensus moderated option work, and 30% to practical work.
The Computer Science taught at a secondary school level may not have been sufficiently rigorous to satisfy Melbourne University, but it was still primarily based in the study of algorithms and did not involve much of what could be called business computing. Contrary to the findings of some of Goodson's work on the formation of new subject areas in England, there is no evidence that what went on at the Secondary School level in Victoria had any effect on tertiary courses in computing. Montgomery (1992) however believes that the year 12 course was worthwhile "as some people who will never do any more computing have been adequately exposed to the rudiments of computing: to using a computer effectively." (Montgomery 1992). One side-effect of the year 12 Computer Science course, however, is that it encouraged a number of computing teachers to consider a move to lecturing at the tertiary level. I can think of a number of such teachers including myself!

Timeline of Courses:

1950 - 1960  The period of early University courses.

The diagram illustrates the timeline of courses and interventions. The key events include:

The diagram also highlights the formation of CAE courses, TAFE courses, and PIT scheme, with a period of intervention by the Commonwealth.
Chapter 5:  
Re-inventing the Business Computer.

The question must now be asked why tertiary courses in business computing evolved as they did. No other curriculum area has developed so quickly, and there are few parallels for curriculum development so closely related to a specific technology, particularly one which is changing so rapidly. Courses in business computing are also most unusual in the degree to which they depend on technology, both for their raison d'être and for their delivery. They involve, in essence, the study of a particular machine and how humans can use this machine to assist in operating and managing their organisations.

In constructing a model to explain the growth of courses in business computing, I have drawn on ideas from a number of writers and particularly those of Ursula Franklin. Franklin (1990) suggests that the manner in which different technologies are introduced into society involves a number of stages: invention, growth, acceptance, standardisation and stagnation. She suggests that first of all the technology must be invented: created, but then the idea has to be sold so that the 'person-in-the-street' feels a need to be concerned with it. Franklin discusses the introduction of new technologies including the motor car, sewing machine and personal computer. She describes how the introduction occurs in a flurry of excitement, often accompanied by claims of how the new device will make our lives better or more exciting, or will alleviate physical labour or drudgery in the home. This excitement creates a feeling in people of wanting, or even needing access to the new technology. "In the course of this phase of youthful exuberance, technologies achieve broadly based entry into the public mind and the public imagination." (Franklin 1990: 96). People are now ready to try out the new machines.

As use of a new technology grows and becomes generally accepted, an infrastructure is built up to support it, and standardisation then inevitably occurs. Franklin describes the infrastructure necessary to support the use of the motor car and how its development led, in many countries, to a decline in infrastructures supporting rival technologies like the railways. Once set up, these infrastructures lead to standardisation, and so affect the uses that can be made of this technology, or indeed of previous technologies. Bigum (1991: 24), drawing on Franklin's
work, remarks on the importance of curriculum infrastructures in the adoption and use of computers in education. He suggests that in schools, these curriculum infrastructures have been largely directed at making the curriculum fit the computers rather than the reverse, and that students have thus had little chance of influencing curriculum development. Something similar probably also happens in the adoption of other technologies in other areas.

Franklin suggests that in the final stages of standardisation, the technology and its supporting infrastructure become institutionalised and stagnation then occurs. When this happens, any further improvements in the technology are marginal and the users become completely dependant on its existence, so loosing the choice of whether to use it or not.

Despite being proposed to explain the slow evolution of new subject areas, Layton's three stage model, described in Chapter 2, also has some relevance here. Layton (1972) describes the first stage of curriculum development in which enthusiastic teachers bring "missionary enthusiasm" to their task, and justify the new subject on grounds of "pertinence and utility". Evolution then occurs into a second stage where a tradition of "scholarly work" emerges and trained teachers take over the delivery of the subject. Greater thought is given to the selection and organisation of subject matter so that this is consistent with the "internal logic and discipline" of the new subject, rather than just being useful. In Layton's third stage complete standardisation, even approaching stagnation, occurs. Subject content is now determined largely by specialist scholars, not on the basis of its utility, and the students have no choice but to meekly accept this.

As discussed in Chapter 3, in describing the socio-technical interactions which have taken place in the evolution of courses in business computing, I also drew on the work of Latour (1991), who argues that we should abandon the dividing line between technology and society and then treat the contributions of human and non-human actors no differently. In constructing a model to explain how courses in business computing have evolved, both people and the computer technology itself are considered to play important parts so, in line with Latour's suggestion, human and non-human actors are given the same status.

In attempting to build a model to explain how courses in business computing developed, an initial attempt was to propose one relating the following elements:

- computer technology;
- invention of educational need;
- growth of courses and educational infrastructure and;
- stabilisation of courses,

within a societal context. These elements can be represented as a sequence:

![Diagram showing the cycle of social context, technology, invention of educational need, stabilization, and growth of courses.]

Although overlapping, these elements form a cycle, but the really unique thing about education in business computing is that this cycle repeats over and over again as new technology is developed or new needs arise. Furthermore, a significant characteristic of each cycle is that in the process of starting out again, it retains little memory of earlier cycles.

A study of the curriculum history of business computing reveals that a complex interrelationship existed between computer technology, educational needs, and the development of curricula. Part of the reason for this complexity is the rapidity of the changes in available computer technology that occurred during this period. These rapid changes, and the relative slowness of the educational response, caused considerable tension in the tertiary institutions offering courses in business computing as they geared to move from mainframes to minis to micro-computers, from punch-cards to terminals, from the use of magnetic tape to magnetic disk, or from O&M to systems analysis. The frantic speed of development led to the culture associated with computing not being taken seriously enough, with the
result that there was often a need to re-invent concepts in each new cycle, sometimes accompanied by a repetition of earlier mistakes.

Before discussing the cycles though, the broader social conditions in which the computer technology developed should be acknowledged. It would be a mistake to put undue emphasis onto computing courses, or the computing hardware itself and not enough on the social interactions involved in their creation and use. Franklin reminds us that technologies arise out of a particular social structure and are grafted onto it. "What needs to be emphasised is that technologies are developed and used within a particular social, economic, and political context." (Franklin 1990: 57). She goes on to say that they then work on the social structure in ways that we may not be able to foresee. She warns that many of the technological systems we have developed are "basically anti-people", and that people are often seen as "sources of problems while technology is seen as a source of solutions." (Franklin 1990: 76). Katherine Hayles (1990: 271) also proposes a model with a feedback loop linking culture, technology and theory, which while contributing some useful ideas, I found less useful than Franklin's.

In working towards the cyclic model proposed, and seeing how each of its elements interrelate, I will begin by examining each of these elements in turn.

The Technology

Franklin proposes that any technology is a system and so consists of more than the sum of its artefacts: more than the wheels, the gears, and the transistors. She suggests that technology entails "organisation, procedures, symbols, new words, equations, and, most of all, a mindset." (Franklin 1990: 12). There is no reason to suppose that computer technology has developed in a way different from that of other technologies.

In thinking about computing technology, the most obvious part is the central computer hardware itself: the mainframe, mini or microcomputer. This is certainly important, but not uniquely so as input and output devices have, perhaps, had a more important impact on the way people are able to interact with computers. While the only way of inputting data or of running a program was by the use of punched cards, many potential users were disenfranchised. The terminal with its keyboard and screen provided a much better user interface and made computers much more useable. Similarly, computer 'printout' on standard continuous printer paper coming from a line printer, is much less acceptable for a business report
than one produced on normal A4 paper by a laser printer. To most people, these
are more important considerations than the configuration or age of the often
unseen machine on the other end of the system.

Early computers had, in today's terms, a quite crude user interface but there were
reasons for this. When using a microcomputer now, vastly improved interfaces
such as that of the Apple Macintosh and Microsoft Windows are available, but
there is a tendency to forget that such interfaces are only possible because of the
relatively high processing speeds and large memories of our present generation of
microcomputers. Even big computers of the 1960s had nowhere near such power,
and would have been totally unable to provide the ease of use of today's micros.
As technology developed to produce faster, cheaper computers with larger
memories, so too did the user interface. The terminal represented a considerable
improvement over the punched card: it was easier to see what you were doing
when your typed program appeared on a screen rather than a card. Another
improvement was the transfer of control back to the user. With terminals, and
later micros, there was no need to have someone at the computer centre enter
your work for you, and turn around time was also very much less.

Computer software is also of great importance as a part of computer technology.
The word processing package is without doubt the most widely used piece of
computing technology in the world today, but it is the software package, rather
than the microcomputer it runs on, that is the critical ingredient. But the word
processing package is a very recent phenomenon. It is hard to imagine many
businesses being seriously interested in generating client letters from punched card
input, and although text editors were available on minicomputers in the 1970s,
few people thought seriously of using them for writing. It required the improved
user interface and relatively low cost of the microcomputer to make word
processing generally accessible.

Other important aspects of changes in computer technology include the
development of systems analysis and design, and structured programming
methodologies in the 1960s and 70s. Each of these brought changes in the way
people used computers.

Invention of a Use and an Educational Need
Once the new computers existed in a useful form their potential for use in
government and commercial organisations had to be justified, but as Franklin
suggests, in the excitement accompanying the creation of a new technology justifying a need to use it is not difficult. In the 1960s, many claims that today seem far fetched, were made in an attempt to sell the need for business to use computers. They would reduce cost, improve efficiency, give everyone more spare time, and generally improve everybody's quality of life, it was claimed. Often the claims were couched in terms that implied that businesses not using computers would soon loose their competitive edge and cease to exist. People just did not really know exactly how the computers could be employed, and so used their imagination. When the microcomputer first appeared, a similar attempt had to be made to sell the need for such devices in the home, office and school. Magazines of the early 1980s are full of suggestions for writing BASIC programs to balance your cheque book, track your physical fitness, read your biorhythms, or store your recipes. These ideas seem silly today, but they were seriously raised at the time in an attempt to justify a need. When it was clear that use of the machines could be justified, a need to educate and train computing professionals in the use of this technology was quickly invented as there was little point in having the machines if no one could use them. In the excitement of the time, a need for education in the use of computers would have seemed self-evident.

Growth of Courses and Educational Infrastructure

For growth of courses to occur there had also to be the growth of an educational infrastructure. This infrastructure consisted of physical computing resources, including central support facilities, technicians, and laboratories in the tertiary institutions. It also consisted of journals and library books - although in the early days few of these even existed, and an academic infrastructure of syllabuses, course and teaching materials, and course advisory committees.

This infrastructure was important as it affected the way in which subsequent developments could occur. Franklin (1990) cites construction of the parkways in New York State, where the bridges and underpasses were built in such a way that only private cars, and not buses could use them. This construction also had subsequent effects on who could enjoy the parkland and its public amenities as it was the poor and the blacks who used the buses and were disenfranchised.

Once an infrastructure has been set up it is difficult to change or dismantle it. When Caulfield Institute of Technology had developed a significant infrastructure to support the use of punched card input devices to its computers in the early 1970s, it was most reluctant to consider an early move to the use of terminals
requiring a completely different infrastructure. The move from using terminals to
micros required a similar change in educational infrastructure. In a sense we can
consider these infrastructures as competing with each other and sometimes
inhibiting the movement to a new cycle.

Stabilisation of courses
During the growth period courses undergo almost continuous development but, in
time, a stage is reached where stabilisation begins to occur. A number of factors
led to courses stabilising, perhaps the most obvious being the passing of time. At
the early stage, much effort goes into curriculum development as people are trying
out new things and 'playing' around with the technology. In time however, this
becomes unnecessary. Another factor pushing courses towards a stable form is the
influence of external constituencies, particularly professional organisations like the
ACS. Although not possible in the early stages, when things settle down, model
curricula are developed and become readily available.

Another factor which tends to move courses towards stabilisation is the need felt
amongst academics and students for the improved status for their subject. The
battle for disciplinary status that all forms of computing have faced has been
alluded to on several occasions. This perceived need means that curriculum
developers are much more open to suggestions offered by the designers of model
curricula, particularly if these also offer recognition of courses by the recognised
professional body. Although there is little evidence of it happening as yet, perhaps
the culmination of this stage is the stagnation alluded to by Franklin.

Repeating cycles
The really interesting part of the system though, and one that must be unique to
an area involving rapidly changing technology such as computing, is that after a
few years a new generation of computer hardware emerges, a new methodology is
developed, new demands are made on educational institutions, and the cycle
recommences: course developers forget much of its history and start again, largely
from the beginning. There have thus been a number of cycles of business
computer education, similar in that they were each aimed at the education of
computing professionals, but different in the way they tried to do this and in the
technology they employed. Each cycle was triggered by some significant event
such as a change in computer technology or, as I will argue, a change in
educational need.
The exact composition of each cycle is, of course, open to much debate. I have introduced the concept of a trigger to start off each cycle, of which I propose that there have been five in computing education. Later in this chapter the model is tested by mapping the curriculum history of business computing onto these cycles.

<table>
<thead>
<tr>
<th>Trigger</th>
<th>Approximate Starting Date</th>
<th>Cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Invention of accounting machines</td>
<td>1930</td>
<td>→ Accounting Machines Cycle.</td>
</tr>
<tr>
<td>Invention of Electronic Computers</td>
<td>1950</td>
<td>→ University Computing Cycle.</td>
</tr>
<tr>
<td>Invention of the microcomputer</td>
<td>1980</td>
<td>→ Microcomputers Cycle.</td>
</tr>
</tbody>
</table>

While the start of some cycles was due to advances in technology, this was not always the case. The most important events in the development of courses in business computing: the need of the Commonwealth Government for computer professionals in the early to mid 1960s, and the creation of the Colleges of Advanced Education in the late 1960s, were not directly related to changes in technology. I have thus modified the previous model to take account of this. The new model then, unlike the first which presumes that each cycle begins with a change in technology, is initiated by a trigger which can either be a significant change in technology, or in educational need. The concept of a trigger is used to suggest something sufficiently dramatic as to causes a move from one cycle to the next. Each cycle now looks like this:
The model is composed of five of these repeating cycles. In each case, the cycles overlap in time, some by a considerable amount, meaning that the start of a new cycle did not necessarily mean extinction of the earlier cycle. New cycles are triggered by some significant event such as the rise of a new technology, or of a new educational need. In Franklin's terms, a trigger could be considered to have something in common with the rise of a "competing technology". The comparative simplicity of the model should, however, not be taken to imply that the process was either linear, or as straightforward as may appear to be suggested, and the system was far from being one closed from societal influences. The series of cycles could now be pictured as follows:

To test the model and to develop it further, I will next proceed to map the course data that I have collected, onto each of the cycles.
1. The Accounting Machine Cycle.

The first important 'computer education' cycle could be consisted to be that relating to the punch-card operated accounting machines. This cycle began with the growth of use of the accounting machine in the 1920s and 30s, before the advent of the electronic computer, and continued well into the 1960s. It is of interest here mainly as a 'pre-historic' cycle representing the beginnings of an early form of business computing.

The Trigger
Going right back, Babbage first introduced the idea that a (mechanical) computer could be used to solve a specific problem: the construction of navigational tables. No other business uses for his machines were then envisaged so this could not be seen as a trigger (or at least not as a direct trigger) for this cycle. Hollerith, building on Jacquard's technology contributed a method of making business data amenable to handling by machine, and Hollerith's punch-card operated Tabulating Machine was the trigger which was to lead the way, both technically and by example, into the use of punch-card operated accounting machines in business.

Invention of Need
DeLamarter (1986: 15) reports that in the 1920s and 30s, as the US economy expanded so did the need for accountants, and their salaries quickly became a significant business cost. IBM was able to successfully exploit this situation to sell its accounting machines by convincing many businesses that by using its machines they would be able to reduce these tedious accounting chores and also the ever increasing need for more accountants. IBM was then easily able to argue to these organisations that they also needed assistance and training in determining how to make best use of their new accounting machines. An educational need was thus invented.

Growth
The widespread adoption of the accounting machine by businesses, including banks and insurance companies, was propelled largely by IBM's commercial muscle but also by a growing understanding of the business advantages of 'automatic' data processing. Organisations were coming to see the commercial advantages of quick and accurate accounting methods, able to be performed without the need to employ large numbers of people.
The first courses in the use of accounting machines were offered by the suppliers, and it was not for some years that tertiary education was to get into the act. Tertiary courses in the use of accounting machines introduced students to concepts such as the formal analysis of problems using techniques such as those of Organisation and Methods. They also introduced the concept of programming and prepared the ground for later computing courses. Until the late-1960s Caulfield Technical College was still offering courses on punched card systems and accounting machine applications, and Swinburne continued teaching such courses into the early 1970s (Adams 1992).

The real importance of courses in the use of accounting machines to later courses in business computing was not so much the technology itself, but its contribution to the way that business was to see possible uses for this technology, and to establishing that such courses could appropriately be offered in tertiary institutions. An infrastructure of machines, support services, and curricula was in place well before the 1960s and by then, courses were becoming quite stabilised, arguably to the extent of stagnation.

Stabilisation
Although accounting machines continued to improve during this period, changes in the technology were relatively slow, allowing courses to stabilise. Stabilisation of courses in the use of accounting machines can be seen in documents like those of the British National Computing Centre (NCC), dating from as recently as the late-1960s. The rapid adoption of the electronic computer by business in the 1970s saw the equally rapid decline of the accounting machine and the end of this cycle.

2. The University Computing Cycle.

The first cycle in computer education proper began with the availability of the early mainframe computers in the universities of the 1950s. While this had little relevance, at the time, to business computing, it did lay the way towards the establishment of the discipline of computer science, and it raised in the minds of a number of people the possibility of using computers in business.
The Trigger
The universities were the first organisations in Australia to acquire computers, and soon after these machines became available for general purposes in the mid 1950s, courses were needed to train people in their use. As already discussed, the motivation of the universities in offering these courses was quite practical, but more internally than externally oriented. Academics within the universities were interested in seeing what they themselves could do with the new machines and needed some training in this.

Invention of Educational Need
There is no available evidence to suggest that companies like IBM took an active part in convincing Australia's universities of the advantages of using computers or of the need to offer courses relating to their use. Invention of educational need probably derived from two different directions, from potential users in departments of statistics and the like, who knew little of computers but had heard of others using computers and wondered whether perhaps they also could profitably make use of these machines. The other direction would have been from academics who had become fascinated with the machines themselves and wanted both to find out more and to encourage the use of computers.

The cost and the level of technology in these early machines was such that they were not highly suitable for general or business uses. There was no software as we know it today and so these machines could only be used by those able to program them directly. To use a computer at all, the user required a knowledge of the programming techniques applicable to the specific machine so the need for education in their use was quite clear. Computers at this time were very expensive machines and were designed mainly to perform scientific calculations, not having the storage or memory capacity to handle masses of business data. These university courses were thus certainly not geared towards business needs.

Growth of Courses
The early courses reflected this bias and were run in the universities mainly to satisfy the needs of their own users. Most courses were mathematical in nature and in many cases were initially offered by departments of Mathematics until separate departments of Computer Science (or Information Science) were set up from the early 1960s and infrastructures of university Computer Centres were developed. Before long, the university computer centres were removing the need
for other departments to retain the mechanical and electric calculating machines they had previously used for mathematical and statistical purposes.

These first university courses had titles like: *The Theory of Computation, Computing Practices, and the Theory of Programming* (University of Sydney, 1947); *Numerical Methods and Computing* (University of Melbourne, 1959); and the *Diploma in Automatic Computing* (University of Queensland, mid-1960s). Growth through the 1960s and 70s was continuous, but not rapid. University courses did continue to evolve over this period, but moved towards stabilisation during the late 1960s and early 70s.

**Stabilisation**

It is tempting to suggest that these courses stabilised to the extent of entering Franklin’s stagnation stage, but this would be something of an exaggeration. University courses did continue to evolve slowly over subsequent years, but this evolution took them down the road towards computer science and not towards business computing. As a newcomer to universities, computer science suffered from a similar fate to the case, already related, of geography and biology in the UK. It was sometimes claimed, particularly by those in university mathematics departments, that there was no *discipline* of computing, and that the area had nothing fundamental to offer, being purely a utilitarian, vocational subject that was just an amalgam of parts of maths, physics, engineering and accounting.

Almost 100 years ago, Mach noted that "the first real beginnings of science appear in society ... when the necessity for the communication of experience arises." (Mach 1898: 81). Mystery surrounding the powers and possibilities of the early computers created a need for the communication of experience about what these machines could *actually* do. Like engineering, computing suffers from having practical possibilities, and this has made the quest for the status of a *discipline* much more difficult. A consideration of the relationship between science and technology is thus particularly important in an area like computing. Franklin questions the view that science is a prerequisite for technology, or that a hierarchical relationship exists between them. "It is more appropriate to regard science and technology as one enterprise with a spectrum of interconnected activity than to think of two fields of endeavour - science as one, and applied science and technology as the other." (Franklin 1990: 38).
Recollecting the problems faced by Bennett at Sydney University in 1964 in convincing his colleagues that academic staff in computing had "adequate qualifications", and that computing courses were not "merely vocational material", it is not surprising that university computing courses quickly underwent stabilisation towards greater academic rigour. But academic pressures of this type prevented university departments of Computer Science from showing any interest in the more utilitarian business computing.

3. The Commonwealth PIT Cycle.

Without the intervention of the Commonwealth during the 1960s, courses in business computing would still have developed, but they would have developed differently, and at a considerably slower rate. The influence of the Commonwealth is important in three major ways: the 'guidance' offered in the design of courses by the model of the Programmers-In-Training scheme, the personnel who moved from the Public Service to the CAEs, and the creation of the CAEs themselves as institutions with a more practical emphasis than the universities.

The Trigger
In the late 1950s the Commonwealth government began to seriously investigate the administrative use of computers. As previously related, in 1958 Ovenstone was appointed Controller of Automatic Data Processing in the Department of Defence, and in 1959 Shaw was sent on an overseas fact-finding trip to investigate the use of computers in government. The needs of the Commonwealth, rather than changes in technology were thus the main spur for the beginning of the next cycle: the beginnings of education in business computing as distinct from computer science. Worldwide, the business use of computers was taken up rapidly and by 1964, 80% of all computer time in the US and UK was used to process business information (McRae 1971). This rapid acceptance was due to the earlier use of accounting machines but also to people having previously thought through the concepts of business data processing. Perhaps also, as Bailey (1992) suggests, it was because people had previously performed the act of computing, and so were more prepared to trust the machines to do this work.

Invention of Educational Need
In Australia, the needs of the Commonwealth for computer professionals led to it commencing its own Programmer-In-Training courses in the 1960s, the running
of which was later taken up by the CAEs. The invention of a need for courses to train computer professionals for positions in Commonwealth government departments occurred readily following the work of people like Ovenstone. Once the Commonwealth had decided to embark on the Defence and PMG Computing Projects, it had a clear need to train or locate professional staff. There was no possibility of 'importing' already trained staff from overseas, as was done to fill a short term need for secondary school teachers in the early 1970s: other countries were in no better position. Staff training thus had to take place in Australia, and the universities were the obvious place for this to be done. Unfortunately, with the problems of the low academic status that computing then faced in the universities and the consequent move towards stabilisation and increased rigour of university computing courses, university Departments of Computer Science were not interested in taking on what they saw as 'vocational training'. As a result, the Commonwealth had no option but to conduct the PIT courses itself.

**Growth of Courses**

The Commonwealth began conducting twelve week courses in Automatic Data Processing in 1960, and PIT courses in 1965. The courses quickly developed a formal syllabus and an infrastructure for their delivery, and were run for the primary purpose of providing computer professionals to staff Commonwealth (and State) Government Departments. Many commercial organisations could nevertheless see the quality of the students coming out of the Commonwealth PIT courses and later even sponsored some of these trainees themselves. The Commonwealth had set the ball rolling in business computing.

Looking at it in a slightly different way, Franklin suggests that since the Industrial Revolution, governments have needed to provided a support structure for the growth and development of new technologies, and that "Arranging to provide such infrastructures has become a normal and legitimate function of all governments." Franklin (1990: 66). With hindsight, the role of the Commonwealth could well be seen in this light as providing, or at least sponsoring the major support structures (including education itself) so that business could make best use of information technology. It is however, highly unlikely that the Commonwealth acted as it did specifically with the aim of assisting business.

Courses did not just grow up in isolation as business computing owes something to a diverse range of areas. Maynard (1990) describes how, when PIT courses started, phases were taken from the building construction industry. It was also
influenced by the adoption of problem solving techniques from engineering: techniques originating in the building of the Erie Canal. The adoption of the techniques of systems analysis, largely refined by the US government, is a good example of one of these 'non-computing' inputs. Inputs to business computing courses from accounting, business management and engineering were also important, and it is only fairly recently that computing has taken an approach of its own in the development of its own methodologies. In designing systems in the 1960s "there were no fancy methodologies, they just talked to users and found out what they wanted." (Juliff 1990). PIT Systems Analysis courses were of interest to officers from many parts of the Public Service and became an important aspect of Public Service professional development.

Stabilisation
The Commonwealth run PIT courses quickly stabilised in structure, continuing through the 1960s. In a sense they ended in 1970, when the Commonwealth Public Service Board handed over their operation to the newly created Colleges of Advanced Education. Unlike the other cycles, the PIT cycle thus had a quite definite starting and finishing time, but then moved smoothly into the next cycle: the CAE Cycle.

4. The CAE Cycle.

The University Cycle continued during the PIT Cycle and eventually led to the computer science courses we have today. Computing courses in the PIT cycle, whilst relating very much to business computing, were not offered by the tertiary education sector, but directly by the Commonwealth. Although some of the Technical Colleges (notably Caulfield) had offered courses in business computing in the 1960s, it was not until the CAE cycle of the 1970s that business computing really took off and gained an important place in tertiary education.

The Triggers
Several things triggered the CAE cycle, firstly the Martin Report leading to the transformation of the Technical Colleges into much higher status Colleges of Advanced Education, and secondly, the transfer of the Commonwealth PIT scheme to the new CAEs in the early 1970s. While the Victorian Technical Colleges of the 1960s were highly respected institutions, they were seen as being several steps lower in importance and in status than the universities. The Martin
Report recommended making the new CAEs equal to but different from the universities and while this later led to some problems in the CAEs, it did mean that they were given a much higher status and academic credibility than previously.

Clearly these two triggers are linked. The Commonwealth had always been keen to have training in business computing offered by the tertiary sector and it was only because the universities were not prepared to offer these courses in the 1960s that it had taken on the role itself. After the Martin Report endorsed the applied / vocational role of the Technical Colleges in setting up the CAEs, it became possible for the Commonwealth to devolve courses in business computing to the CAEs. The crucial trigger is thus the Martin Report.

Growth

In 1970 the course infrastructure set up to offer the Commonwealth PIT courses was transferred to the new Colleges of Advanced Education which, with their more practical bent, were much more keen to adopt these courses than had been the universities. These courses were new and did not replace any existing courses, but, fortunately, came at a time when the CAE sector was expanding.

While being aware of the dangers inherent in a great man theory of history, in the case of business computing it does seem clear that several important individuals did play a significant part, particularly in the CAEs. The three wise men coming from the Commonwealth Public Service Board to Caulfield and Bendigo Technical Colleges, and to RMIT had a large effect on the direction taken by courses in these institutions perhaps not in triggering this cycle, but certainly in affecting the way it developed. They also had a considerable, indirect influence on other business computing courses around Victoria. Computing is noteworthy in the relatively small number of people involved. Even today, it is still possible to go to a computing conference, perhaps one run by the ACS, or a computer education conference, and to know many of the other people attending. Even more so in the early days, the community of interest was small, and with the added difficulties of working in a completely new field, it is not surprising that those involved talked to each other.

The movement of these key personal from the Commonwealth Public Service to tertiary institutions around Australia, but particularly in Victoria had another important effect. The fact that these, and many other staff coming to work in the
new Colleges of Advanced Education, had a background of working in a 'real' environment, rather than coming up directly through academia can be seen to have contributed to the outward-looking nature of their courses. Having a good idea of the needs of business, these people were concerned that students completing their courses could be usefully employable upon their completion, rather than having the more abstract goal of ensuring that they had learned to exercise their minds.

Tradition in the universities, in most subject areas, has always been to appoint academics who had come from a background in which they first completed a higher degree, then took a tutoring position, before eventually moving up to becoming a lecturer. Tradition in the CAEs, the former Technical Colleges, was quite different, with many more staff being brought in from industry. These staff were certainly not academics in the traditional university sense: often they did not have higher degrees, or in some cases, any degrees at all. It is thus not surprising that the early courses they developed had a practical, rather than an academic flavour.

It has already been related that manufacturers did have some early influence on courses, although mainly just through the choice of their particular type of hardware and the consequent need to teach the corresponding software. Perhaps what is more important though is the comment made by Juliff that Caulfield felt that they should teach using the same type of machine as their major 'clients'. Juliff relates how he "grew up with consultative informal groups from industry and the Public Service: people like Eric Myer from National Mutual." (Juliff 1990). He remembers that there was always a particularly large involvement from the Public Service in courses at Caulfield. "Jack White had come from the Commonwealth Public Service of course, and so had Gerry Maynard. Gerry had been running PIT courses in the Public Service for the Board when Caulfield 'pirated' him to do the same here." (Juliff 1990).

Another side to this relationship with industry was the setting up of training centres such as the Pearcey Centre at Chisholm, and Technisearch at RMIT. Pearl Levin (1991), then Director of the Pearcey Centre, suggests that Caulfield set up the centre in the mid 1970s for several reasons. They were certainly concerned to try to fill an industry need for computer training in the form of non-academic short courses, but also saw the financial benefits of doing so both for the Institute itself, and for the staff involved in delivering the courses. This was widely
regarded as an easy way in which staff salaries, considered low in comparison to what could be earned in industry, could be supplemented. Another reason for setting up the centre was the need to facilitate the consulting and research opportunities for computing staff at Caulfield. Levin describes the use of the Pearcey Centre to maintain the good connections between Caulfield and the business sector, as most successful. The Pearcey Centre also offers a Certificate of Computing (which now comes out on Monash letterhead) to trainees who have completed 180 hours of training: 6 short courses each of 30 hours.

A further aspect of industry involvement in tertiary courses in computing, is that of the military. In Australia, most of this involvement was through the Commonwealth Public Service Board, but it must be remembered that the first push came from the Department of Defence. As far as business computing is concerned, the link is with the administrative needs of defence, rather than with the design of weapons, however another interesting connection is with the Weapons Research Establishment at Salisbury. Although it is difficult to obtain information on what research in computing, or of the use of computers was done at Salisbury in the 1950s and 1960s, it is known that a number of the important actors in this story (people such as Ovenstone, Overheu, Northcote, Dober and others) had worked there, even if only briefly. It does appear however, that this military influence was relatively less important in the Australian context than it was in America. Speaking of the situation in the United States, Douglas Noble writes: "I will suggest that education research has had less to do with education than with the human performance needs of weapons systems and other advanced technological systems." (Noble 1992: 190)

The 'utilitarian potential' of business computing, whilst it did not suit the universities, did fit in with the philosophy of the CAEs. Business Computing also had no rival to supplant or replace, except perhaps Computer Science itself. The difficulty later was in claiming that is also had 'intrinsic value ... as disciplinary training'. As far as the students were concerned however, the utilitarian nature of the courses was what interested them: they know they could get a good job upon completion. The work of Burgess (1984) and of Measor (1984) on student perception of the status of subjects (referred to in Chapter 2) is of interest here. There is no evidence that such considerations as discussed by Burgess deterred business computing students in the 1970s, although the situation has changed in recent years and academic credibility has gained in importance.
Infrastructure: Computer Technology

It is quite clear that the nature of the available computer technology has played an important part in the development of business computing courses, and this is well illustrated by the arrival of the minicomputer. In the early 1970s, the minicomputer came onto the scene and the computing world changed. Now it was possible for an organisation to consider the use of several departmental computers rather than just one enterprise-wide machine. In many organisations, dissatisfaction with the service offered by those operating the central machine, combined with the availability of this new technology, led to its adoption. The CAEs themselves also adopted the cheaper minicomputers for their own use leading to changes in their courses. While the availability of the minicomputer was significant, it could probably not be considered to constitute a completely new cycle.

The early minicomputers were still punch-card operated, but by the mid 1970s terminals had come into general use. In the days of punch-cards, computing was essentially a batch operation: students punched up a set of cards, or more often had someone else punch the cards up for them, and then put the cards into the machine to run. The result was that the program either worked or it did not. If it did not work, it was back to the drawing board to redesign the program, then to the card punch for re-punching, before finally re-submitting the cards to be run again. When the terminal became available, computing could be done on-line and debugging a program became a much less disagreeable task. It was now possible to type up a program, run it, correct any mistakes and re-run it, all from the terminal. This made a big difference to how computer programming was done, and so to courses in computing. The biggest difference though was to the educational infrastructure: computer laboratories were transformed from rooms containing one or two large punch-card machines to contain rows of terminals behind which sat earnest looking programmers. In Caulfield Institute at least however, the move to using terminals was delayed by the existence of a previous punch card based infrastructure (Juliff 1992).

Stabilisation: Credentialing in the Universities and the CAEs

I have already touched on some of the differences between the universities and the CAEs in the 1960s and 70s, but there was also an important similarity: both served as credentialing agents. Popkewitz (1987: 5) notes that the role of the university as a credentialing agent "for both knowledge and people in society" emerged in the United States in the late 18th and early 19th century. In the case of
computing however, at least in the CAEs, it seems to have been a need for knowledge and training rather than a certificate, that motivated people to take courses. Today, many professional societies: doctors, engineers, and accountants to name just a few, act as gatekeepers to the professions. This is not really the case with computing, probably largely due to the acute shortage of people trained in this area, and the necessity for employers to take the best they could get, qualified or not. The ACS believes it is likely that as the shortage lessens in coming years it will be able to exercise the same control on entry to the profession of computing that other societies now exert on entry to theirs, but this has not been the case up to this time.

Popkewitz suggests that in the United States before the Industrial Revolution, universities considered that their major function was to prepare the elite for their 'station in life'. They were also concerned with "defining what the society was to value as its sacred knowledge." (Popkewitz 1987: 13). Around the turn of the century, American universities adopted the provision of education for the professions in the belief that practical knowledge could provide a foundation for corporate development. It was also thought that "useful knowledge was necessary for an enlightened citizenry." (Popkewitz 1987: 13).

Melbourne University however showed considerable reluctance to take on courses involving too much 'practical knowledge', at least in the case of computing. Monash was rather less reticent, but the difficulty that Montgomery relates of finding an acceptable place for computing; "Is it a science, or is it engineering, or what?", indicate a tension here also. In Victoria, it was the CAEs that took on the role of providing practical knowledge to business, and given their relationship with business, this does much to account for why business computing went from strength to strength in these institutions.

**Stabilisation: The Influence of Professional Societies.**
The importance of educational constituencies (Cooper, 1984 and Ball, 1984) was discussed in Chapter 2. An important factor in the stabilisation of courses in computing from the 1970s onward has been the influence, in this manner, of the Australian Computer Society, and to a lesser extent its American equivalents.
The Australian Computer Society (ACS)

In 1966, the various societies of computer professionals which had been operating for several years in the various Australian states joined to form the Australian Computer Society. According to its Members' Handbook, the objectives of the ACS are:

- to extend as widely as possible the knowledge and appreciation of computing;
- to further the study, application and practice of computing;
- to maintain a Code of Ethics and minimum standards of knowledge for members of the Society;
- to promote and develop the competence of persons engaged in computing;
- to promote the formulation of effective policies on computing matters;
- to serve its members" (ACS 1986).

Both Maynard (1990) and Juliff (1990), however, comment that the ACS had little effect on tertiary courses until the 1970s. Juliff remarks that the ACS was fairly low key in those days, and that he became a member in about 1972: before that time he either didn't know about the ACS, or didn't think it worth joining. Maynard reflects that it was not until about the mid 1970s that the ACS started to take an interest in tertiary courses, thanks largely to the efforts of Bob Northcote from the South Australian Institute of Technology (SAIT)23. Applicants for the professional grades of membership of the ACS were required to demonstrate a certain standard of knowledge, gained on the basis of their academic qualifications as well as having practical experience of computing in a work situation. In order to facilitate this, the ACS needed to assess, and to offer accreditation to tertiary courses in computing. There was no reason why a tertiary institution must have its courses accredited by the ACS, but most did want this added recognition. On behalf of the ACS, Northcote set about the task of assessing the many computing courses submitted for accreditation. Maynard says that Northcote did an enormous amount of work for the ACS on that behalf, and largely on his own. He adds that, by comparison, the Institute of Engineers (Australia) "has got twelve people accrediting engineering courses" (Maynard 1990).

Not every tertiary institution was, however, happy with Northcote's assessment criteria. Adams (1992) conveys that the ACS (or perhaps Northcote) had a fairly strict view, carried through into the 80s, that ACS membership should be

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23 In the early 1960s, in common with a number of other prominent actors in this story, Bob Northcote also did some work at the Weapons Research Establishment at Salisbury. (Pearcey, 1988: 148)
restricted to computer science graduates, and his criteria for course accreditation reflected this view. Adams says that Northcote had "a typical computer science view that hardware and mathematics was what it was all about, and that Systems Analysis and the like were a side issue." (Adams 1992). The Graduate Diploma in Computer Studies offered by the Faculty of Business at RMIT, for example, could not obtain ACS accreditation. Adams says that "Bob Northcote was immovable, and was seen as an ogre by RMIT and some other institutions" (Adams 1992). He adds that Northcote's views did not really affect things much, and only a few institutions would have changed their courses just to get ACS accreditation. In most cases this was more of an issue in undergraduate than in post-graduate courses.

Montgomery (1992) suggests that the professional development seminars offered by the ACS to its members have also been important. Since its formation, the ACS has run such seminars, along with special short courses to enable members to upgrade their skills. In the 1970s, Montgomery recollects that a number of these seminars which related to commercial data processing were conducted, and "people from places like Monash, and the industry spoke at them. They were about the interface of computer science and commercial DP." (Montgomery 1992). He also believes that the development of a Code of Ethics by the ACS was a most important move in relation to business computing, as were the national ACS conferences that gave a forum for the exchange of ideas. Montgomery was also involved in ACS courses accreditations.

Overseas Societies
Peter Juliff (1990) considers that Victorian tertiary institutions were not really much influenced by events from interstate or overseas. He suggests that, in the 1960s and early 70s, courses grew up state by state with very little interchange of course material between the states. Others interviewed also agreed with this view. Similarly, there was not much overseas influence, in those early days, from organisations like the Association for Computing Machinery (ACM) in the United States, or the British Computer Society (BCS). Juliff notes that it is only in the last ten years or so that the ACS and the ACM have had any influence with the setting of model curricula.

In 1968 in the United States, the ACM first published recommendations for undergraduate programs in Computer Science, in a report called Curriculum
"68\textsuperscript{24}, and since then "has been providing updates to recommendations for Computer Science programs as well as recommendations for other academic programs in computing." (Turner 1991: 69). In the forward to a text on Systems Analysis, Couger & Knapp (1974) write that Curriculum '68 was widely adopted by tertiary institutions in the US. They went on to say that they had written this text, as the ACM committee (of which Couger had been a member) had been unable to find a suitable text on Systems Analysis and Design. The ACM did not get into Information Systems curriculum development until the early 1970s, with the publication in 1972 of its *Graduate Professional Program in Information Systems*. Another American society to offer guidelines in computing curricula is the Data Processing Management Association (DPMA), but its influence has only been felt in quite recent years.

Louis Fein however cautions on the dangers inherent in the multiple role in computing being attempted by the ACM. He notes that "like other sciences, our science should maintain its sole abstract purpose of advancing truth and knowledge. It is not clear to me that an organization can play simultaneously the role of a profession, of an industry, and of a science." (Fein 1967: 1). This problem is particularly acute in an area where technology is moving rapidly, as society is also shaping this technology and shifting along with the moving technology. Business also experiences this movement.

When asked whether he looked at what the Americans were doing when he was in the process of developing courses at Monash University in the 1970s, Montgomery declares that he did indeed give some attention to the computer science curriculum developed by the ACM, "with one exception and that was the section on commercial DP because the ACM curriculum did not address the objective we were trying to address, which was computer science for the comparatively small number who want to seek out knowledge, but information processing for the other 85%" (Montgomery 1992). He says that there was some information processing in the ACM curriculum, but not to the extent that Monash was trying to introduce. Neither Maynard nor Juliff mentioned having seen, or been influenced by the ACM curricula.

\textsuperscript{24} These programs had originally been outlined by the ACM in 1965.
5. The Microcomputer Cycle.

The invention of the microcomputer has done more than any other piece of technology to make the computer generally accessible. In tertiary institutions the micro caused fundamental change in computing courses: its low price and relative ease of use altered what was educationally possible. In the early 1980s, almost all tertiary institutions moved to using micros for most of their computing courses and it could be argued that both the University Cycle and the CAE Cycle merged with the new Microcomputer Cycle at this time.

The Triggers
This current cycle in business computing began with the arrival of microcomputer in the early 1980s. The general trend towards more, smaller, cheaper machines - begun with the mini computer - accelerated with the micro. In the late 1970s, microcomputers like the Apple II and Tandy were seen by most businesses as little more than toys. This attitude changed in the early 1980s, largely due to the entry of IBM into the field, but also to the invention of the electronic spreadsheet\(^{25}\). Other software packages soon also appeared, constituting the second part of the trigger to this cycle.

Invention of Educational Need
Soon the micro was being adopted at a great rate by business and the use of software packages was becoming extremely important. The low cost of the microcomputer meant that education using computers could now be contemplated in both tertiary institutions and in schools on a scale not previously possible.

The potential market for micros was much larger than that for earlier computers and homes and schools were now targeted as well as commercial enterprises and universities. As the micro became a mass consumption commodity it needed to be sold as such and advertising campaigns attempted to convince everyone of the need to own one. The marketing strategy adopted by Apple in selling computers to schools and universities would make a fascinating study in its own right. The marketing was quite brilliant in that Apple managed to convince education that it was not really the greedy multi-national after a sale that it actually is, but a company which was concerned with education. IBM, by comparison, was much less successful in the micro market but still did much to invent a need for these machines.

\(^{25}\) VisiCalc: initially written for the Apple II, then for the IBM PC.
Inventing a need for computer literacy was also given much attention, with people pushing this with near hysteria. The message was that in the future everyone would have to be able to use a computer to do just about anything. Some even suggested that anyone not understanding computers had no hope for the future. With a message as strong as this, if people had to be computer literate, the need for courses in the use of computers was self-evident.

**Growth of Courses and Infrastructure**

In the 1980s with the ready availability of the microcomputer, the number of courses on computing and the use of computers grew explosively. The widespread availability of software packages meant that the need for everyone to program computers had grown less, and courses began to reflect this. Micros and software packages also meant that the *end user* was now better catered for, and that it was possible to be a user without also being a computer professional. In line with this, computer use began to grow at an increasing rate in many 'non-computing' curriculum areas with the aim of educating these *end users* in how to use a computer rather than in understanding how the machine worked or how to program or develop systems or applications for it.

Some of the expensive infrastructure built up in tertiary institutions to support the teaching of business computing was now unnecessary. The need for centralised computing centres housing mini computers and supporting a large staff of computer systems officers and technicians was considerably reduced, but the number of microcomputer laboratories increased exponentially.

Maynard believes that, in general, courses that remain in business are degrading, both with reduced funding, and in content. Programming is getting lighter treatment and there is a reluctance to teach systems analysis and design. He suggests that the accounting influence has been a bit unfortunate and that it had held 'pure' computing back. "Maybe it will develop into computing studies - a tool specifically for accountants. There is a danger that it will do that. As money gets shorter, accountants don't get squeezed - they are the key people in a business faculty." (Maynard 1990) His advice to academics in computing today is to "get out of Business if possible into Information Technology. Computing is better in a faculty of its own. It is a discipline in its own right." (Maynard 1990). He suggests that most institutions are now looking at putting their offerings in computing together as a single group.
"Computer science started off in universities. Data processing started in the Technical Colleges, as they were at the time, with diploma courses that developed into degrees. Most courses started in Business, then some moved to Applied Science or other areas. If they stayed in business they tried to ensure they were a department in their own right. Two things are developing in the universities now. They have had computer science for some time, and the computer science people now are starting to introduce information systems courses, which could be good courses. The other thing is Computer Systems Engineering. These are good looking courses, but very much on the engineering side. They look at the computer, at chip making, etc. These are four year courses and both IE (Aust) and the ACS accredit them. IE (Aust) are also introducing 3 year engineering technology courses, and many computer people will then be able to qualify as engineers." (Maynard 1990).

**Stabilisation**

In recent years, a need has been felt both by academic staff and by students for the increased academic respectability of business computing. What had begun in the purely utilitarian need of the government and of large commercial organisations for computing professionals, began to develop into a significant discipline in its own right in the 1980s. There began to be considerable talk of the discipline of information systems, and lecturing staff moved to gain higher qualifications and to formalise the courses they offer. The Australian Computer Society continues to accredit tertiary computing courses, and in doing so, to exert a measure of control over their content.

Another factor just beginning to affect courses is the amalgamation of the CAEs with the universities, completed in 1992. Business computing courses at the new universities are already beginning to gain a different flavour as old courses are merged in the new institutions. In a sense then, this part of the Microcomputer Cycle also sees the end of the University and CAE Cycles as these old institutions now no longer exist.

It is likely that status was also an important consideration in the development of courses in business computing. In describing the growth of biology, Goodson
suggests that subjects seen as being utilitarian were given only low status, and that this was the fate of biology until Crick and Watson's work on DNA. The fundamental discovery that DNA, upon which all life depended, had the structure of a double helix which could then be investigated, raised the status of biology immeasurably.

Does business computing need a DNA to give it credibility? I suppose that you could suggest that the early interest of the Commonwealth government, and of large commercial organisations gave business computing all the credibility it needed in terms of importance, but not necessarily in academic status. Computer science has, after something of a battle, gained academic status as well as general importance, but business computing is still battling to be taken seriously in academic circles. Perhaps Systems Analysis or Data Modelling will be seen as the DNA of business computing. While teaching people how to use computers and application packages could be seen as no more than vocational training, the concepts of systems analysis, modelling of data, and representation of knowledge - all of which are now found in a typical business computing course, have much wider, deeper possibilities consistent with a discipline.

The Five Cycles.
Comparing the Cyclic Model with Layton's Three Stage Model.

As described in Chapter 2, Layton (1972) proposed a three stage model in attempting to explain the evolution of school subjects. While he was speaking of the slow evolution of school subjects, if I may paraphrase him slightly to remove this emphasis, his argument could be stated as follows. Firstly the new subject justifies its existence on grounds of 'pertinence and utility'. Then, as a tradition of scholarship begins to build up, it moves its ground in a search for greater rigour and academic status. Finally, specialist scholars, and professional societies, with established rules and values determine the selection of subject matter.

Elements of Layton's model could be applied to business computing, both overall and to each cycle. In much the same way that fractals, in chaos theory, display a deeper (but related) structure the more closely you look, there is evidence of Layton's three stages in the overall development of education in computing, and also at a closer look, within each cycle.

Looking at developments overall, courses in business computing certainly began with Layton's first stage. They were introduced for purposes of utilitarian need: to produce sufficient computing professionals to fill the needs of government departments, and large commercial organisations, not in an attempt to 'improve the minds' of its students. The introduction was largely pragmatic. The earlier introduction of computer science had similarly been pragmatic, but by the time that an interest in business computing began to develop, computer science had moved down the road towards academic respectability: Layton's stage 2.

Exactly where business computing should currently be placed in Layton's stages is a matter for some conjecture, but it would appear that it has at least moved through his second stage, and is maybe now entering the third. Perhaps relating to an increased interest in the ACM curriculum guidelines in the 1980s, but probably beginning a little earlier for reasons that need to be further investigated, there certainly appears to be evidence that academics have been searching for greater rigour in business computing courses: Layton's second stage. Computer science, on the other hand, went briefly through the first stage in the 1950s when electronic computers were still new 'toys', the second stage in the 1960s, and must be considered to be now well into stage three.
In relation to the cyclic model proposed earlier, within at least some of the cycles there is some evidence of Layton's stages also. I would suggest caution in pushing the model too far, but some benefit can be gained by looking within the cycles for this development. Taking for an example the PIT Cycle, it is clear from talking with people like Gerry Maynard that lecturers at the time saw themselves in a light similar to Layton's 'enthusiastic practitioners' bringing a wealth of practical experience, and the courses were certainly utilitarian in nature. In the CAE Cycle, it can be seen that the first stage corresponds to the time an educational need was first established. The lecturers taking business computing courses at this time again fit within the title of 'enthusiastic practitioners' and were, in most cases, not highly qualified academics. Another dynamic is the influx of new lecturers into this cycle, people who had not lectured in the Commonwealth PIT courses. A similar influx occurred at the beginning of the Microcomputer Cycle when the low cost of the technology led to an expansion of courses. This complicates the interpretation of Layton's model which appears to fit well with regard to these new lecturers and less well for those who have taken part in previous cycles. In each case, as the cycle moves through the establishment of an academic infrastructure towards course stabilisation, Layton's second stage unfolds. The cycles to date never get to Layton's third stage, as a new cycle has always commenced before things have time to develop to this extent.

Limitations of the Cyclic Model.

The above interpretation of the cyclic model in relation to Layton's three stages is very tentative and should be treated with some caution. Further work is needed to investigate the usefulness of this comparison. Returning to the model itself though, I suggest that it does offer a useful way of organising the curriculum history of business computing up to this time. The important questions however, are how well it will continue to work into the future, and whether it can be applied to other curriculum areas, particularly those involving the investigation or use of 'developing' technology.

One of the major computer-related curriculum developments occurring at the moment is a de-emphasising of the technology in favour of its uses. With the early computers, users had no choice but to be concerned with their workings and it was not possible to use one at all in the 1950s and early 60s without a knowledge of programming. Advances in technology have meant that this level of knowledge
of the internals of a computer is unnecessary. A consequence of these advances has been in the huge expansion in use of computers in many other curriculum areas and the resulting deep integration of computers into many of these areas is producing significant changes in their curricula.

The extent to which the cyclic model is applicable to an investigation of such changes makes an interesting question. The model was designed to account for changes in curricula relating to a study of computing, not to the use of computers in other curriculum areas. Whether this model, or a modification of it, offers a useful way of investigating these changes bears investigation. I make no claims that it does.

Another question that arises is whether other aspects of curriculum development also have a similar cyclic nature. If other curriculum histories do exhibit cyclic properties it is likely, however, that the cycles would occur more slowly than has been the case with business computing. Further work could also be done here.

With regard to the future of the study of business computing it is dangerous to attempt any predictions. Almost all of the public predictions made concerning the future nature and uses of computer technology made over the last fifty years have turned out to be wrong, some spectacularly so. Nevertheless, as long as computer technology continues to develop as it has, and business continues to need a supply of computing professionals, it is likely that the model will also be of use in describing future cycles.

**Methodological Conclusions.**

After completing this account of the development of the new curriculum area of business computing, I am now in a position to consider the appropriateness of the use of a curriculum history methodology for this purpose. As discussed in Chapter 2, curriculum history is grounded on social constructionism, and much of the published literature relates to primary and secondary, rather than to tertiary curriculum. Perhaps it is for others to judge, but I believe that the use of a methodology requiring the elucidation of life histories, along with some investigation of relevant documents, has been appropriate in bringing some life into an account that could otherwise have been just a dry list of courses and dates. I would suggest that curriculum history certainly does offer, in Goodson’s words,
"an antidote to the depersonalised, ahistorical accounts ... to which we are only too accustomed." (Goodson 1991b: 134).

Although little of the published work in curriculum history has involved an investigation of tertiary curricula, I can see no good reason for this, other than the interests of those who have used this methodology to date. One of the most important differences between secondary and tertiary education is the systemic nature of the one and the more individualistic nature of the other. In 1981 when the year 12 course in computer science was published, every secondary school in Victoria had two choices with regard to this curriculum area at this level: they could adopt and offer the published course, with its external examination, or they could choose not to offer computer science at all. When the Commonwealth PIT courses were devolved to the CAEs in the early 1970s, similar content controls were at first exerted. On the other hand, when tertiary courses such as the Graduate Diploma in Computer Science at La Trobe University were designed, consideration was given to the offerings of other tertiary institutions and the suggestions of the ACS and ACM, but the institutions did not feel bound to follow any of them.

Although this constitutes an important difference in the way that curricula in secondary and tertiary education are handled, I suggest that it does not in any way invalidate the use of curriculum history methodology at this level. I would thus discount any suggestion that curriculum history is suitable only for the study of primary and secondary classrooms, and recommend that others contemplating studies in tertiary education consider using this approach.
Appendix A:
Data on Current Tertiary Courses


<table>
<thead>
<tr>
<th>Occupation</th>
<th>1986</th>
<th>1991</th>
<th>Average annual growth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computing professionals (2707) and data processing managers (1331)</td>
<td>46,600</td>
<td>89,500</td>
<td>14.0%</td>
</tr>
<tr>
<td>Electrical and electronic engineers (2211)</td>
<td>24,000</td>
<td>26,700</td>
<td>2.2%</td>
</tr>
<tr>
<td>Electrical and electronic engineers - associates and technicians (3201)</td>
<td>31,200</td>
<td>32,100</td>
<td>0.5%</td>
</tr>
<tr>
<td>Office equipment and computing services (4315)</td>
<td>7,400</td>
<td>11,700</td>
<td>9.5%</td>
</tr>
<tr>
<td>Data processing machine operators (5201)</td>
<td>75,800</td>
<td>100,200</td>
<td>5.8%</td>
</tr>
</tbody>
</table>


---

26 The data given here has been selected from tables contained in the Information Industry Education and Training Foundation's report: The Supply of People Skilled in Information Technology: A statistical profile 1992. It should be noted that the data is not quoted verbatim, and that some details, considered irrelevant to my study, have been omitted.

27 Australian Standard Classification of Occupations Code (ASCO)

28 Includes the following occupations: 1311 Data Processing Manager, 2707-11 Applications programmer, 2707-13 Systems Programmer, 2707-15 Analyst Programmer, 2707-17 Computer Systems Analyst, 2707-19 Software Engineer, 2707-21 Database Administrator, 2707-23 Computer Scientist, and 2707-25 EDP Auditor.
• **Location of Employment.**
Of the 89,500 persons employed in as Computing professionals in Australia in 1991, 25,200 (28%) are employed in Victoria, and 36,700 (41%) in NSW.


• **Age.**
In 1991, 73% of Computing professionals in Australia were under the age of 40.


• **Educational attainment of persons employed in information technology occupations in Australia.**

<table>
<thead>
<tr>
<th>Occupation</th>
<th>Degree</th>
<th>Certificate or diploma</th>
<th>Trade</th>
<th>No post-school qual.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computing professionals (2707) and data processing managers (1331)</td>
<td>53%</td>
<td>21%</td>
<td>4%</td>
<td>22%</td>
</tr>
<tr>
<td>Electrical and electronic engineers (2211)</td>
<td>62%</td>
<td>20%</td>
<td>10%</td>
<td>8%</td>
</tr>
<tr>
<td>Electrical and electronic engineers - associates and technicians (3201)</td>
<td>4%</td>
<td>41%</td>
<td>34%</td>
<td>21%</td>
</tr>
<tr>
<td>Office equipment and computing services (4315)</td>
<td>19%</td>
<td>36%</td>
<td>15%</td>
<td>30%</td>
</tr>
<tr>
<td>Data processing machine operators (5201)</td>
<td>5%</td>
<td>33%</td>
<td>3%</td>
<td>59%</td>
</tr>
</tbody>
</table>

*Source: Australian Bureau of Statistics, Canberra.*

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
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<tbody>
<tr>
<td>NSW</td>
<td>826</td>
<td>963</td>
<td>917</td>
<td>1060</td>
</tr>
<tr>
<td>Victoria</td>
<td>1176</td>
<td>1010</td>
<td>1272</td>
<td>1436</td>
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<tr>
<td>Queensland</td>
<td>449</td>
<td>439</td>
<td>533</td>
<td>665</td>
</tr>
<tr>
<td>Western Australia</td>
<td>310</td>
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<td>South Australia</td>
<td>169</td>
<td>233</td>
<td>224</td>
<td>205</td>
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<td>Tasmania</td>
<td>119</td>
<td>137</td>
<td>130</td>
<td>191</td>
</tr>
<tr>
<td>ACT</td>
<td>129</td>
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<td>15</td>
<td>19</td>
<td>24</td>
<td>17</td>
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<tr>
<td>Other (unknown)</td>
<td>23</td>
<td></td>
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</tr>
<tr>
<td>Australia</td>
<td>3216</td>
<td>3264</td>
<td>3670</td>
<td>4208</td>
</tr>
<tr>
<td>% growth on previous year</td>
<td>1.5%</td>
<td>12.4%</td>
<td>14.6%</td>
<td></td>
</tr>
</tbody>
</table>

Source: Department of Employment, Education and Training, Canberra.

- Estimated completions, higher education subject specialisations in computing. Type of course by state/territory, 1989, 1990.

<table>
<thead>
<tr>
<th>State / Territory</th>
<th>Higher degree (research)</th>
<th>Higher degree (coursework)</th>
<th>Other</th>
<th>Graduate diploma</th>
<th>Bachelor degree</th>
<th>Associate diploma</th>
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<tbody>
<tr>
<td></td>
<td>'89</td>
<td>'90</td>
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<td>'90</td>
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<td>'90</td>
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<tr>
<td>NSW</td>
<td>9</td>
<td>7</td>
<td>45</td>
<td>62</td>
<td>12</td>
<td></td>
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<tr>
<td>Victoria</td>
<td>21</td>
<td>22</td>
<td>21</td>
<td>42</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Queensland</td>
<td>7</td>
<td>3</td>
<td>9</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Western Australia</td>
<td>2</td>
<td>5</td>
<td>8</td>
<td>1</td>
<td>30</td>
<td>15</td>
</tr>
<tr>
<td>South Australia</td>
<td>1</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tasmania</td>
<td>1</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ACT</td>
<td>2</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Northern Territory</td>
<td>19</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Australia</td>
<td>43</td>
<td>46</td>
<td>56</td>
<td>93</td>
<td>88</td>
<td>19</td>
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</table>

Source: Department of Employment, Education and Training, Canberra.

<table>
<thead>
<tr>
<th>Institution</th>
<th>1989</th>
<th>1990</th>
</tr>
</thead>
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<tr>
<td>Ballarat University College</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Bendigo College of Advanced Education</td>
<td>56</td>
<td>53</td>
</tr>
<tr>
<td>Deakin University</td>
<td>118</td>
<td>141</td>
</tr>
<tr>
<td>Footscray Institute of Technology</td>
<td>53</td>
<td>66</td>
</tr>
<tr>
<td>La Trobe University</td>
<td>81</td>
<td>106</td>
</tr>
<tr>
<td>Melbourne University</td>
<td>127</td>
<td>100</td>
</tr>
<tr>
<td>Monash University</td>
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<td></td>
</tr>
<tr>
<td>- Clayton</td>
<td>122</td>
<td>176</td>
</tr>
<tr>
<td>- Caulfield</td>
<td>314</td>
<td>308</td>
</tr>
<tr>
<td>- Gippsland</td>
<td>23</td>
<td>21</td>
</tr>
<tr>
<td>Phillip Institute of Technology</td>
<td>13</td>
<td>22</td>
</tr>
<tr>
<td>Royal Melbourne Institute of Technology</td>
<td>227</td>
<td>255</td>
</tr>
<tr>
<td>Swinburne Institute of Technology</td>
<td>65</td>
<td>114</td>
</tr>
<tr>
<td>Victoria College</td>
<td>73</td>
<td>52</td>
</tr>
<tr>
<td>Western Institute</td>
<td>0</td>
<td>20</td>
</tr>
</tbody>
</table>

Source: Department of Employment, Education and Training, Canberra.
Appendix B:
Timeline of Business Computing Courses.

1890    Hollerith: punch card tabulating machine.
1920-65  Extensive use made of punch card tabulating machines in business.
1935    First accounting courses at Melbourne and Footscray Technical Colleges.
1940s    First electronic computers: ENIAC (USA), Colossus (UK)
1947    First courses in computing introduced by Pearcey at the University of Sydney, in the Department of Mathematics: Theory of Computation, Computing Practices, Theory of Programming.
1948    CSIRAC built by Trevor Pearcey and Maston Board.
1951    UNIVAC-1, the first computer designed for business applications.
1950s    Organisation and Methods (O&M) becoming very important in Government Departments around the world.
1953    IBM's first computer: IBM 650.
1956    Several university computer systems open to general use.
1956    Courses involving practical training in programming and the application of computers introduced in the universities of Melbourne, Sydney and NSW.
1957    Papers on commercial and administrative applications of computers by J.A. Ovenstone at the second Australian conference on 'Automatic Computing and Data Processing'.
1958    Ovenstone appointed Controller of Automatic Data Processing in the Department of Defence.
1958    First computer used for commercial purposes in Australia, at the Bureau of Census and Statistics.
1959    Melbourne University offers Numerical Methods and Computing (taken by Pearcey) in the BA course in Pure Maths.
1959    First post graduate diploma in computing offered by the University of Sydney: Post graduate Diploma in Numerical Analysis and Automatic Computing.
1959    John Shaw sent overseas on a 'fact finding trip' by the Commonwealth Public Service Board.
1960    Ovenstone begins implementation of the Defence Department's Computing Project. (The PMG project follows shortly.)
1960    Commonwealth Public Service Board: twelve week training courses.
1961    J.M. Bennett appointed Professor of Physics (Computing), University of Sydney.
1961    Royal Melbourne Technical College becomes the Royal Melbourne Institute of Technology (RMIT).
1961    Ramsay Report into the 'Development of Tertiary Education in Victoria'.
1961    Martin Committee into the 'Future of Tertiary Education in Australia' set up.
1961 President Kennedy appoints Robert S. McNamara as US. Secretary of Defense.

1962 Maynard reporting on punched-card machines to the PMG's Department.

1962 Overhey appointed at the University of Queensland as Manager of the Computer Centre, coming from the Weapons Research Establishment.

c1962 Cliff Bellamy takes up a position as Director of the Monash University Computer Centre.

1962 RMIT gets its first computer: an Elliot 803.


c1963 The 'three wise men of computing': Jack White, Westy Williams and Brian O'Donaghue left the Public Service Board to take up academic positions.

1963 A survey, conducted by Bellamy, suggests that business in Victoria believes that it will need only ten programmers in the next ten years.

1963 Tony Adams appointed to the Monash University Computer Centre.


1964 Doug Mills leaves Caulfield Technical School, where he was Head of the Computing Department, to become an Inspector of Technical Schools.

1964 Formal courses introduced at CIT: Diploma of Information Processing, Post Diploma of Electronic Computing, Associate Diploma in Accountancy (Data Processing).

1964 Most educational institutions still teaching about punched-card operated accounting machines. The bulk of ADP training being done outside the universities.

1964 University of Melbourne established a Department of Information Science and offers courses in the Theory of Computation.

1964 Owenstone appointed to chair at Adelaide University.

1964 Jack White appointed as head of the IBDP Department at CIT.

1964 Pearl Levin comes to CIT as a laboratory technician.

1964 Bennett tells Sydney University Appointments Board of the difficulties in finding suitably qualified academic staff.

1964 John Shaw has (unsuccessful) discussions with RMIT on courses.

c1964 University of Queensland offers a Diploma in Automatic Computing.

1965 Maynard joins the Public Service Board.

1965 First intake of the Commonwealth Public Service Board's Programmer-In-Training scheme.

1965 Overhey takes over the Defence Project.


1965 Victorian Institute of Colleges (VIC) set up.

1965 CIT introduces a Certificate in Electronic Data Processing (Operating and Coding).

1965 Academic teaching in computing begins at the University of NSW.

1967 CIT introduces a Diploma of Business Studies (Data Processing).
1967  Peter Juliff joins CIT.
1967  Geoff Dober attends FIT course whilst working at the Department of Supply.
1967  Ralph Treloar and David Wilde appointed to Swinburne, from positions with IBM. Swinburne offers its first course in computing; Diploma in Commerce (Computing).
1968  Caulfield, Footscray and other Technical Colleges become CAEs.
1968  Monash University sets up a Department of Information Science in the Science Faculty.
1968  FIT offers a Diploma in Business Studies (Data Processing).
1969  Gerry Maynard joins the Department of Civil Aviation as a Senior Programmer.
1969  Tony Montgomery appointed to a lecturing position in the new Department of Information Science at Monash.
1969  First computing subject introduced at Monash: Computer Science 3
1969  Brian Betcher appointed to Footscray Institute of Technology. Footscray was then offering the Diploma of Data Processing
1969  Queensland University creates a Department of Computer Science.
1970  Gerry Maynard joins CIT.
1970  Commonwealth Public Service Board decided to hand over the running of FIT courses to Caulfield Institute, Bendigo Institute, Canberra CAE and NSW Institute of Technology.
1970  Business Studies at Queensland University offers a Diploma in Data Processing.
1971  Undergraduate courses in Computer Science at the University of Queensland.
1971  Overhead appointed to Canberra CAE.
1971  c1971  CIT first offers Bachelor of Applied Science (EDP), later renamed the Bachelor of Applied Science (Computing)
1971  First year of operation of the new FIT scheme at the CAEs.
1972  Pearcey joins CIT.
1972  Swinburne introduces a Bachelor of Business (Accounting), containing several computing subjects.
1972  More and more computer courses begin to be offered in the CAEs.
1973  Bendigo Institute of Technology establishes a Department of Information Science.
1973  Geoff Sandy appointed to FIT.
1973  Bachelor of Business (Accounting), with several Data Processing units at Footscray.
1974  Bachelor of Business (Computing) introduced at Swinburne.
La Trobe University introduces *Computer Science 3*

La Trobe takes its first intake in the *Graduate Diploma in Computer Science*.

Watsonia High School (where Arthur Tatnall and Bill Davey were teaching) is one of the first high schools in Australia to obtain an Apple II computer.

Computer Science Department set up at La Trobe.

Tony Adams takes up a contract position as a lecturer at RMIT in the Department of Computer Science.

At RMIT the Department of Mathematics and Computer Science offers a *Bachelor of Applied Science (Computer Science)*, and the Department of Administrative Studies offers a *Graduate Diploma in Computer Studies*.

Peter Julius leaves CIT to take up the position as HOD at Prahran CAE.

Chisholm still using punched-cards for students to enter their programs.

FIT purchases its first Apple II computers.

CIT introduces the *Graduate Diploma in Information Technology* as the first 'higher' diploma for those with an existing qualification in computing.

Swinburne introduces a *Graduate Diploma in Management Systems*.

Chisholm uses terminals for students to enter their programs.

Computer Science offered for the first time as a HSC (year 12) subject.

Melbourne University Department of Computer Science introduces two 'token' business subjects (COBOL programming and Systems Analysis) into its course.

At RMIT the Department of Computer Science is set up with Tony Montgomery as its head.

Swinburne purchases its first IBM PC: imported direct from the US.

*Graduate Diploma in Commercial Data Processing* at FIT.

*BBus (Information Management & Communications)* commences at FIT.

An Information Technology Division is created at RMIT, headed by Tony Montgomery.

Widespread adoption of microcomputers in tertiary institutions.

Computing courses running at Bendigo Institute of Technology: *Bachelor of Business (Data Processing), Bachelor of Applied Science (Computing), Graduate Diploma in Electronic Computing, Associate Diploma in Information Processing*.

CIT introduces a *Master of Applied Science (Computing)*.

Associate Diploma in Applied Science (Computing) at FIT.

RMIT creates a Department of Business Information Systems, headed by Tony Adams. The department offers the degree: *Bachelor of Business (Business Information Systems)*.

Swinburne offers a *Graduate Diploma of Business (Information Technology)* and a *Bachelor of Information Technology*.

One thousand four hundred students study computing related subjects in tertiary institutions in Victoria.
Appendix C: 
Glossary of acronyms and terms.

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accounting machine</td>
<td>Mechanical device based on the use of punched-cards, for the performance of the arithmetic operations used in accounting.</td>
</tr>
<tr>
<td>ACM</td>
<td>Association for Computing Machinery (USA).</td>
</tr>
<tr>
<td>ACS</td>
<td>Australian Computer Society.</td>
</tr>
<tr>
<td>A.D.P</td>
<td>Automatic Data Processing.</td>
</tr>
<tr>
<td>ALGOL</td>
<td>Computer programming language.</td>
</tr>
<tr>
<td>AIITA</td>
<td>Australian Information Industry's Association.</td>
</tr>
<tr>
<td>Analytical Engine</td>
<td>A mechanical computational device of Charles Babbage.</td>
</tr>
<tr>
<td>Apple II</td>
<td>A popular microcomputer of the late 1970s and 1980s.</td>
</tr>
<tr>
<td>ASA</td>
<td>Australian Society of Accountants. (This is the former name of the ASCPA.)</td>
</tr>
<tr>
<td>ASCPA</td>
<td>Australian Society of Certified Practicing Accountants.</td>
</tr>
<tr>
<td>Batch operation</td>
<td>Use of a computer in such a way that all the execution is performed at one time.</td>
</tr>
<tr>
<td>BASIC</td>
<td>Beginners all Purpose Symbolic Instruction Code - a programming language designed to instruct students in computer programming, but now in widespread use.</td>
</tr>
<tr>
<td>B.Bus.</td>
<td>Bachelor of Business degree.</td>
</tr>
<tr>
<td>BCS</td>
<td>British Computer Society.</td>
</tr>
<tr>
<td>Burroughs B5500</td>
<td>Mainframe computer manufactured by Burroughs.</td>
</tr>
<tr>
<td>Burroughs B3500</td>
<td>Mainframe computer manufactured by Burroughs.</td>
</tr>
<tr>
<td>CAE</td>
<td>College of Advanced Education.</td>
</tr>
<tr>
<td>CAI</td>
<td>Computer-assisted instruction.</td>
</tr>
<tr>
<td>CDC 3200</td>
<td>A Control Data Corporation computer.</td>
</tr>
<tr>
<td>CDC 160A</td>
<td>A Control Data Corporation computer.</td>
</tr>
<tr>
<td>CIT</td>
<td>Caulfield Institute of Technology, Chisholm Institute of Technology and now Monash University (Caulfield).</td>
</tr>
<tr>
<td>COBOL</td>
<td>A computer programming language used primarily for commercial transaction programming. The name is an acronym from: COnmon Business Oriented Language.</td>
</tr>
<tr>
<td><strong>CODASYL</strong></td>
<td>An acronym from Conference On DAta SYstem Languages, an organisation which devised important database and computing language standards.</td>
</tr>
<tr>
<td><strong>Colossus</strong></td>
<td>Built during World War II in Britain as a special purpose computer adapted towards Boolean logic and designed for the task of breaking enemy codes.</td>
</tr>
<tr>
<td><strong>Commodore C64</strong></td>
<td>Low price home computer of the 1980s.</td>
</tr>
<tr>
<td><strong>CPSB</strong></td>
<td>Commonwealth Public Service Board.</td>
</tr>
<tr>
<td><strong>CS</strong></td>
<td>Computer Science.</td>
</tr>
<tr>
<td><strong>CSE</strong></td>
<td>Computer Systems Engineering.</td>
</tr>
<tr>
<td><strong>CSIRAC</strong></td>
<td>Australia's first computer, (also known as CSIR MkI) built by the CSIRO.</td>
</tr>
<tr>
<td><strong>CSIR MkI</strong></td>
<td>see CSIRAC.</td>
</tr>
<tr>
<td><strong>CSIRO</strong></td>
<td>Commonwealth Scientific and Industrial Research Organisation.</td>
</tr>
<tr>
<td><strong>DEC 11/03</strong></td>
<td>Digital Equipment Corporation minicomputer.</td>
</tr>
<tr>
<td><strong>Difference Engine</strong></td>
<td>A mechanical computational device of Charles Babbage.</td>
</tr>
<tr>
<td><strong>DNA</strong></td>
<td>Deoxyribonucleic acid.</td>
</tr>
<tr>
<td><strong>DP</strong></td>
<td>Data Processing.</td>
</tr>
<tr>
<td><strong>DPMA</strong></td>
<td>Data Processing Management Association. (USA)</td>
</tr>
<tr>
<td><strong>E.D.P.</strong></td>
<td>Electronic Data Processing.</td>
</tr>
<tr>
<td><strong>EDSAC II</strong></td>
<td>An early computer.</td>
</tr>
<tr>
<td><strong>Elliot 803</strong></td>
<td>Computer used in the early 1960s.</td>
</tr>
<tr>
<td><strong>ENIAC</strong></td>
<td>Generally recognised as the world's first stored program electronic computer, built in the USA in the mid 1940s.</td>
</tr>
<tr>
<td><strong>Facom</strong></td>
<td>Computer company, now called Fujitsu. Maker of IBM look-alike mainframe computers.</td>
</tr>
<tr>
<td><strong>Ferranti Sirius</strong></td>
<td>Type of computer.</td>
</tr>
<tr>
<td><strong>FIT</strong></td>
<td>Footscray Institute of Technology.</td>
</tr>
<tr>
<td><strong>FORTRAN</strong></td>
<td>A programming language used primarily for scientific and mathematical applications. The name come from FORMula TRAnslatation.</td>
</tr>
<tr>
<td><strong>Fractal geometry</strong></td>
<td>Patterns of constantly repeated shapes relating to chaos theory, and discovered by Benoit Mandlebrot.</td>
</tr>
<tr>
<td><strong>GE System 4</strong></td>
<td>General Electric mainframe computer (IBM look-alike).</td>
</tr>
<tr>
<td><strong>Harvard Mark-I</strong></td>
<td>A pre-World War II electronic calculating machine.</td>
</tr>
<tr>
<td><strong>HCC</strong></td>
<td>Health Computing Services. (Monash University)</td>
</tr>
<tr>
<td><strong>HSC</strong></td>
<td>Victorian Higher School Certificate - year 12 certificate awarded in Victoria before the VCE.</td>
</tr>
<tr>
<td>Term</td>
<td>Description</td>
</tr>
<tr>
<td>----------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>HP 2100a</td>
<td>Hewlett Packard computer.</td>
</tr>
<tr>
<td>HP 9100</td>
<td>Hewlett Packard programmable calculator.</td>
</tr>
<tr>
<td>Honeywell DPS6</td>
<td>Mini computer.</td>
</tr>
<tr>
<td>IBM</td>
<td>International Business Machines Corporation.</td>
</tr>
<tr>
<td>IBM 650</td>
<td>IBM's first electronic digital computer suitable for business applications.</td>
</tr>
<tr>
<td>IBM 3090</td>
<td>IBM mainframe computer.</td>
</tr>
<tr>
<td>IBM PC</td>
<td>IBM Personal Computer.</td>
</tr>
<tr>
<td>IBM 1400</td>
<td>IBM mainframe computer.</td>
</tr>
<tr>
<td>IBM DB2</td>
<td>IBM Database system.</td>
</tr>
<tr>
<td>IBM ESE</td>
<td>IBM Expert system.</td>
</tr>
<tr>
<td>I.C.L. 4-50</td>
<td>ICL mainframe computer.</td>
</tr>
<tr>
<td>ICL 900, 901a</td>
<td>ICL mainframe computers.</td>
</tr>
<tr>
<td>IE(Aust)</td>
<td>Institution of Engineers (Australia)</td>
</tr>
<tr>
<td>IEEE-CS</td>
<td>Computer Society of the institution of Electrical and Electronic Engineers.</td>
</tr>
<tr>
<td>IIETF</td>
<td>Information Industries Education and Training Foundation.</td>
</tr>
<tr>
<td>IS</td>
<td>Information Systems.</td>
</tr>
<tr>
<td>IT</td>
<td>Information Technology.</td>
</tr>
<tr>
<td>MONECS</td>
<td>A computer system based on the use of punch cards and mark sense cards, and designed by Monash University.</td>
</tr>
<tr>
<td>Motorola 6800</td>
<td>Assembly language for the Motorola 6800 chip.</td>
</tr>
<tr>
<td>MS-DOS</td>
<td>An important microcomputer operating system.</td>
</tr>
<tr>
<td>MS/OS</td>
<td>A Control Data Corporation operating system.</td>
</tr>
<tr>
<td>MVS</td>
<td>An IBM proprietary operating system.</td>
</tr>
<tr>
<td>NACCS</td>
<td>The Commonwealth Schools Commission's National Advisory Committee on Computers in Schools.</td>
</tr>
<tr>
<td>NCC</td>
<td>National Computing Centre of Great Britain.</td>
</tr>
<tr>
<td>O&amp;M</td>
<td>Organisation and Methods.</td>
</tr>
<tr>
<td>On-line operation</td>
<td>Using a computer from a terminal so that instructions are executed (almost) at once, rather than being saved up and all run together as in batch mode.</td>
</tr>
<tr>
<td>Pascal</td>
<td>Computer programming language.</td>
</tr>
<tr>
<td>PC</td>
<td>Personal Computer. The term is usually applied to micro computers which are IBM compatible.</td>
</tr>
<tr>
<td>PDP-8</td>
<td>Digital Equipment Corporation minicomputer.</td>
</tr>
<tr>
<td>PDP-11 assembler</td>
<td>One of Digital Equipment Corporation's assembly languages.</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Description</td>
</tr>
<tr>
<td>--------------</td>
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</tr>
<tr>
<td>PICK</td>
<td>A minicomputer operating system.</td>
</tr>
<tr>
<td>PIT</td>
<td>The Commonwealth Government's <em>Programmer-In-Training</em> scheme.</td>
</tr>
<tr>
<td>PLAN</td>
<td>An assembly language.</td>
</tr>
<tr>
<td>PLATO</td>
<td>Computer Assisted Learning system developed by Control Data.</td>
</tr>
<tr>
<td>PLI</td>
<td>A programming language developed by IBM.</td>
</tr>
<tr>
<td>PMG</td>
<td>Post Master General's Department.</td>
</tr>
<tr>
<td>RJE</td>
<td>Remote Job Entry: inputting a computer program at one location, for execution at another.</td>
</tr>
<tr>
<td>RMIT</td>
<td>Royal Melbourne Institute of Technology.</td>
</tr>
<tr>
<td>RUCCUS</td>
<td>Research Unit on Classroom Learning and Computer Use in Schools (University of Western Ontario, Canada).</td>
</tr>
<tr>
<td>SCOPE</td>
<td>A Control Data Corporation operating system.</td>
</tr>
<tr>
<td>SILLIAC</td>
<td>Early computer system.</td>
</tr>
<tr>
<td>Systems Analysis</td>
<td>The application of general systems techniques to the analysis of business information processing needs.</td>
</tr>
<tr>
<td>Tabulating Machine</td>
<td>Mechanical punch-card operated device, originally designed by Herman Hollerith. It was used for counting and simple arithmetical operations on the data stored on punched-cards.</td>
</tr>
<tr>
<td>TAFE</td>
<td>College of Technical and Further Education.</td>
</tr>
<tr>
<td>Tandy</td>
<td>Early microcomputer of the late 1970s.</td>
</tr>
<tr>
<td>TOTAL</td>
<td>A fourth generation database access system.</td>
</tr>
<tr>
<td>Uniplex Plus</td>
<td>A minicomputer software package running under UNIX.</td>
</tr>
<tr>
<td>UNIVAC-1</td>
<td>The first electronic computer available for business applications.</td>
</tr>
<tr>
<td>UNIX</td>
<td>An important minicomputer operating system.</td>
</tr>
<tr>
<td>UTECOM</td>
<td>Early computer system.</td>
</tr>
<tr>
<td>VAX systems</td>
<td>Digital Equipment Corporation minicomputers.</td>
</tr>
<tr>
<td>VDU</td>
<td>Visual Display Unit.</td>
</tr>
<tr>
<td>VIC</td>
<td>Victorian Institute of Colleges.</td>
</tr>
<tr>
<td>VCE</td>
<td>Victorian Certificate of Education.</td>
</tr>
</tbody>
</table>
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